A WORD ABOUT THIS GUIDE

My entire career has been devoted to the field of radio frequency gluing. As a machinery manufacture, my point of view has naturally been focused on RF equipment. My colleagues in adhesives and in the woodworking companies have their own particular points of view.

The woodworker's view is the one I strive to see: and it is the one most likely to benefit from some additional insight about RF gluing. My objective in publishing this booklet has been to create a handy reference tool that will cover all the basic facts about radio frequency gluing for those of you who make things from wood.

I invite you to spend a few minutes brushing up on your RF knowledge. I promise that you will come away with the facts and insights you need to add an extra dimension to your professional development.

Steve Rosenquist

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WHY RF GLUING CONTINUES TO GROW

Radio Frequency Gluing is by far the most efficient manufacturing technique ever developed for gluing wood. The curved (molded) plywood industry is almost totally dependent on RF and many other wood products are manufactured more efficiently because of it. As prime timber resources grow scarcer, RF gluing systems allow woodworkers worldwide to utilize smaller dimension lumber in glued-up panels. Consider the advantages of RF:

*Lowered Labor Costs - one worker with an RF press can easily out produce several workers with other types of equipment.

*Short Curing Times – RF joints cure in minutes, not hours or days.

*Reduced Floorspace Needs – compact RF presses require less floorspace than most other types.

*Better Quality Joints – RF glue lines are more uniformly cured than those made with other heat-activated presses.

*Excellent Adhesive Selection - choose from a wide range of adhesives for various applications, including crosslinked polyvinyl acetates.

*Energy Efficiency – RF presses use less energy than any other type of heated press. In applications where the glue line is perpendicular to the platens, only the glue line is heated; and in an RF press, energy is used only during load processing.

*Comfortable Work Environment – RF presses generate very little heat compared to other types of heated presses.

The History of Radio Frequency Gluing

As 19th century woodworkers became aware of the many advantages of plywood, demand for it began to grow. Early plywood manufacturers were faced with long waiting periods as glue bonds cured in presses at room temperature. Hot pressing and new thermosetting glues became more widespread in the 1880s; but since wood is a good insulator, large amounts of energy were required to heat the plywood mass.

In 1891, medical researchers discovered that high frequency radio waves could be used to heat the internal tissues of their patients. By 1910 the technique was standardized and came to be known as “diathermy”. An enterprising woodworker must have reasoned that diathermy would also heat the internal layers in wood – and radio frequency gluing was born.

By the 1930s, advances in electronics allowed manufacturers to begin making the first RF plywood. RF generators were bulky and expensive. Electronic components of that time were very large and it took a small room to hold a commercial RF generator.

World War II Changed Everything

World War II accelerated the evolution of the plywood industry. The strength, stability and light weight of plywood made it a vital component for many applications especially aircraft. Cost was no longer the most important factor. The war also stimulated advances in electronics, and soon the massive banks of water-cooled vacuum tubes were reduced to compact, relatively trouble-free units.

Manufacturing flat plywood in large, steam heated steel presses had been economically feasible before the advent of RF gluing, but molded or curved plywood was rarely used because of the prohibitive cost of the molds. RF technology permitted the use of inexpensive wooden molds faced with their copper or aluminum plates (electrodes). Suddenly it became possible to make plywood parts in a wide variety of shapes and configurations at low cost.

As electronics continue to improve, and with the advent of inexpensive wooden molds, the demand for RF-glued plywood began to skyrocket. An entire genre of furniture with slim lines, light auditorium seating, curved components in casegoods, and the use of molded plywood parts in previously untapped fields like the home elcctronics and automotive markets all began important contributors to the development of RF gluing.

Along Came Television

The rise of television in the 1950s, for example, was in part made possible by the availability of RF glued panel-on-frame cabinets. Plywood is a good electrical insulator, and it protected American families from the high voltages inherent in TV circuits.

Edge gluing soon became the next goal of wood workers using RF technology. For the first time, wet glue lines were placed in contact with the electrodes. It was found that some glues were poor electrical conductors and others were too good, overheating rapidly. Glue manufacturers soon solved these problems by adjusting the electrical properties of their glues.

RF Continues To Develop

Improvements in adhesives and electronics continue to add momentum to advancements in RF technology, but most of the most recent gains have been achieved by the machinery companies. Batch gluing presses are still popular, and delivering better quality than ever, but the new "continuous flow" automated machines are pushing production efficiency higher and higher. As "lumber woodworkers, high-quality and efficient RF machines are becoming a standard tool in most plants.

How Does RF Gluing Work?

The physical principles which govern radio frequency gluing are easy to understand when you think of matter (in this case, wood or glue) as being composed of molecules. High frequency radio waves moving through a good electrical insulator excite the molecules and cause molecular friction. Friction generates heat.

The amount of heat generated in a given load depends on the power of the RF generator, the wood and its moisture content, and the conductivity of the glue. To accommodate these variables, RF generators are adjustable. Each load to be heated has its own electrical properties. Even in particular load these properties are not fixed: they change as the load goes through the cure cycle.

The role of the RF generator is to convert the 60 cycle power supplied by electric utilities to millions of cycles (MHz), then send it through the load via the positive electrode.

Radio frequency generators have three main components:

(1) the power supply
(2) the oscillator circuit
(3) the matching network

The power supply contains a transformer to elevate the voltage to several thousand volts, and a rectifier to convert alternating current to direct current.

The rectified direct current then feeds into the oscillator circuit which converts it back to alternating current at radio frequencies.

As noted above, the loads to be heated possess differing electrical properties. Large capacitance loads require lower frequencies, while small loads require higher frequencies. The voltage between the electrodes decreases as the frequency increases.

The role of the matching network is to regulate the output of the generator to match the electrical properties of the load being processed. Various gauges and variable controls allow the operator to activate the matching network and control the output of the generator.

By adapting these basic principles to virtually any gluing application, RF machinery manufacturers have made it possible for wood workers to utilize RF gluing techniques in a wide range of systems.

A Radio Frequency Primer

Alternating Current (A.C.): a flow of electricity which reaches a certain value in one direction, then reverses itself and reaches the same value in an opposite direction. U.S. household current cycles 60 times each second.

Radio wave: a high frequency electromagnetic wave generated by alternating current.

Radio Frequencies: waves of electromagnetic energy cycling between 10,000 and 3,000,000,000,000 (3 trillion) times per second.

Woodworking Radio Frequencies: radio waves which cycle between 6 to 30 million times per second (6 to 30 MHz).

Microwaves: radio waves (1000 to 3000,000 MHz) used in cooking and communications which cycle many times faster than woodworking radio waves.

Megahertz (MHz): a term which means 1 million cycles per second ("mega" is a metric prefix for 1 million, "hertz" is a German term meaning cycles per second).

Kilohertz (KHz): 1 thousand cycles per second.

Gigahertz (GHz): 1 billion cycles per second.

Three RF Systems

The characteristics of three basic types of wood/adhesive loads encountered in woodworking have been responsible for the evolution of three separate RF heating systems:

1. Perpendicular Heating or "mass heating" where the load most often consists of layers of wood veneer with intervening glue lines. (Example: edge gluing.)

2. Parallel Heating-where the load consists of side-by-side strips of wood and the wet glue lines are in contact with the electrodes. (Example: edge gluing.)

3. Stray Field Heating- where the electrodes are on the same side of the glue Line. (Examples: panel-on-frame construction, RF hand gun applications.)

Perpendicular Heating-Where RF Got Started

The name “Perpendicular Heating” was adopted because the RF current passing between the electrodes is perpendicular to the glue lines. It is the original application for RF gluing, and is a direct descendant of the steam-heated or hot water heated presses once used to speed up the cure cycle in plywood plants.

Electrodes

Entire load is heated.

In perpendicular heating the entire mass of the load is heated, and thus this system requires more power and longer cure cycles than parallel heating cure cycles. Thermosetting adhesives generally cure most efficiently when the load temperature is taken to 200 F.

Operators of Perpendicular RF systems should be aware of several potential problems:

a. The outer piles of a load, particularly if they are thin veneers, may not bond properly because heat is being carried away by the electrodes. This is because RF electrodes do not heat themselves during a cure cycle, and because they are made from either copper or aluminum, both excellent heat conductors. Sometimes they act as a heat sink, draining heat away from the outer layers. Overcome this problem by insulating the load. Place and additional layer or two of veneer, without glue, between the electrode and the load.

b. Poorly cured edges may occur when thick load bundles are heated between electrodes with approximately the same surface area as the load, or when drafts cool the edges.

   Overcome this problem with electrodes that overhang the load by a distance greater than the distance between electrodes. This will create a stray field zone around the edges of the load that will assure uniform heating of the entire bundle.

c. Shapes with sharp curves or bends may rebound even after the glues have cured. This occurs because hot, moist wood will attempt to return to its original shape. Overcome this problem by keeping the load under pressure after the RF power has been turned off. This will allow the load to cool a little. It will also allow any steam pockets that might have formed in moist areas to dissipate. This ideal duration for this cooling period under pressure is at least one half of the cur cycle time.

Calculating Curing Times In Perpendicular Heating

To heat a load (wood and glue) to the recommended 200 F requires a certain quantity of heat which can be measured in BTUs (British Thermal Units). The formula for calculating BTUs required is:

Weight of Load X Specific Heat of Load X Temperature Increase = BTUs Required

(‘Specific Heat” is a value which varies somewhat with species and moisture content, but for most operations assume it to be 0.45).

Then use the output of your RF generator to find the duration of the cure cycle using the following formula:

BTUz Required / 56 / Generator Output in Kilowatts=Curing Time in Minutes

Example: When the load weighs 24 pounds, has been stored at 66 F and is to be hated to 200 F with a 20 kilowatt generator.

24x.45x134=1447 BTUs
1447/56/20=1.29 minutes or 1 minute 17 seconds Cure Time.

Parallel Heating-Where The Glue Line Conducts The Current

Parallel Heating is so named because the RF current runs parallel to the glue lines. In this system, the electrical characteristics of the glue become very important. The stock should be machined to a uniform thickness to allow the wet glue lines to contact the electrodes.

This RF system is different from perpendicular heating because it encourages selective heating of the glue lines. Electricity always follows the path of least resistance. In parallel heating the load becomes a series of alternating insulators (wood) and conductors (glue). The glue lines conduct the current directly form the positive to the negative electrode.

Electrodes Glue lines conduct current and are selectively heated.

In the process, the glue lines become selectively heated while the wood remains at or near its starting temperature. Thus, this system requires less overall energy than perpendicular heating.

When stock used in parallel gluing varies in thickness, air gaps occur between the electrodes and the glue lines. This can result in uneven heating. Increasing the cure cycle can help overcome this problem.

The matching faces of stock to be glued should be machined flat to avoid another parallel gluing problem. Poorly matched edges can result in glue lines of uneven thickness. Increasing pressure to force the stock faces together can lead to “starved” joints where too much of the glue is forced out. A glue line that is thicker than the others becomes a line of least resistance for RF current. Even within a single glue line, some sections may be thicker than others and will subsequently draw a greater share of the power. Accurate machining of stock and careful regulation of RF presses make parallel gluing a highly efficient process which produces panels of the highest quality.

Calculating Curing Times In Parallel Heating

In parallel heating the conductivity of the glue line(s) is the primary determinant in curing time calculations. It is not practical to measure conductivity, so a general formula has been developed (NOTE: For hardwoods divide the glue line area by 100, for soft woods by 125):

Sq. In. of Glue Line / 100 / Generator Output in Kilowatts = Curing Time in Minutes

Example:

An oak panel with 10 glue lines. The stock is 5/4’, the panel length is 36’. The generator output is 6 kilowatts.

10 x 1.25 x 36 =450 sq. in. of glue line
450 / 100 /6 = 0.75 minutes of 45 seconds Cure Time.

A second and very practical method involves readings from the “Plate Current” meter on your machine. Begin by noting the maximum reading at the start of the cure cycle. As the conductivity of the glue lines decreases, this reading will fall, then level off. Time this process then multiply by 1.5 to obtain an approximate curing time.

Example:

Plate current takes 28 seconds to level off.

28 x 1.5 = 42

The approximate cure cycle is this 42 seconds.

RF “Stray Field” Gluing

In contrast to the perpendicular and parallel gluing systems, in tray field gluing both electrodes are on the same side of the glue line. The electrodes are usually in the form of narrow strips arranged in a grid. A ‘field” of RF current develops and as loads pass into the field, the current finds the glue lines and heats them.

Electrodes “Field” of RF current envelops load.

RF ‘handguns” employ the stray field system to deliver concentrated RF power to small areas. Rather than heating entire continuous glue lines, handguns are better adapted for spot gluing.

Cure times for stray field RF heating systems are best calculated by following the manufacturer’s guidelines and through on-site testing.

Selecting RF Equipment

As with most industrial equipment purchases, it is important to select a machine with enough capacity-but not so much that the initial equipment cost is greater than necessary. Most RF equipment manufacturers can tailor their machines to match your expected needs.

Some factors to consider are:

*Type of gluing process: edge gluing, face gluing, rim banding, molded plywood, etc.

*Maximum expected hourly production needs.

*Maximum product dimensions.

*Available floorspace and layout of system support equipment.

Answers to questions like these will make it possible to specify a machine with the right size generator, press and operational characteristics.

Batch or Continuous Feed?

There are two basic types of radio frequency machines for parallel gluing: “batch feed” and “continuous feed”.

Batch machines process materials in single units. The operator first applies glue to the stock then aligns the pieces to be joined in an infeed system. It is then pushed or conveyed into the press Pressure is applied, the RF current is activated and the glue is cured.

Batch machines are typically designed with a heavy fence on one side and a bank of pneumatic or hydraulic cylinders on the opposing side. The electrodes are brought into contact with the top and bottom on the load.

Edge glued panels, heavy face-glued squares and lumber banded cores can all be produced efficiently on batch machines. They are also adaptable to many special applications. It is this adaptability which makes batch machines particularly suitable for many industrial systems.

Continuous feed machines are designed to efficiently produce large volumes of panel product. High production is achieved by mechanical indexing of the stock. Wood strips are fed continuously into the curing area. Stock is typically limited to a maximum of 2' in thickness and 100" in length. Excellent results are also achieved in applications such as rim banding of lumber bands onto an MDF core.

Preparing Stock

Creating a strong joint involves proper handling of the stock and preparation of its surfaces to receive the adhesive. In this section these variables will be discussed in detail.

Some Species Glue Up Better Than Others

Under favorable conditions, glue rarely penetrates more than a few thousandths of an inch into the surface of the wood. Different species vary in their microscopic cell structure, thus affecting adhesive penetration. Penetration is most dependent on porosity-a measure of the size and spacing of the spaces between the fibers. Oil content and mineral composition are also important variables. Finally, it is moisture content-the one physical characteristic that woodworkers can easily measure and control-which affects the ability of the adhesive to achieve a good bond. A moisture content of 6% to 8% is optimal in RF processes. (See Gluability Groupings of Commonly Used Domestic Wood Chart on next page.)

Handle With Care

Even when you are working with a species with excellent gluing characteristics, handling is critical. Improper storage can lead to warpage. Moist conditions and poor ventilation can increase moisture content. Frozen wood is difficult to bond and requires more time and energy to achieve a good bond. Dusty surfaces will not bond well, and even pencil marks resist good glue penetration.

Good Preparation Means Good Joints

Many of the limitations of even the most difficult species can e overcome with good preparation. To achieve the goal of straight, flat, and smooth mating surfaces, follow the three rules of good stock preparation:

Rule 1 – Act quickly. Don't give the stock time to warp or twist.

Prepare stock for gluing within minutes or hours, certainly no longer than 24 hours, before placing it in the press. The forces that cause a perfectly machined surface to "go out of true" will be

Gluability Groupings of Commonly Used Domestic Wood (a)

Group 1 – BOND EASILY (b)

U.S. Hardwoods

Alder	Chestnut, American
Aspen	Magnolia
Basswood	Willow, black
Cottonwood	

Imported Woods

Balsa
Cativo
Courbaril
Datema©
Hura
Purpleheart
Robte

U.S. Softwoods

Cedar, incense	Redcedar, western
	Redwood
Fir: White	Spruce, Sitka
Grand	
Noble	
Pacific	
Pine: Eastern White	
Western White	

Group 2 – BOND WELL (d)

U.S, Hardwoods

Butternut
Elm: American

Rock
Hackberry
Maple, soft
Sweetgum
Sycamore
Tupelo
Walnut, black
Yellow-poplar

U.S. Softwoods
Douglas-fir
Larch, western(e)
Pine: Sugar
Ponderosa
Red Cedar,eastern

Imported Woods
Afromosia
Andiroba
Angelique
Avodire
Banak
Iroko
Jarrah
Limba
Mahogany:
African
True
Meranti (lauan):
White
Light red
Yellow
Obeche
Okoume
Opepe
Peroba rosa
Sapele
Spanish-cedar
Sucupira
Wallaba

Group 3 – BOND SATISFACTORILY (f)

U.S. Hardwoods
Ash, White
Beech, American

Birch: Sweet
Yellow
Cherry
Hickory: Pecan
True
Madrone
Maple,hard
Oak: Red©
White©

U.S. Softwoods
Alaska-cedar
Port-Orford-cedar
Pine,southern

Imported Woods
Angelin
Azobe
Benge
Bubinga
Karri
Meranti (lauan), dark red
Pau marfim
Parana-pine
Pine:
Carribbean
Radiata
Ramin

GROUP 4 – BOND WITH DIFFICULTY (g)
U.S. Hardwoods
Osage-orange
Persimmon

Imported Woods
Belata
Balau
Greenheart
Kaneelhart
Kapur
Keruing
Lapacho
Lignumvitae
Rosewood
Teak

A From Wood Handbook, 1987 Edition. Table 9-1 (with the species incense Cedar added to Group 1) U.S. Forest Service, USDA, Washington, DC. Although this table is a historical significance, it is recognized that more Modern adhesives might lead to different species groupings in regard to difficulty of bonding. The user is referred to 5.2.

B Bond very easily with adhesives of a wide range of properties and under a Wide range of bonding conditions.

C Difficult to bond with phenol-formaldehyde adhesive.

D Bond well with a fairly wide range of adhesives under a moderately wide Range of bonding conditions.

E Wood from burl logs with high extractive content are difficult to bond.

F Bond satisfactorily with good quality adhesives under well-controlled bonding Conditions.

G Satisfactory results require careful selection of adhesives and very close Control of bonding conditions; may require special surface treatment.

Overcome or equalized as one surface is joined to another.

Rule 2 – Use the best quality tools.

Rip saws are the most common and probably the most satisfactory tool for cutting a joint surface. Saw tooth marks and torn surface fibers are both enemies of strong glue joints. The truest rip saw joints are produced when:

a. The stock has a freshly planed "reference" face.
b. The blade is kept sharp and the teeth are properly dressed.
c. The feed rate is low enough to avoid vibration and blade stress.
d. The arbor bearings and chain guides are in top condition.

Abrasive-prepared surfaces can be excellent for gluing. Avoid torn wood fibers by using belts finer than 50 grit.

Moulders have a tendency to polish wood surfaces, particularly on the high density species. Keep the knives extra sharp. By applying adhesive to both mating surfaces, it is possible to achieve better penetration of the pores and thus overcome some of the polishing tendencies of knife-cut surfaces.

Finally, with any type of stock and in any type of RF process, consistent and uniform pressure must be maintained throughout the joint. Ask your manufacturer for specific recommendations about how much pressure to use, and make sure that the pressure shoes are positioned and sized correctly.

Rule 3 – Use good RF "common sense".

In edge gluing remember that all stock should be sized to the same thickness to allow uniform contact of the electrodes with the glue joints. Most species should be less than 3 ½" wide to help equalize internal stresses in the finished panel, and when using random width stock, place the wide boards at the edges of the panel.

Molded plywood gluing is sometimes affected when the veneers are not uniform in thickness. Spliced veneers are particularly susceptible, when pieces in the same ply are of different thicknesses.

Panel on frame gluing is most effective when frame elements are uniform in dimension. In this process it is particularly important that stock be machined just prior to gluing, and that moisture content be closely monitored.

Putting On The Pressure

Putting On The Pressure

After the stock is prepared and the adhesive has been applied, and before the RF current is turned on, the correct pressure must be applied. Here are some practical guidelines:

Pressure Required

Low Density Wood……………………………….100-150 psi.
Medium Density Wood……………………………150-200 psi.
High Density Wood……………………………….200-250 psi.

Gauge Settings

(Batch machines with hydraulic or pneumatic cylinders.)

a. When the desired PSI is known:

$$\frac{\text{Sq. In. Stock Per Cylinder} \times \text{PSI}}{\text{Cylinder Area}} = \text{Gauge Setting}$$

Example:

When 2 ½ " bore cylinders are spaced 6" apart, stock is 2" thick; and desired pressure is 180 psi.

$$\frac{(2 \times 6) \times 180}{4.9} = 441$$

b. When the gauge setting must be translated into PSI:

$$\frac{\text{Cylinder Area X Gauge Setting}}{\text{Sq. In. Stock Per Cylinder}} = \text{PSI}$$

Example:

$$\frac{4.9 \times 441}{12} = 180$$

Calculating Cylinder Area

(Radius) 2 x 3.14(n) = Cylinder Area

* STEVE CHECK THIS WITH BOOK.

Example: (2 ½” cylinder)

(1.25”)2 X 3.14 = 4.9 sq. in.

R.F. Adhesives

The overwhelming majority of adhesives used in radio frequency gluing are cured by chemical reaction, not simply by driving water from the glue. A catalyst added to the glue formula causes polymerizing-a process in which molecules link up into long chains. We call this “setting” or “curing”. The heat generated by radio frequency waves greatly accelerates the chemical reaction. As a rule of thumb, each 10 degrees C increase in temperature will double the speed of the reaction.

Choosing the right adhesive for a particular application is, like choosing equipment and preparing the stock, crucial to the success of the product. A compromise here can jeopardize the entire manufacturing process. It is best to consult a reputable adhesives expert and make adhesive buying decisions by considering the following factors:

1. the type of bond you plan to make
2. the mixing and handling dynamics of the adhesive
3. adhesive shelf life
4. adhesive curing time (pot life)
5. ease of cleanup
6. cost factors

There are five primary types of adhesives used in RF gluing. The brief discussion of each type given below describes the main features of each:

Cross-Linking Polyvinyl Acetates

Most edge/face-gluing (parallel heating) systems use these adhesives. Their long pot life (approximately 24 hours) make them both cost-effective and user-friendly. The catalyst is an acid salt which acts as a conductor for the RF energy. A strong, water-resistant bond with light colored glue lines is the result. A separate class of catalysts is available which yields waterproof joints. These adhesives are thermoplastic-that is, they are soft when hot. After removal from the RF press, curing progresses as the glue joints cool to room temperature. Thermoplasticity can be advantageous since over-stressed joints will usually open at the press rather than at some future time. Open joints can then be resurfaced and reglued.

Urea Formaldehydes

Once the dominant RF adhesives, these are still popular in many applications, especially in molded plywood (perpendicular heating). They can be purchased in either liquid or powdered form. Common table salt (NaCl) frequently serves as the conductor. They produce a water-resistant bond with no thermoplasticity, and thus tight curved shapes have little tendency to rebound as pressure is removed from still-hot forms. Heating does, however; thin the viscosity of these glues, and this can be a problem when gluing under high pressure. To avoid starved joints it is sometimes necessary to add fine hardwood floor to increase viscosity and hold the glue in the joint. Melamine resins are sometimes included in these glues to increase water resistance.

Resorcinol-Phenol-Formaldehydes

These are the strongest, most durable wood glues. They are primarily used in exterior and marine applications. These glues often require tailored formulation since conductivity is harder to regulate.

Aliphatics ("Yellow" Glues)

These glues are non-catalyzed and cure by loss of water. They have good thermoplastic and solvent resistance. The long cure times make them generally less efficient in RF applications, and the cured glue lines are not water resistant.

Polyvinyl Acetates ("White" Glues)

Sometimes used in RF applications, these adhesives are so extremely thermoplastic that their usefulness is limited.

Gluing Problem Guide

PROBLEM____

1. Panel falls apart. Glue appears to be wet.

POSSIBLE CAUSE

A. Power setting too low for amount of glue to be cured.
B. Curing time cycle too short.
C. Improper glue mixture or outdated glue.

RECOMMENDATIONS

Increase power to obtain full load. If unable to do so, increase the curing time cycle. Check the glue formula to that recommended by the glue manufacturer.

PROBLEM____

2. Panel falls apart. Glue appears to be cured.

POSSIBLE CAUSE

- A. Excessive moisture content preventing adhesion.
- B. Insufficient edge pressure due to:
  1. Under-size filler boards
  2. Low edge pressure
  3. High top pressure
- C. Improper glue mixture or storage.

RECOMMENDATIONS

Check the moisture content. It should be from 6% to 10%. The glue could be partially cured prior to use. Check the formula and storage methods. The filler boards should be wide enough so as not to allow more than 3” space with top down prior to the edge being energized.

PROBLEM____

3. Panel comes apart but glue, although cured, seems to have been too thin.

POSSIBLE CAUSE

- A. Starved joint due to:
  1. High edge pressure
  2. Glue mixture too thin
  3. Glue spread too thin
- B. Insufficient moisture content of the stock (common during the Winter).
- C. Excessive moisture, causing the glue to be forced out by steam pressure.

RECOMMENDATIONS

Reduce the edge pressure on soft woods. With hard woods, increase the glue application if needed. Check the moisture content of the stock.

PROBLEM____

4. Panel shows open joints at one or both ends.

POSSIBLE CAUSE

- A. Poor stock preparation or poor positioning with the press.
- B. Lack of glue on the stock ends.
- C. Insufficient power or time.
- D. Too much time between machining and gluing.

RECOMMENDATIONS

Check on the stock preparation and its lineality within the press. If needed, relocate the stock to obtain uniform pressure on its full length. (Refer to recommendation for #1.) Stock should be glued as soon after machining as possible.

PROBLEM____

5. Panel shows evidence of steaming or burning.

POSSIBLE CAUSE

A. Excessive power, RF voltage could be too high at work.
B. Curing time too long.
C. A reduced number of glue lines.
D. Edge pressure too high.
E. Improper glue mixture.
F. Wrong type of glue.
G. Mineral content of wood.
H. Improper glue spread
I. High moisture content of wood.
J. Irregularities on wood surface.

RECOMMENDATIONS

Check the curing cycle length. Soft woods tend to burn when edge pressure is too high. If the number of glue lines has been reduced, reduce the power accordingly. Check for proper glue mixture and storage and assure that the proper type of glue is being used.

PROBLEM____

6. Panels show evidence of crushing along joints, although cured.

POSSIBLE CAUSE

A. Excessive edge pressure.
B. Power level too high.
C. Moisture content too high.

RECOMMENDATIONS

Reduce edge pressure and/or the power level accordingly. The moisture content should be within tolerance. The problem may be occurring due to occasional pieces of stock with high moisture content.

PROBLEM____

7. Panels show evidence of crushing at the corners next to the shoes.

POSSIBLE CAUSE

Entire edge pressure being applied to only a small area.

RECOMMENDATIONS

Isolate the questionable shoe or rearrange the stock so as to distribute the pressure more evenly over the entire length of the panel.

PROBLEM____

8. Glue setting up too quickly (short pot life)

POSSIBLE CAUSE

A. Glue is at too high a temperature for proper storage and use.
B. Improper glue mixture.

RECOMMENDATIONS

Increase or add cooling to glue pot. Check the formula as to that suggested by the glue representative. At no time do we change a glue formula without consulting the glue representative. As a last resort, the addition of a SMALL amount of ammonia to ureas will increase the pot life. BE CAUTIOUS in this practice as the curing time in the press will also be increased. Pot life is not a problem with emulsion adhesives such as KOR-LOK formulations.

PROBLEM____

9. Incomplete curing of panels.

POSSIBLE CAUSE

A. Insufficient power and/or time.
B. High moisture content of stock being processed.
C. Plate voltage too low.
D. Oscillator tube is at the end of its life.

RECOMMENDATIONS

Increase power to obtain full load. If unable to do so, increase the curing time cycle. Check the glue formula to that recommended by the glue manufacturer.