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Federation of Safety Glass

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# Skilled Man Power Training Manual for Glass Processing Industry

Draft Version -1.0 | May 2011

## FOREWORD

Idea of this instruction cum training manual was born last year during one of our FOSG meetings. During that meeting among a number of topics we discussed, one thing that remained in our minds was about standardization in our process. A book or manual which could be used as reference by freshers as well as experienced ones. A book that could help some one to understand the safety glass processing in a better way. A book that could train a new employee and lift them immediately to the quality standards of FOSG.

With the suggestion & guidance of Mr. Sharanjit Singh, Executive Member - the guiding force behind FOSG-, I initiated the process of bringing out this manual. With the help of our internal team to coordinate and collate the data on various operations and functions, this process was kick started. Our team interviewed technical people from each section/ department to get insight into their operations and standards. They also clicked photographs of all processes and machinery to make this manual an easy-to-understand one.

As per our plan, we were able to bring out the first draft of the Skilled Man Power Training Manual within our deadline. I am pleased to unveil this in the AGM of FOSG held in 1st May 2011, in Goa. We are very well aware of the scope of improvement this draft version offers and are working towards this. I request your valuable comments, suggestions and criticism to improve this manual, so that we develop this into the most reliable and useful one in our industry. After making the final version in English, we will bring out the same in all major regional languages to make it easy to understand for every one.

I sincerely thank each and every individual involved in the process of bringing out this manual. Particularly I must appreciate and thank Miss. Chitra - my personal secretary - whose hard work has played an important role in this.

Thank You.

Sincerely.

Balaji Konidala

*Vice Chairman, FOSG, South Region  
Managing Director, Balaji Safety Glass (India) Pvt. Ltd.*

## INTRODUCTION

**G**lass is a non-crystalline solid material, which are typically brittle, and often optically transparent. Glass - a modern building material that can be transparent, colored, heat and sound insulation. It is quickly mounted. However, glass has the ability to break. Modern technology allows the glass to reinforce the seven times and treated in a way that it will not injure people around.

The safety glass can be tempered, laminated, or tempered and laminated. Glass treatment depends on the purpose of usage. The safe manufacture of glass using a variety of technologies. They differ in their technical solutions, productivity, quality glass processing. However, safety glass production dependent on the basic principles. If the glass is installed in high buildings or roofs, it sure is tempered and laminated. This method is the safest. If glass is used in the interior (partition walls, doors, furniture), it can be tempered, or just laminated. Safe use of glass in architecture, interior design, furniture become increasingly popular because of transparency, lightness, an impression space. Glass is increasingly being used as weights and mechanical crush-resistant material. The increasing use of glass for safe use requires tighter cooperation between manufacturers of glass, glass processors, constructors, designers, installers, in order to create a safe environment for humans.

### **Main Types of Glass**

Today, flat glass comes in many highly specialised forms intended for different products and applications. Flat glass produced by way of the float process is often further processed (see below) to give it certain qualities or specificities. In this way, the industry can meet the various requirements and needs of the construction, automotive and solar-energy industries :

- Annealed glass
- Coated glass
- Mirrored glass
- Patterned glass
- Extra-Clear glass
- Tinted Glass

### **Annealed Glass**

Annealed glass is the basic flat glass product that is the first result of the float process. It is the common glass that tends to break into large, jagged shards. It is used in some end products -- often in double-glazed windows, for example. It is also the starting material that is turned into more advanced products through further processing such as laminating, toughening, coating, etc.

### **Coated**

Surface coatings can be applied to glass to modify its appearance and give it many of the advanced characteristics and functions available in today's flat glass products, such as low maintenance, special reflection/transmission/absorption properties, scratch resistance, corrosion resistance, etc.

Coatings are usually applied by controlled exposure of the glass surface to vapours, which bind to the glass forming a permanent coating. The coating process can be applied while the glass is still in the float line with the glass still warm, producing what is known as "hard-coated" glass.

Alternatively, in the "off-line" or "vacuum" coating process, the vapour is applied to the cold glass surface in a vacuum vessel.

### **Mirrored Glass**

To produce mirrored glass, a metal coating is applied to one side of the glass. The coating is generally made of silver, aluminium, gold or chrome. For simple mirrored glass, a fully reflective metal coating is applied and then sealed with a protective layer. To produce "one-way" mirrors, a much thinner metal coating is used, with no additional sealing or otherwise opaque layer.

Mirrored glass is gaining a more prominent place in architecture, for important functional reasons as well as for the aesthetic effect.

### **Patterned**

Patterned glass is flat glass whose surfaces display a regular pattern. The most common method for producing patterned glass is to pass heated glass (usually just after it exits the furnace where it is made) between rollers whose surfaces contain the negative relief of the desired pattern(s).

Patterned glass is mostly used in internal decoration and internal architecture. Today, it is typically used for functional reasons, where light but not transparency is desired, and the patterns are accordingly subtle. However, it has also at times been fashionable as a design feature in itself, in such cases often displaying more prominent patterns.

### **Extra-Clear glass**

Extra-clear glass is not the result of processing of annealed glass but instead a specific type of melted glass. Extra-clear glass differs from other types of glass by its basic raw material composition. In particular, this glass is made with a very low iron-content in order to minimize its sun reflection properties. It therefore lets as much light as possible through the glass. It is most particularly of use for solar-energy applications where it is important that the glass cover lets light through to reach the thermal tubes or photovoltaic cells. Anti-reflective properties can be further increased by applying a special coating on the low-iron glass. It can also be used in windows or facades as it offers excellent clarity, which allows occupants to appreciate true colours and to enjoy unimpaired views.

### **Tinted Glass**

Tinted glass refers to any glass that has been treated with materials such as a film or coating, which reduces the transmission of light through it. Glass can be tinted with various types of coating, which block and/or reflect different amounts and types of light, according to the needs and preferences of the consumer.

Tinted glass is also used in commercial buildings to keep the inside cooler, has the added benefit of giving the outside of the building a more uniform aesthetically pleasing appearance. Depending on the creative use of different colours of tinted glass, the building can also take on a unique and interesting appearance while being insulated from the sun at the same time.

## USE OF SAFETY GLASS

**S**afety glass is widely used in: - Buildings (windows, walls, balconies, frameless) - Interior (partitions, decorative kitchen wall, glass tiles) - Furniture (tables, shelves, chairs, table tops) - Household appliances (oven, refrigerator shelves, a microwave oven) - Other areas (greenhouses, conservatories, car windshields) Safety glass is prepared in accordance with the specific dimensions of a given object according to architects, designers and constructors generated drawings. Most popular are the AUTOCAD drawings, dressed in a computer program which files are compatible with the equipment needed to prepare for glass applications. In today's world is not enough to use one type of material products (buildings, interiors, furniture, etc.). Often required to coordinate the glass with wood, concrete, metal, plastic or other materials. In general, the requirements for buildings, appearance, security, integrity, durability, easy maintenance, heat, moisture and sound insulation. Safety glass has to meet all these requirements.

Depending on safety glass to be used for different purpose there are those glass mounting options:

### **-System with the Framework-**

Frameless System Frame system or line-lock mode (linearly supported glazing) is the oldest and simplest systems. Safety glass used in frame system first of all simply processed – seamed and tempered. The most common in architecture glass frames used to manufacture glass as insulating glass unit. There are only different ways of insulating glass unit composition: plain glass with tempered glass, laminated glass with plain glass, plain glass with laminated tempered glass. In this system to ensure the safety of glass design as well as to keep lifetime of the construction the impact made by seaming quality of the glass, which guarantees freedom of movement of the glass unit, also, testing of glass unit in the heat test oven.

**Frameless system** or a way to capture spot (point fixed glazing) is a new system. There is no linear sections, covering the perimeter of the glass. Spot sensing method based on point to specific holders. This is a big challenge for designers, manufacturers and installers. Of course a number of spot-fixing supports (Fig. 3), which vary in diameter, intermediate composition, mounting bracket against the glass, area and form holes in the glass holder record.

In summary, the glass structures of security and reliability of quality can only be achieved through professional work and quality of professional care of any safety glass production stage:

Projecting;  
Team work;  
Production of components: fixing, glass, keeping constructions;  
Production and assembling.

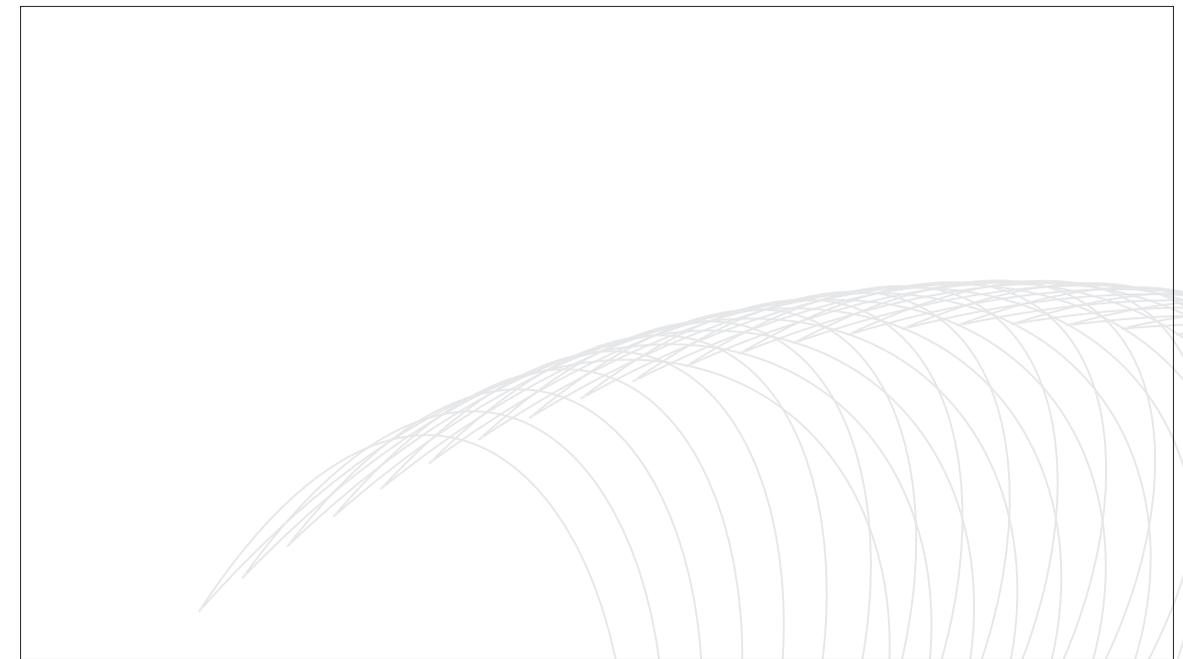
The main criteria for daily architects, designers, glass manufacturers, investors, installers - a quality of each work permanent quality system in all the glass processing chain, high-quality raw material usage. All that it allows for proper, safe and reliable use of shatterproof, laminated, tempered-laminated glass.

### **Glass Applications**

Automotive: OEM & replacement parts

Interior Design: shower enclosure, bathscreen, desk partition, kitchen cabinet, bedroom furniture, computer furniture, cooker hoods and backsplash

Architectural: balustrade, windows, façade, office partition, glass barriers and overhead canopy



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# HANDLING & OTHER TIPS

01

## 01A. GLASS HANDLING PROCEDURE

- The following are the general glass handling guidelines to be followed strictly.
- Do not touch the glass on the side with coating, especially on Low – E glass.
- Do not touch the glass without gloves.
- While unloading glass onto table, wooden edges should be clean.
- While stacking the glass on trolley, make sure they do not touch each other.
- Do not slide one glass over another.
- Stack glass in the ascending order.
- Use glass separator between the glasses.
- Use the specified separator for Low E glass.
- Make sure the glass is secured using ratchet on trolley, before pushing the trolley.

## 01B. DOCUMENTATION PROCEDURE

- All activities and procedures must be documented to ensure efficiency and quality. The following documentation procedures must be followed.
- Record all production data in the log book.
- Prepare reports
- While receiving glass, issue acknowledgment.
- While handing over glass, make sure acknowledgment is received.
- Every trolley with glass must have the right Work Order Number and Quality detail.
- In case of a machine breakdown, a breakdown slip must be raised and handed over to maintenance department. Acknowledgment slip for this must be collected immediately.
- In case of glass breakage or rejection of glass due to quality, an Internal Work Order must be raised and forwarded to Cutting Department. This must be done after obtaining signature from Quality Maintenance and Production Department.
- In case of any doubt or clarification, contact Production Head.

## DUTIES AND RESPONSIBILITIES 02

### 02A. PLANT MANAGER

**P**lant Manager (PM) will plan and control the overall operations of the plant. He/she must ensure optimum production levels at desired quality levels within the targeted budgets.

### 02B. PLANT SUPERVISOR

**S**upervisor will assign duties and tasks to subordinates. He/she must explain how these duties/ tasks are to be done. It is supervisor's responsibility to explain the subordinates on how the performance of these duties are measured and evaluated. Supervisors must create a supportive working and professional relationship with the subordinates. He/she must provide a motivational work environment to get the best out of everyone. Supervisor must facilitate constant development of each employee by providing opportunities for advancement and future growth in the organization.

### 02C. QUALITY MANAGER

**Q**uality Manager / Assistant Manager will report directly to production manager. He/ She must check and ensure the quality plans set by the company. Periodical calibration of monitoring and measuring devices will be his/her responsibility. QM/ AM will have to co-ordinate with the customers during customer inspections/ visits. In case of non-conformance, QM/AM must initiate corrective actions to correct them. He/ she must monitor the rejection levels at different stages and must inform the Production Manager to stop the production if any non-conformance occur.

### 02D. QUALITY INSPECTOR

**Q**uality Inspector (QI) will report to Quality Manager. He/ she must carry out inspections to maintain the status at incoming, in-process and final stage of glass processing. QI must give approval on incoming, regular production and final inspection components. He/she must follow relevant documents like inspection plans, control plans etc to ensure quality.

QI must raise non-conformance in case of inward and in-process deviations in standards. He/she must maintain quality system related documents and records pertaining to quality department. QI must monitor and check all instruments for zero error.

### 02E. MAINTENANCE MANAGER

**M**aintenance Manager (MM) must ensure minimum level of inventory for necessary spares. Routine, preventive and predictive maintenance schedule charts for all machines and equipments must be prepared and maintained by MM. He/she must identify areas for constant improvement and must implement all appropriate actions. MM must attend to any breakdowns in any machines. He/she must analyze the intensity of faults to judge whether it is a minor or major issue, where an external service provider is required. MM should disband the machine as per the manual to fix the faults.

### 02F. OPERATOR

**O**perator must prepare the tools/ machines and settings for manufacturing operations. He/she must handle the pre-requirement guidelines of the respective process as per the manual. The operator must follow the procedure guidelines/rules explained in this manual for the respective machine/process. It is the operator's duty to keep his/her work area clean as per the manual. He/she must follow the safety standards of the factory. In case of any doubt, The operator must clarify it with the Head of Department.

## EMPLOYEE RIGHTS

RIGHT to a safe and healthy workplace  
 RIGHT to have questions regarding safety and health addressed  
 RIGHT to receive and have access to all information regarding workplace hazards  
 RIGHT to refuse to perform an unsafe act

## EMPLOYEE RESPONSIBILITIES

RESPONSIBILITY to comply with all policies and procedures  
 RESPONSIBILITY to report all unsafe acts and conditions  
 RESPONSIBILITY to be a team member - to assist others in compliance  
 RESPONSIBILITY to offer suggestions that may have a positive impact on safety

## TIPS FOR BETTER WORKING ENVIRONMENT

### DOCUMENTATION

- Training Records
- Maintenance Records
- Job Descriptions
- Job Safety Requirements

Good record keeping provides data to evaluate incident problems and safety program effectiveness, identify high incident rate areas, create interest in safety, enable the company to concentrate efforts on the more serious problems and measure effectiveness of countermeasures against hazards and unsafe practices.

### TEAM WORK !!

Be a Team,  
 Work Together  
 Watch out for each other

## STAFF MEETINGS

One of the regular features of training activities in an Industrial Training Institute should be instructional/supervisory staff meetings at different levels to take stock of the progress made in the training programme, to spell out and discuss difficulties encountered at different levels in implementing the programme and to chalk out the future plan of action.

The principal may hold the meeting of the supervisory and instructional staff, depending upon the size of the institute, at a regular interval, at least once in a month. Proper record should be kept of the minutes of these monthly meetings and of the decisions arrived at and actions taken. These records should be submitted to the inspecting officers.

## HEALTH AND SAFETY PROCEDURES

- Management policy
- Employee selection/placement
- Employee orientation/training
- Educational activities
- Employee meetings
- Inspections
- Accident reporting & investigating
- Program review
- Safety responsibilities & analysis
- Training
- Record keeping
-

## 02G. PEP TALK-DISCIPLINE

The following rules must be strictly followed to ensure quality work and safety in the factory.

- Employees must not indulge in cross talking.
- Do not leave the working area/ machinery without permission.
- Use dustbins for dumping waste and make sure the dust bins are available in the place allotted for them.
- Keep the entire work area clean.
- Do not leave any unwanted things on the factory.
- Use safety equipment and gear without fail.
- Do not use personal mobiles and other gadgets inside the factory.

## 02H. SECRET OF GOOD PREPROCESSING METHODS

The secret of a good preprocessing line can be attributed to the following.

- Only the glass which needs to be processed must be cut.
- Do not keep on transferring glass between trolleys. This will lead to chipping of glass.
- Online processing of glass is always preferable. If this is not possible, make sure there is less transfer of glass between machineries.
- Less movement of glass is advised.
- Do not overload the trolley.
- After preparing any machine, use one sample glass to try the quality and finishing of the process. If the quality is fine, proceed with the actual job.
- After the process is completed, inspection of the processed glass must be done, to verify that quality is as per the FOSG standards.

## UNLOADING OF GLASS

03

### 03A. INTRODUCTION

The first process in the safety glass processing line is unloading the glass arrived at the factory. Normal the glass is unloaded using mechanised cranes. Unloading process is very important as the chances of damaging the glass is high. Follow the rules and procedures to ensure smooth unloading of glass.



## 03B. UNLOADING PROCESS

- Check whether the strap holding the glass is in good condition.
- Make sure it is strapped tightly to the A frame or the truck body.
- Check and verify the glass arrived is same as the PO issued to the supplier.
- First, cut the steel strap using scissor.
- A crowbar can be used to loosen the nails in the case.
- After this, open the box carefully without touching the glass.
- Check the glass for any damages. In case of damages, inform the respective supplier. The supplier will send a surveyor to estimate the damages and replace them.
- Raw glasses arrived in Case Packing / Naked Packing must be unloaded with the help of Belt Sling and Cranes.
- While unloading the glass from truck, make sure the it is unloaded from both sides of the truck to maintain the balance of the truck.
- As far as possible unload the glass nearer to the activity area to avoid unwanted and wasteful movements.
- Keep glasses in a slanting position of 70 degree to the bottom, with adequate support.



- Make sure the glasses are stacked together in the same size and thickness; avoid stacking odd sized glasses together.
- Suction cup must be vacuum cleaned everyday and should be dry before handling any glass.
- Opening of glass cases must be restricted. A new glass case must be opened only after issuing all glasses in the already opened case.
- Issue glasses only against authorized Store Requisition Slip.
- Maintain and update the Stock Register as and when the glasses are received or issued.

## STOCKING IN WAREHOUSE

04

### 04A. INTRODUCTION



- Glass must be stored only in a closed and dry environment.
- Glass should not be stored near doors. If the doors/walkways are near by and cannot be avoided, make sure the exposed area of the crate must be covered with plastic sheet.
- Once the case is opened, the glass must be consumed as per the manufacturer's instructions.
- Warehouse in charge must keep a track on the amount of available open cases.
- He/she is responsible for First in First Out basis. (FIFO).
- Glass must be checked and verified against the Master Sample before issuing for cutting.

## 04B. ISSUING THE GLASS

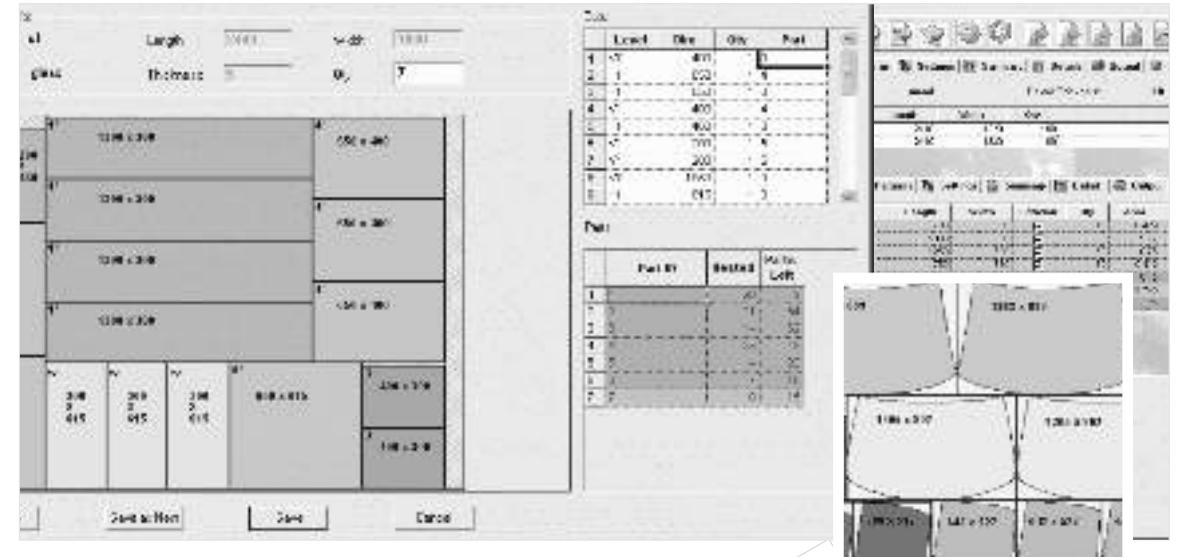
- Issue the glasses only against authorized cutting requisition slip.
- The glass Stores person should check the availability of the glass as per the work orders.
- While issuing the glass to the cutting department, optimization report along with the requisition slip has to be verified by the glass store person.
- For CNC Cutting Machine directly cases can be loaded to the cutting table.
- Loose sheets should be issued to the manual cutting table.
- Visual inspection has to be done before issuing the glass.
- If different sizes of glasses are available in one thickness check with the cutting department which sizes has to be issue first.



## OPTIMIZATION

05

**O**ptimization is the process of planning the production of glass to avoid wastage and achieve best efficiency or optimum usage of glass and resources. Follow the guideline strictly for optimization process.



- Small quantity or Single piece glass requirements are issued from usable cut size stock first.
- If there is no balance glass for this, then this will be provided from the sheet.
- Before optimization process, study the order copy and drawing for better understanding.
- Check for any special / additional information or instructions in the work order.
- Check the stock report before optimization process and keep the list always while entering the sheet size in the software.
- Do not allow any unauthorized personnel in the optimization room.
- Concentrate while entering the sizes in the optimization software.
- After optimization, re-check and verify the sizes, thickness, colour and sheet size.
- Optimization wastage must be decided as per company policy.
- Different jobs of same description (same type) of glass can be clubbed together for best optimization result.
- Maintain reports and records of all job orders and optimization copies.
- In case of any doubt about the order, template or drawing, ask your HOD immediately for confirmation.
- While issuing for cutting, take signature for receipt from cutter/ operator to avoid double cutting.

# CUTTING

# 06

## 06A. MANUAL CUTTING

### 06A(I). INTRODUCTION

**M**anual cutting is a process where the glass is cut manually using hands.



- Vacuum cups must be cleaned during the start of every shift.
- Make sure the vacuum cups are free from dust or glass chips.
- If the glass is broken during lifting, the vacuum cup must be cleaned immediately.
- After cleaning, check whether the pneumatic pressure is uniform or not.
- Clean cutting table bed using an air gun before placing the glass sheet. This will avoid any scratches on the glass.
- Before cutting the glass sheet, make sure it is free of defects and has no inner cracks.
- If you have any doubt about the order, template or drawing, clarify with your HOD.
- Before cutting make sure that the sheet size matches with the optimization sheet size and final output dimensions as per customer requirement are attached.
- Check the condition of cutter point.
- Cut one sample glass to confirm the sharpness and cutting quality of the cutter.
- After cutting the sheet, remaining piece must be kept for further requirements (300 mm x 500 mm).
- Records must be maintained.
- Extra care must be taken while cutting large sizes.
- Take signature from the next process in charge about quantity and quality confirmation.
- Check and ensure that the glass is lifted uniformly by vacuum cup.
- Cutting table must be free from glass chips.
- If the glass is broken during cutting or snapping, the glass chips must be removed immediately.
- Do not use broom to clean the cutting table.
- Always ensure the collect table is far off from the cutting table.
- Do not throw the cut glass beneath the cutting table.



## 06B. CNC CUTTING

### 06B(I). INTRODUCTION

**C**NC Cutting is the process of computerised cutting of glass using a CNC machine. This method of cutting is faster and more accurate compared to other types of cutting.



#### 06B(i). Auto Loader Cleaning

- Clean the entire body of the machine.
- All hose cables must be checked.
- Clean all rollers and suction cups.



#### 06B(ii). Cutting Table Cleaning

- Clean the cutting head with cotton cloth.
- The entire cutting table must be cleaned using an AIR gun.
- Transfer belt must be cleaned using air gun
- Clean the side guide rails.

#### 06B(iii). Breakout Table Cleaning

- Clean the entire breakout table using air gun.
- Clean the blower nozzle using air.
- Clean wooden area to remove any glass particles.
- Clean wire cable and entire machine.

#### 06B(iv). Pre Start Machine Requirement

Follow the guidelines to prepare the machine prior to starting it. Check and ensure the following are available.

1. Power supply
2. Compressed Air
3. Cutting Fluid
4. Cutting Wheels

#### 06B(v). Glass Cutting Planning

- Review the balance work order from last shift.
- Take new work order and optimization from PPC department.
- Coordinate with the glass warehouse for issue of glass as per production plan.

#### 06B(vi). Glass Cutting Precaution

- Read and follow the work order.
- Check the thickness and colour of the glass as per work order.
- All internal work orders must be executed immediately.
- Coated glass must be cut only on the coating side.

## 06B(vii). Pre Startup Procedure

- Align the glass sheet on cutting table as per machine specification.
- Check oil level in the tank, and fill up to the marked level if required.
- Check the cutting wheel and if required change as per the glass thickness.
- Check and maintain air pressure as per machine standards.
- Check emergency switch and if found active, release and reset it.

## 06B(viii). Startup Procedure

- Switch on the main power from the distribution panel.
- Switch on the supply to controller.
- Switch on the UPS supply.
- Switch on the CPU and Insert the software security key.
- Check the lubrication oil level. Ensure that the air pressure is maintained at 7.0 to 8.0 bar.
- Ensure that the suction cup is clean and dry.
- Make sure the path of the loader movement is free before sending the loader.
- Ensure that the emergency stop is released.
- Switch ON the control panel and PLC.
- Check for the Home Position of X, Y and Z axis. Check the condition of the cutting wheel.
- Bring automatic loader/ cutting head to home position.
- Ensure the surrounding areas are dust free.
- Transfer the optimization program to CNS machine. Before pressing the confirmation button, ensure that the required glasses are in the desired racks and loader has picked single glass.
- Switch the translation button to bring glass to cutting table.
- Before cutting, make sure the glass sheet is defect free.
- Check and ensure that lubrication knob is opened.
- Before cutting, ensure that the sheet size matches with optimization sheet size and final output dimensions are as per the customer requirement.
- Do a trial run before the first cutting.
- After cutting, check the dimensions of the cut glasses and make sure they match with loaded optimization.
- Keep aside the usable balance after cutting.



## 06B(ix). Glass Breaking Procedure

### 06B(ix a). Glass Breaking

- After completing the cutting operations, press ready to transfer button to transfer glass from cutting table to breakout table.
- Raise wooden bar by pressing foot switch to break glass.
- Apply equal pressure on the glass by hand while breaking.

### 06B(ix b). Snapping

- Place the cut line of the glass on the center of the wooden bar for breaking.
- After cutting, glass is separated in to 2 or more pieces through snapping process.

#### 06B(ix b1). Using breaker bar in the cutting table.

##### **Dos and Don'ts of snapping**

- It is ideal to use a breaker bar for snapping.
- The scored glass must be on top of the breaker bar.
- When the bar is raised, glass snaps.
- Do not stop the compressor air during snapping, as it helps the glass to float over the table.

#### 06B(ix b2). Using plier

##### **Dos and Don'ts of snapping**

- Use a plier in case the width to be cut is less than 75 mm.
- Never use a plier as a pinching tool as it can break the glass into small pieces.
- Separated glass must be loaded to marked trolleys as per thickness and job order number.
- Individual cut glasses must be marked and given the job identification number.
- Glasses must be secured to trolley before handing over to the next department



## GRINDING

07

### 07A. INTRODUCTION

After cutting the glass edges will have sharp edges. To give the edges a smooth finish and polished look, they are passed through grinding process. There are 4 types of grinding.

### 07B. BELT GRINDING

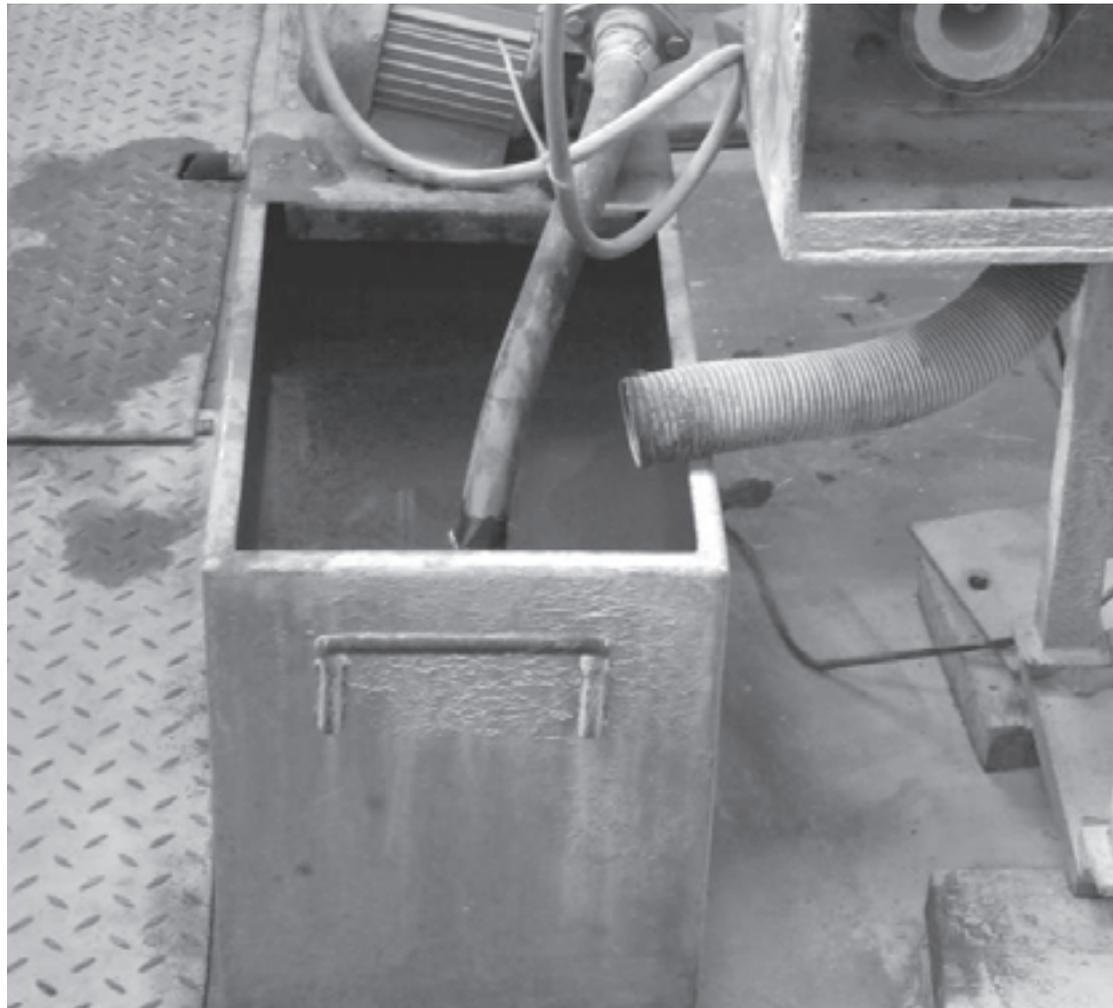
#### 07B(I). Introduction

**B**elt grinding is one of the quickest processes to remove sharp edges of glass. This is used when polishing is not required on the edges. It is done by using a machine with belts fixed in a scissor form – where 2 belts are running in clock and anti clock wise directions.



## 07B(ii). Procedure

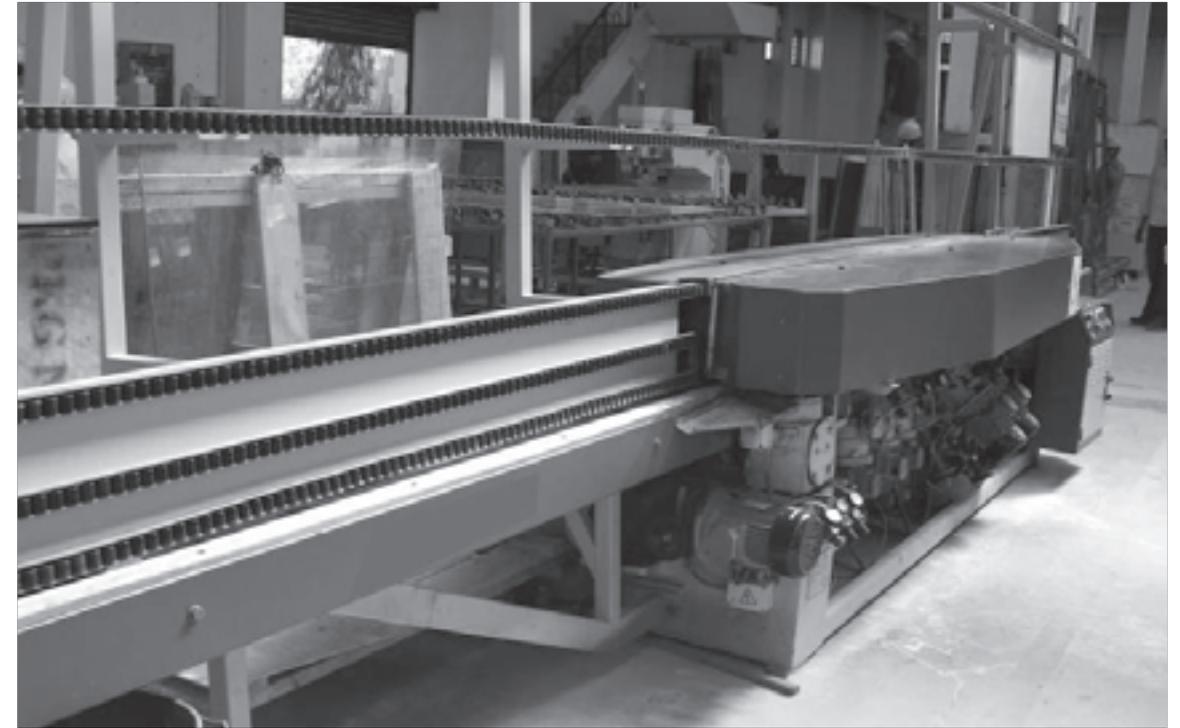
- Clean the grinding area.
- Check the tightness of the belt. If required change the belt.
- The glass that needs to be ground must be placed on the machine table.
- Switch on the motor.
- In belt grinding, water is used as coolant or lubricant.
- Operator must move the glass manually on to the belts, which are running in opposite directions.
- This gives the edges of the glass a finished look.
- The belt grinding is the cheapest form of grinding and faster than single or double edger grinding process.



## 07C. SINGLE EDGER

### 07C(i). Introduction

In single edger grinding, glass is loaded vertically and one side is ground at a time.



### 07C(ii). Cleaning Procedure

1. Clean water tank and fill fresh water
2. Clean pneumatic pipes and motor case
3. Clean entry and exit conveyer
4. Clean conveyer belt

### 07C(iii). Pre Start Requirement

1. Calibrated Measuring Tape
2. Spacers between glasses must be maintained to avoid scratches & chipping while handling or moving the glass from one department to the other.

### 07C(iv). Glass Grinding Planning

1. Review the balance work order from last shift
2. Receive new work order from PPC department

### 07C(v).Glass Grinding Precaution

1. Read and follow the work order
2. Check the glass thickness and colour against the work

### 07C(vi).Pre Startup Procedure

1. Check the compressed air pressure and power supply
2. Check the water level and quality. If the water is contaminated, replace with fresh water.
3. Tank needs to be cleaned to remove the grinding dust, depending on the work volume.
4. Check whether all emergency switches are active. If active, release and reset
5. Check all drive movements.

DRAFT

### 07C(vii).StartUp Procedure

1. Switch on the power from the main distribution panel
2. Align all grinding wheels to zero point
3. Enter the glass thickness - ( For CNC/PLC Machines only)
4. Enter the distance - ( For CNC/PLC Machines only)
5. Glass must be loaded vertically
6. Start all motors
7. Start all drives(forward)
8. Start all water pumps
9. Check the quality, wear & tear of the grinding & polishing wheels
10. If they are worn out to the maximum permissible level, replace

### 07C(viii).StartUp Procedure

1. Operator must check the wheel quality at the beginning of the shift.
2. He/she must insist on having all glasses supplied in uniform or near to size for processing. Operator must check the tapering on all glasses.
3. Use the machine speed and feed as specified by the machine manufacturer.
4. Use the same diameter and grit of the wheel as specified by machine manufacturer.



## 07D. DOUBLE EDGER

### 07D(i). Introduction

**D**ouble edger machine can grind 2 sides of the glass at the same time. This is a horizontal machine, in which glass is fed horizontally. The right and left side of the glass will be ground simultaneously in this machine.



### 07D(ii). Cleaning Procedure

1. Clean water tank and fill fresh water
2. Clean pneumatic pipes and motor case
3. Clean entry and exit conveyor
4. Clean transfer table

### 07D(iii). Required Tool Preparation

1. Use Calibrated Measuring Tape
2. Spacers between glasses must be maintained to avoid scratches & chipping while handling or moving the glass from one department to another.

### 07D(iv). Glass Grinding Planning

1. Review balance work order from last shift
2. Receive new work order from PPC department

### 07D(v). Glass Grinding Precaution

1. Read and follow the work order
2. Check the glass thickness and colour against work order



### 07D(vi). Pre Startup Procedure

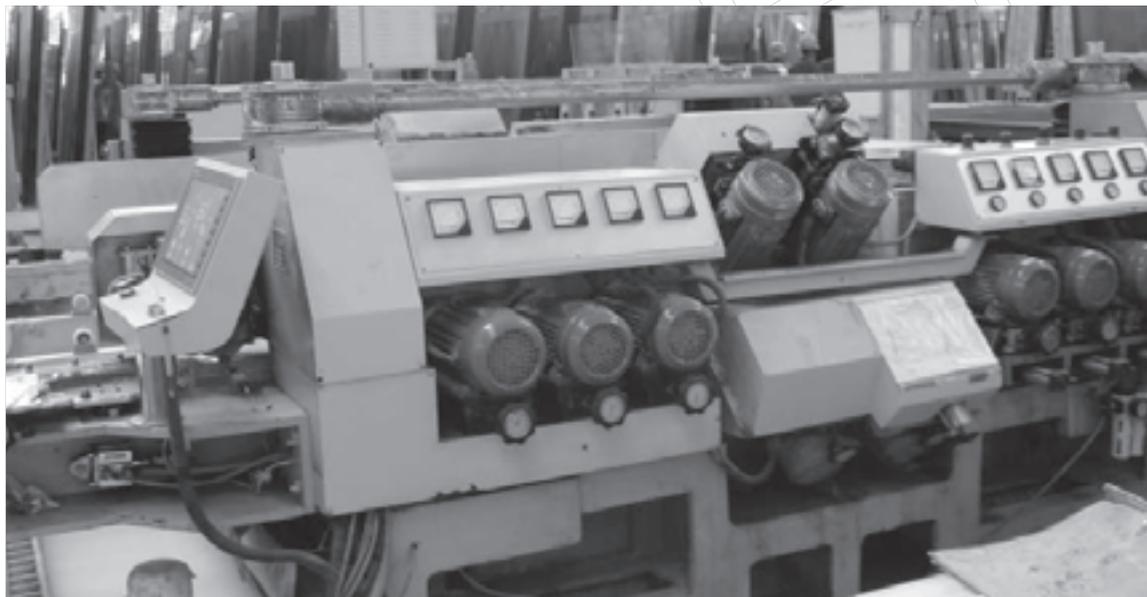
1. Check the compressed air pressure/power supply
2. Check the water level and quality, if contaminated replace with fresh water
3. Check whether the emergency switches are active. If active, release and reset
4. Check all drive movement

## 07D(vii). StartUp Procedure

- Switch on electrical power from the main distribution panel
- Align all the grinding wheels to zero point
- Enter the glass thickness
- Enter the glass width(Movable A)
- Enter the glass height(movable B)
- Enter the distance
- Start all motors
- Start all drives(forward)
- Start all water pumps

## 07D(viii) .StartUp Procedure

- Operator must check the wheel quality at the beginning of the shift.
- He/she must insist on having all the glasses supplied in uniform or near to size for processing.
- Operator must check tapering on all the glasses.
- For glasses with size exceeding 1000 mm, it is always preferred to have a support in the bottom of the glass to avoid bend and taper on glass.
- Use the speed and feed as specified by the machine manufacturer.
- Use the same diameter of the wheel and grit of the wheel as specified by machine manufacturer.



## 07E.MANUAL GRINDING

### 07E(i). Introduction

**I**n manual grinding process, edge polishing of glass is done manually by using a hand held machine. This process is used for shape glasses, cutout glasses etc.



### 07E(ii). Procedure

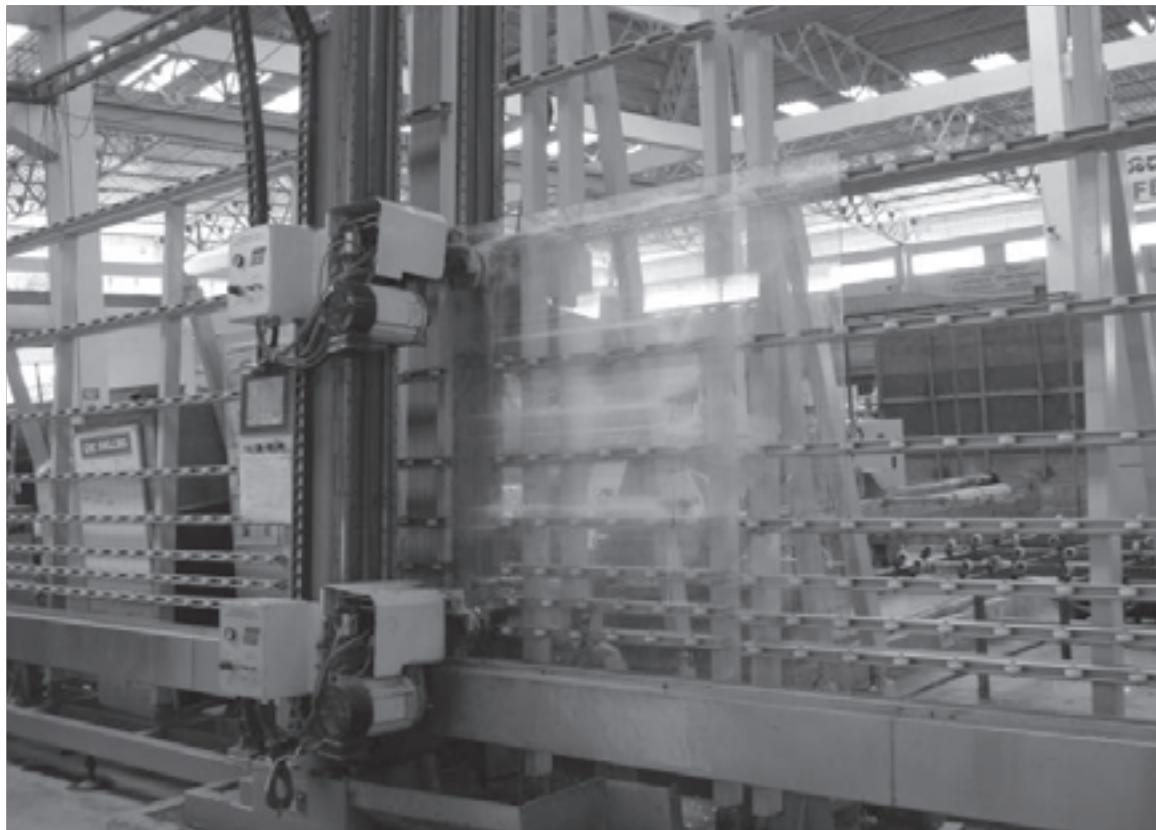
1. Clean the table
2. Lubricate table
3. Required tools – polish & grinding wheel, emery wheel, polish belt, safety equipments, cutter, pincher etc.

## 08A. INTRODUCTION

For spider / frame less glass fittings the glass has to be fabricated as per the fitting requirements. This consists of holes, cutouts, shape cutting etc and can be done by manual drill machine or CNC machine.

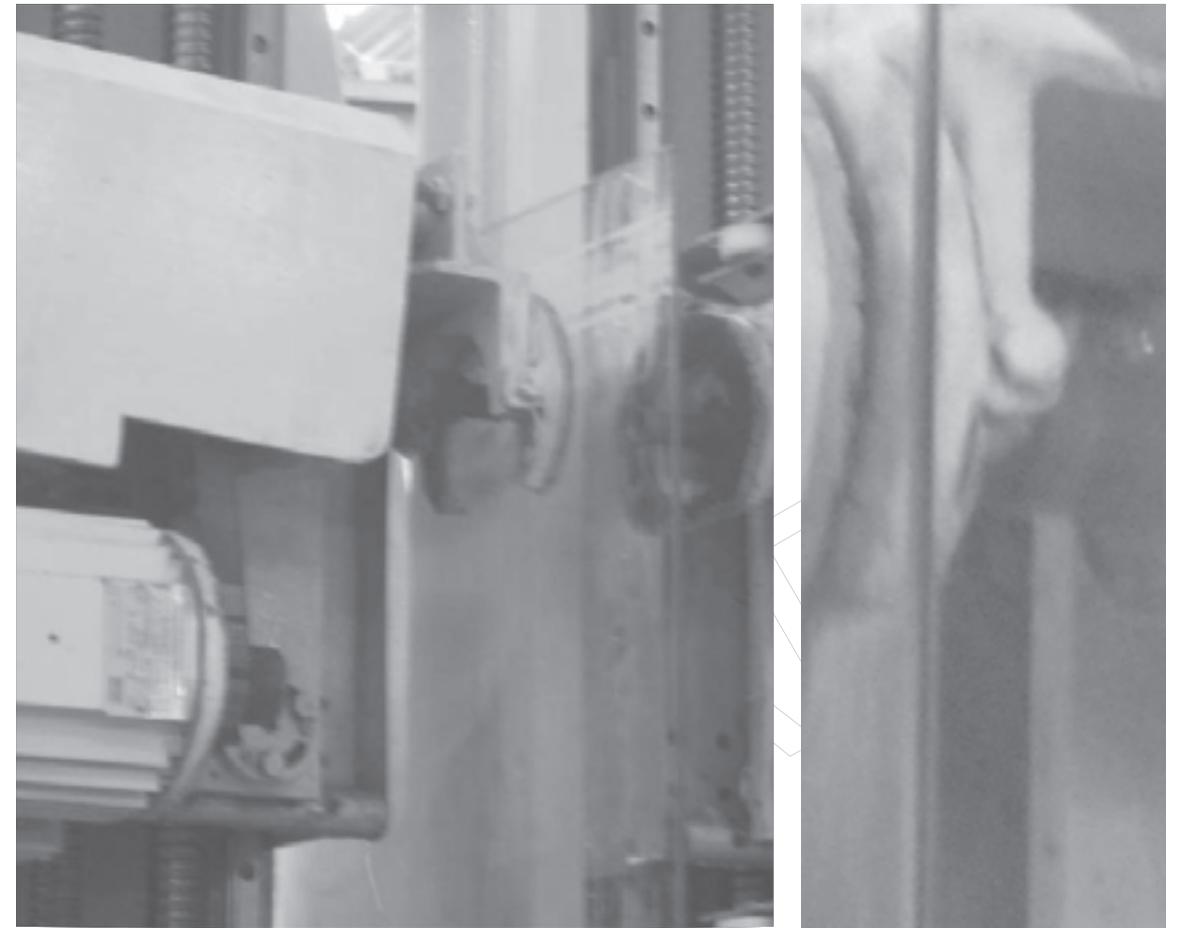
## 08B. CNC DRILLING

For spider / frame less glass fittings the glass has to be fabricated as per the fitting requirements. This consists of holes, cutouts, shape cutting etc and can be done by manual drill machine or CNC machine.



## 08B(i). Pre Startup Procedure

- Clean and lubricate the machine.
- Switch on the control panel and main switch.
- Turn on the key to set the parameters.
- Clean the sensor before starting the work.
- Check the air pressure and water quantity and quality
- After selection of drill bit mount the spindle.



## 08B(ii). Startup Procedure

- Give proper pressure and torque depending upon the thickness and size of the glass.
- Select a glass sample to check the operations and machine finishing.
- Make the proper programme as per the requirement and save the programme to start the drilling.
- Use diamond bits for drilling.
- Use plenty of lubricants/ coolant to keep your drill tip cool and clean.
- Reduce the speed while drilling, as friction heat can destroy your drill bit.
- The coolant must be facing the tip of the tool.
- The tool should be wet at the starting of the process.
- Start out slowly and gradually increase the speed.
- If you see yellow, brown or black marks on the drill bit, stop the process. The tool heating up and will wear out fast.
- A list of available tools ready for drilling and removal of broken tools should be integrated with the store personnel.
- Check the dimension and finishing after completing the process.



## 08C. MANUAL DRILLING

### 08C(i). Introduction

**M**anual Drilling is used for drilling holes on glass, which is not suitable to handle in bigger CNC drilling machines.



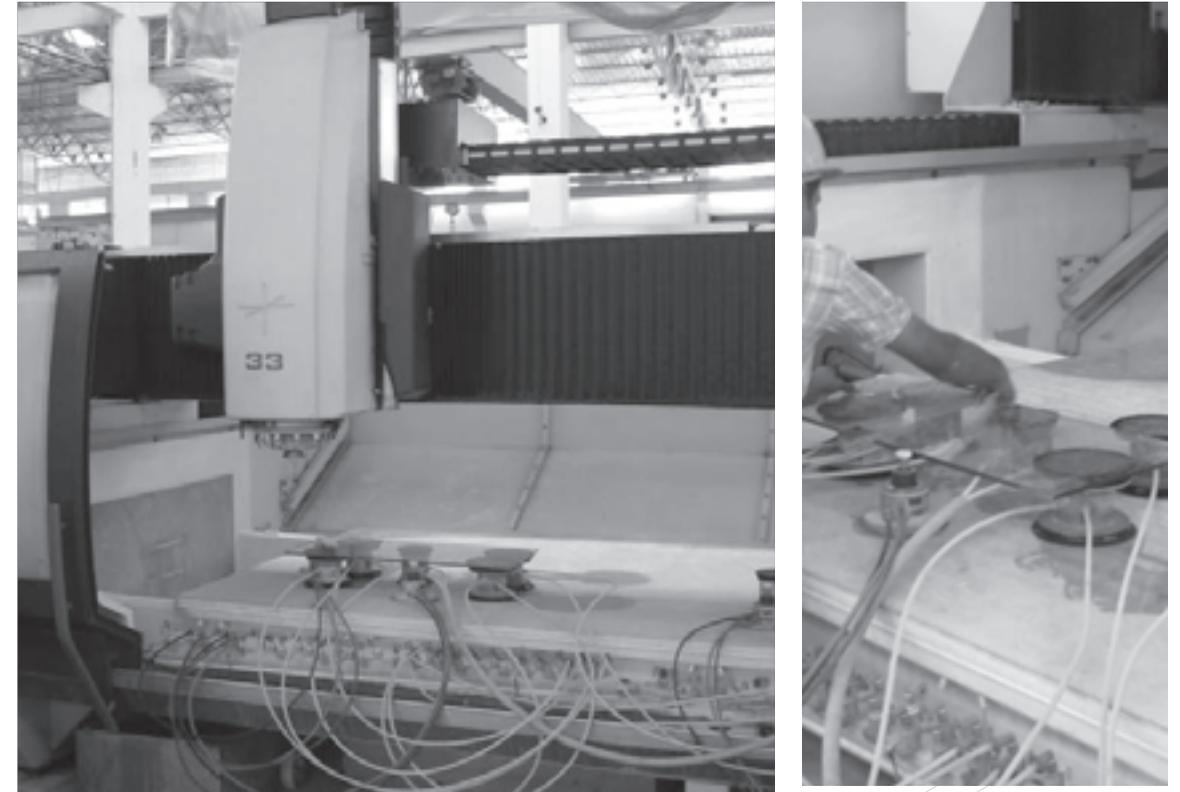
### 08C(ii). Procedure

- Fabrication department will manually mark the positions for drilling as per the drawing details provided.
- Use a manual drilling machine to drill the hole(s)

## 08D. WORK STATION

### 08D(i). Introduction

**T**his is a CNC operated Machine. Cutting Process can be done with the help of 2D CAD programming. Any shaped drawings which cannot be done manually can be processed by this multi axis operated machine. Cut glasses can be polished in this machine itself, which gives a better quality and finish.



### 08D(ii). Pre Startup Procedure

- Clean and lubricate the machine.
- Switch on the control panel and main switch.
- Turn on the key to set the parameters.
- Check air pressure and vacuum pressure.
- Release all emergency switches and turn on the key
- Start the computer and set the command to reset the zero axis.
- Check and clean the catcher rubber, valves and vacuum tables
- Clean the sensor before starting the work and select the language from the program display.
- Check the air pressure and water level in the tank.
- After the selection of tools, mount the spindle.
- Check and clean the glass holders mounted on the work station.
- Select a glass sample to check the operation and finishing.
- Put the catcher on the bed as per rotations displayed in the computer. At this point zero axis must be observed.
- Connect all the vacuum lines to catcher and finally check the catcher indicator. It should show vacuum yield point.

## 08D(iii). Startup Procedure

1. Make the CNC program is as per the job requirement.
2. Give proper pressure and torque depending upon the thickness and size of the glass.
3. Select a glass sample to check the operations and quality of finish.
4. Check the dimension and finishing after completing the process.
5. A list of available tools ready for drilling and removal of broken tools should be integrated with the store personnel.



## 08E. WASHING

### 08E(i). Introduction

**G**lass must be thoroughly washed prior to tempering or any other processes. This is mainly done to avoid scratched and dented glass resulting from tempering of unwashed glass. Washing also serves the purpose of keeping the tempering furnace clean. Once dirt or particles from grinding/cutting process enter the furnace through an unwashed glass, it will accumulate on the conveyor rollers and eventually damage the glass as it flows through the system. Also, these particles will get baked on to glass and causes blemishes on surface.

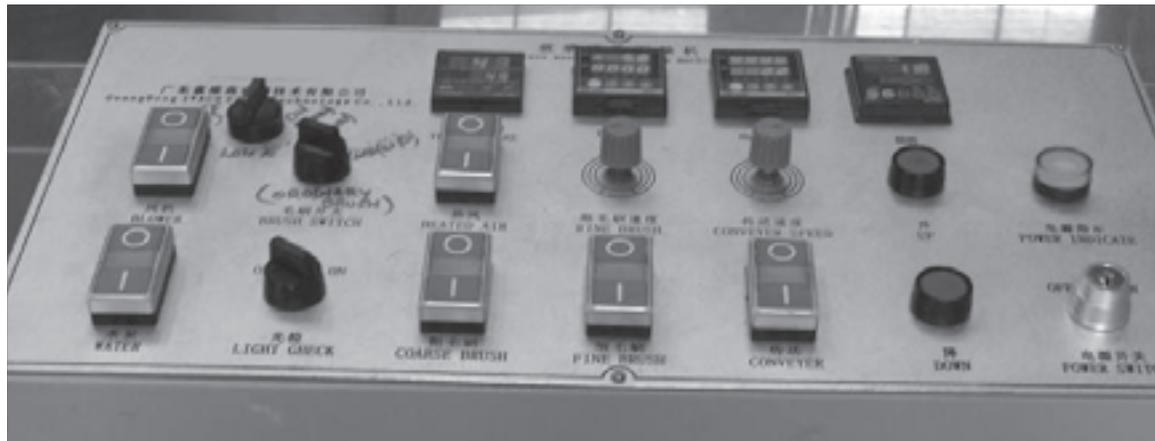


### 08E(ii). Water Quality Check

- Check PH level with the help of PH Meter. It must be around [6 - 8]
- Check conductivity of the water with conductivity meter. It must be with in 5.

### 08E(i). Pre Check Procedure

- Clean the machine rollers and brushes, including blower filters.
- Clean the water tank and fill fresh water
- Check the water quality by pH and TDS Meter.
- Lift the top body and check the brush condition, if any glass pieces or dirt are found, it must be removed immediately.
- Press the start button and switch on the lightings to inspect the washed glass.
- Check the dimension and visual defects like scratches, chip outs etc. Also check and make sure that polish finishing and fabrication work are as per drawing. Final quality inspection has to be done by washing department.
- After inspection and acceptance, identification & traceability should be mentioned and kept in the proper racks / trolleys convenient for next process.



### 08E(ii). Start up Procedure ( for clear & tinted glass)

- Check the quality of water at the start of the shift.
- If the water quality is contaminated, replace with fresh water.
- Ensure the water is directed against the glass not against the brush.
- Check whether there is any water mark in the glass after drying. If so, it is due to water and water needs to be changed.
- Check for residual water mark. If there, check for any clogging in the nozzle.
- It is the responsibility of the washing operator to check any problem in glass.
- Use the specified speed and feed as specified by the machine manufacturer.
- Use same thickness glass in washing process.

### 08E(iii). Start up Procedure (For coated glass & Low- E glass)

#### Pre check is common

- The operator must start water pumps before the conveyer is started.
- For different thickness of glass, the machine has to be set as per the requirement.
- The glass has to be washed by putting the coated surface on top side.
- For Low- E glass the operator must use the Low-E brush only.
- The operator has to check for visual defects in glass (scratches, chipping, coating peel off etc.)
- The operator must check the dimensions and drawings against the job order
- All personnel who handle glass must use gloves while loading /unloading.
- Once the glass is washed moves to the drying area, the operator must start the warm air blower to dry the glass



## 08E(iv). Washing of Clear Glass

- Check the quality of water at the start of the shift.
- If the water quality is bad, change the water.
- Ensure that the water is directed against the glass not against the brush.
- Change the washing machine brush once a year.
- Check whether any water mark is present in the glass after drying. If yes, it is due to water and water needs to be changed.
- Check for residual water mark. If there is, check for any clogging in the nozzle.
- Toughen the glass within 3 hours after processing. Good washing means good toughening.
- It is the responsibility of the washing operator to check for any problems in the glass, before sending for toughening. It is NOT the responsibility of the toughening operator to check the quality of glass.
- The major quality issue includes scratch mark in any glass.
- Use the speed and feed as specified by the machine manufacturer.
- The coating burns in coated glass.



## 08E(v). Washing of Coated Glass

1. Check the quality of water at the start of the shift.
2. If the water quality is bad, change the water.
3. Ensure that the water is directed against the glass not against the brush.
4. Change the washing machine brush once a year.
5. Check whether any water mark is present in the glass after drying. If yes, it is due to water and water needs to be changed.
6. Check for residual water mark. If there is, check for any clogging in the nozzle.
7. Toughen the glass within 3 hours after processing. Good washing means good toughening.
8. It is the responsibility of the washing operator to check for any problems in the glass, before sending for toughening. It is NOT the responsibility of the toughening operator to check the quality of glass.
9. The major quality issue includes Scratch mark in any glass.
10. Use the specified speed and feed as specified by the machine manufacturer.
11. The coating burns in coated glass.



## 08E(vi). Washing of Low E Glass

1. Check the quality of water at the start of the shift.
2. If the water quality is bad, change the water.
3. Ensure that the water is directed against the glass not against the brush.
4. Change the washing machine brush once a year.
5. Check whether any water mark is present in the glass after drying. If yes, it is due to water and water needs to be changed.
6. Check for residual water mark. If there is, check for any clogging in the nozzle.
7. Toughen the glass within 3 hours after processing. Good washing means good toughening.
8. It is the responsibility of the washing operator to check for any problems in the glass, before sending for toughening. It is NOT the responsibility of the toughening operator to check the quality of glass.
9. The major quality issue includes Scratch mark in any glass.
10. Use the respective brush for Low E glass.
11. Use the specified speed and feed as specified by the machine manufacturer.



## 08F. SCREEN PRINTING

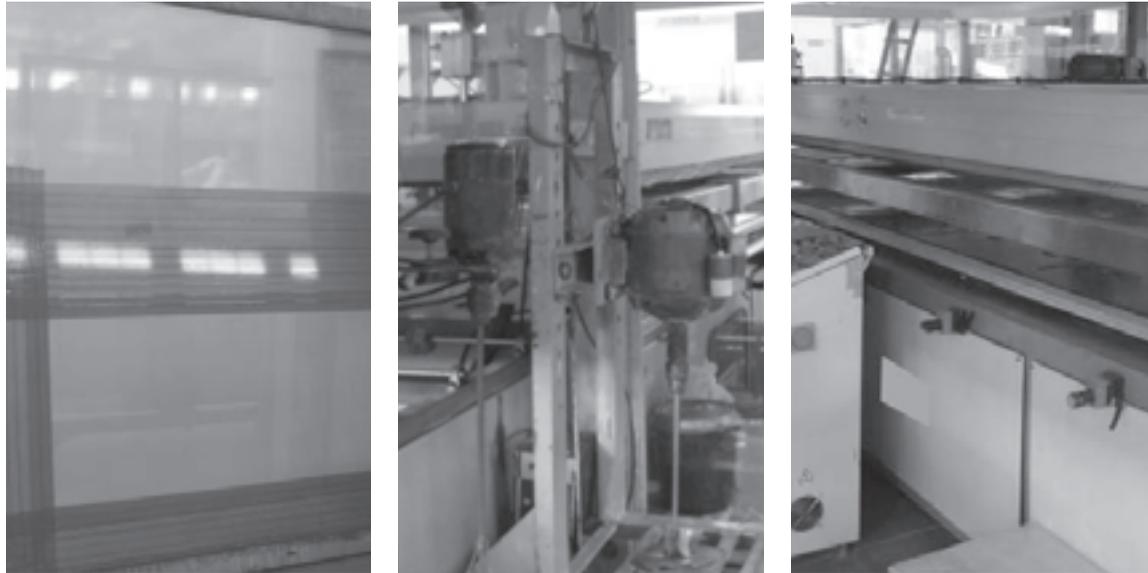
### 08F(i). Introduction

Screen printing is where a glass meets art and technology. Printed using a silk screen with glass enamel before it is tempered and heat strengthened, this glass comes with a permanent coating that cannot be removed by cleaning or scrubbing. The heart of the process involves a fine mesh or screen that is tightly stretched around a rigid frame.

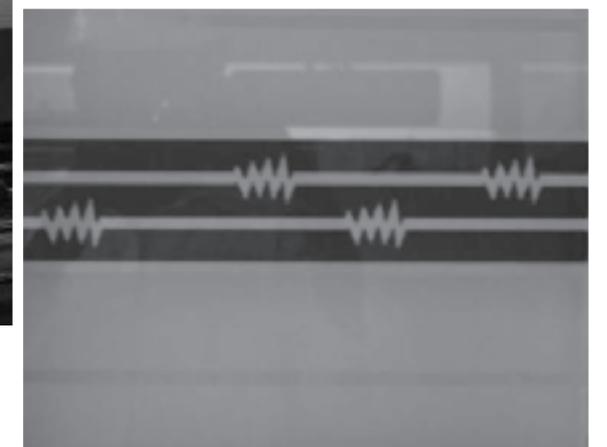


### 08F(ii). Procedure

1. Screen measurement is taken.
2. Tape is applied on screen for controlling the size.
3. Glass is washed and cleaned using IP solution
4. Clean & lubricate the machine. Release all the emergency switches and power on the machine check the working condition.
5. Switch on the PLC Control to start.



- Check the proper Air pressure Range.
- Switch on the hot drier to get preheating temperature to 150°C.
- Weigh the Ink and hardener in digital weighting scale.
- Mix the ink
- Check the mixing quality of ceramic printing Ink.
- Clean and prepare the screen as per the glass size check the actual dimension of the printing area.
- Place the glass on the working table and check the dimensions, thickness and also for visual defects.
- Keep the glass on the printing table in the right position.
- Adjust the printing screen in the machine and tighten all fasteners
- Fix the scraper and squeezer as per the guide provided in the machine.
- Apply the printing ink on the screen thoroughly.
- Start the printing by pressing Start Button. Auto / Manual settings can be done.
- The masked areas prevent ink from passing through, but the unmasked WILL PRINT
- Check for any uneven printing. If observed, it should be cleaned and reworked.
- If the printing is even, send the print to drier to dry the ink.
- Set the temperature of the dryer depending on the thickness of the glass.
- The final step is to send the item on a conveyor belt through a heat-tunnel. This curing process ensures that the inks dry quickly so that the materials can be stacked or packaged.
- After drying, unload from the drier zone and send for tempering. Take special care while handling before sending for tempering.
- Properly cured inks will remain on the printed glass even under harsh conditions.



# TEMPERING

09

## 09A. Introduction - Toughened Glass

**T**oughened Glass is a type of Safety Glass. It is made stronger in a furnace; a Toughened glass is 4 to 6 times stronger than an annealed glass of the same thickness. A toughened glass when it breaks shatters in to small cuboids, these fragments do not cause any Body harm. Toughened or tempered glass is a type of safety glass processed by controlled thermal or chemical treatments to increase its strength compared with normal glass. Tempering creates balanced internal stresses which cause the glass, when broken, to crumble into small granular chunks instead of splintering into jagged shards. The granular chunks are less likely to cause injury. For Safety from Body Harm in case of Glass Breakage. Once a glass has been toughened, no Edge Finishing or Hole can be drilled in the glass, the glass will be shattered.

As a result of its safety and strength, tempered glass is used in a variety of demanding applications, including passenger vehicle windows, shower doors, architectural glass doors and tables, refrigerator trays, as a component of bulletproof glass, for diving masks, and various types of plates and cookware. Toughened glass is also used in buildings for unframed assemblies (such as frameless doors), structurally-loaded applications, and any other application that would become dangerous in the event of human impact.



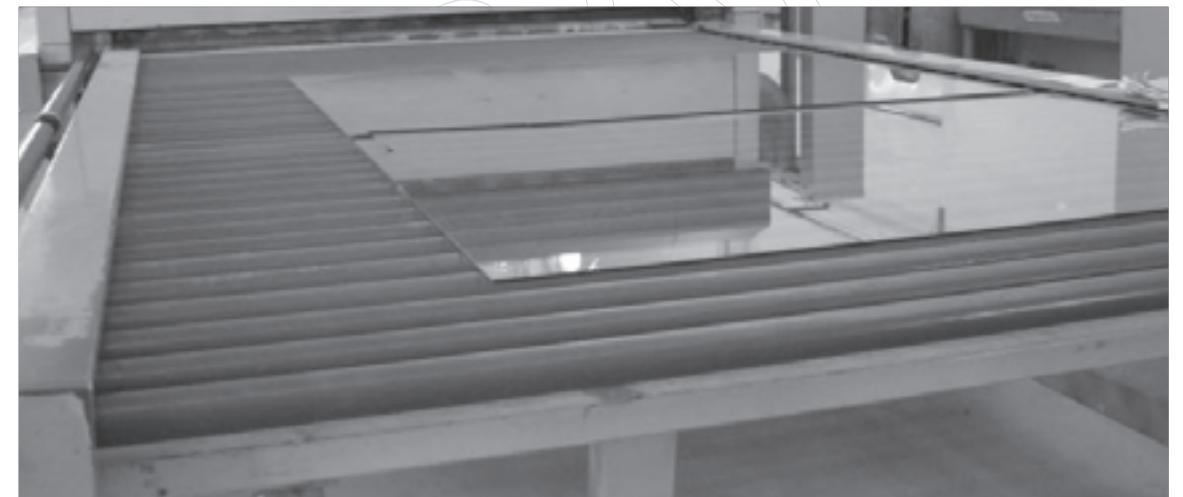
Tempered Glass - Breakage Pattern

## 09Ai. Toughened glass production technology

One essential thing to know before quenching the glass, it is that the glass before quenching to be processed, i.e., seaming or ground the edges, otherwise glass during tempering process will be broken. Thus, it is necessary to maintain the glass processing sequence: 1) cutting; 2) grinding (when all glass edge is worked) or seaming (processed only the arrises of edge); 3) drilling or milling, if necessary holes in glass; 4) washing; 5) continuous painting or a drawing forms of screen-printing method, if necessary. Another important factor before tempering is glass washing. If the washing of the glass is bad, on the surface will be contaminated by dirt or stains, which burnt during the tempering of glass and to clean it after it is not possible without damaging the glass surface. As mentioned earlier, during the tempering the glass is heated to approximately 600 °C and then suddenly blown by strong air currents. Such a process is derived from a large glass of internal stress, i.e. the outer layers of high compression occurs, the inner (thin layer) - tensile strength. This the glass is much more resistant to mechanical and thermal effects, and the split breaks into small pieces.

### 09A(ii). Loading Section

- It mainly consists of rubber-coated rollers, lifting castor and edge rolls.
- The glasses are transferred into the heating section through the rolls of loading table.
- The rolls moved will push the glass forward.
- A set of photoelectric switches at the end of loading table close to the furnace door respond when the glass reaches them.
- As a result, the rollers will stop running and the glass will be in a stand-by situation.



### 09A(iii). Heating Section

- It is made of an insulating box divided into upper and lower parts with refractory ceramic conveyors in middle.
- The electric heating radiation plates (a special kind of refractory and corrosion-resistant material) are mounted in the upper part.
- The lower part is composed of two kinds of heating structures.
- Radiation tubes and heating wires covered by the radiation steel plate.
- Its structure is similar to that of the upper part---zone heating.
- When the glass reaches the furnace, the door opens.
- And the rollers of the loading table and the furnace run in sync.
- When the glass enters the furnace, the door closes.
- Glass is conveyed by rollers in the furnace and oscillates with in the range for heating.
- When the heating time is over, back door of the machine opens and the glass will be transferred from heating section to the cooling section.



### 09A(iv). Quenching Section

- It is composed of the upper and lower quenches which can be opened or closed.
- The blowing distance is adjustable.
- The upper and lower quenches are several air boxes in parallel arrangement for easy diffusion of hot air.
- Between the quenches are conveying rollers.
- The upper and lower quench can be adjusted by computer and the formation can be monitored on the screen.



### 09A(v). Unloading Table

When glass is at the end of the table, the rollers automatically stop running and glass is taken away by hand.

### 09A(vi). Cooling System

This system consists of the fan; wind manifold and actuating mechanism of air cock. The air-pressure is controlled through computer, which adjust the openness of air-cock of fan. During tempering process, air is the ideal cooling media. Its advantages are the following:

- 1) The glass can be cleaned during cooling
- 2) Cooling speed can be easily adjusted only by changing air-pressure.
- 3) Every part of the glass sheet can be evenly cooled.
- 4) Fan motors are simple and reliable cooling equipment

Cooling process consists of two stages:

- 1) Quenching air-pressure and time  
It refers to the air pressure and time for glass tempering.
- 2) Cooling air-pressure and time.

## 09A(vii). Control System

- It includes the computer console, control cabinet, test elements and operation buttons.
- The monitor is mounted on the operation console.
- It has the functions of readable-writable parameters, automatic control, unit test and self-diagnose as well as alarm and warning.
- Driving system is controlled by a variable inverter which is controlled by computer.
- The temperature control is realized by the power of heating elements handled by trigger.
- The temperature on the upper and lower is controlled separately.
- Temperature in the furnace is controlled by the volume and direction of compressed air.
- Temperature homogeneity in the newly designed furnace is realized through controlling the heating power of every region.



## 09A(viii). Startup Procedure

- First procedure is to clean the machine and main body parts thoroughly.
- Release all emergency switches to start the furnace.
- Check the power supply and switch on the control panel and the PLC.
- Check all heaters and thermo couples and make sure they are in working condition.
- Check whether the glasses have sufficient finish as per customer requirements.
- Before sending for processing, check cutouts, holes, thickness, cleanliness & edge finishing
- Set the parameters of loaded glass for toughening / Heat strengthening.
- After tempering check the following quality objectives:-

### **Bend | Waviness | Scratches | Coating burn | Roller marks**

- While changing every parameters, send three samples for specified operation to check the quality i.e. Particle Test, Impact Resistance and Lab Test.
- Keep accepted glass, rework glasses and rejected glasses separately after tempering.
- Operator must check whether lubrication and service are done properly as per schedule or not.



## 09A(ix). Pre Start Requirement

Power supply  
Compressed Air  
Calibrated Measuring Tape  
Coating Detector

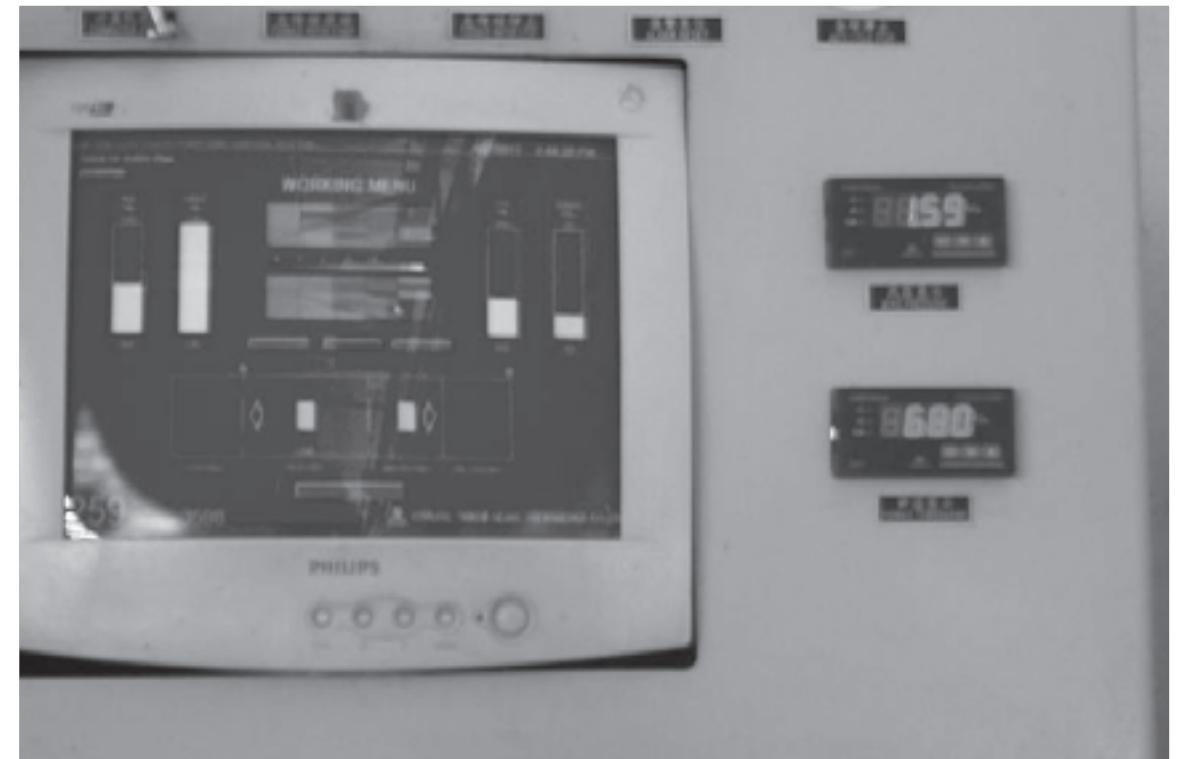
## 09A(x). Pre Start Up Procedure

- Check and make sure the glass colour and coating side are as per the work order
- Check air and cooling water supply (air pressure should be 6 bar)
- Switch on power to processor
- Check the drive movement
- Check all emergency switches, if active release and reset
- Turn on control supply main switch
- Switch on MCCB heater panel
- Turn load, main, quench and unload conveyor idle-off-auto switches to the idle mode
- Turn on power to the heater panels and turn on all heating elements switches



## 09A(xi). Procedure

1. Click on the recipe and select the required recipe
2. If any error/alarm reset it
3. Enter the required heating time
4. To change furnace temperature and aspiration parameter, click on furnace and go to furnace page
5. To change quench parameter, click on quench and go to quench page,
6. To change the zone temperature and firing rate, click on the zone and go to zone page
7. To change the temperature during cycle time, click and change.



## 09A(xii). Procedure 02

1. Click on the block to enable/disable the aspiration pressure in the particular zone
2. Enter the required aspiration time to keep the glass flat in the furnace
3. Enter the required aspiration pressure to keep the glass flat in the furnace

### 09A(xiii). Procedure 03

- Enter the required quench speed and quench time
- Enter the required cooling speed and cooling time
- If outcome glass is bow concave/convex, adjust the top/lower damper
- Once the temperature reaches the required degree, switch conveyor drive to auto mode.
- Once the temperature reaches the required degree, switch quench fan to auto mode.
- When the glass enters the furnace ,open the furnace entry door and check the oscillation of the glass, if required adjust the temperature.

### 09A(xiv). Warm Up Procedure

- Switch on the main air routes in the main power and circuit control cabinet.
- Switch on the controlling power
- Switch on the loader, furnace, quench and swinging motor
- Switch on the DC power battery.
- Switch on the bottom and top heaters.
- Switch on the PLC and heaters start switch
- Switch on the industrial computer
- Now the computer is in a self checking and startup stage
- Press the main drive button.
- Set the parameters in the computer and heat up the furnace.
- Check the air pressure in the furnace and ensure it meets the requirement.
- Before glasses enter the furnace, make an analog signal with hand to check the coupled movement of the loading table, furnace door, cooling section, unloading table, air pressure and data signal on the monitor.
- Send the load into the furnace and inspect the outer and inner of the glass after tempering, so as reset the parameter of necessary.

### 09A(xv). Cold Up Procedure

- Switch on the main air routes in the main power and circuit control cabinet.
- Switch on the control power.
- Switch on the DC power battery.
- Switch on the bottom and top heaters.
- Switch on the PLC and heaters start switch.
- Switch on the industrial computer
- Now the computer is in a self checking and startup stage.

- Press the main drive button.
- In the cold start, the furnace will have room temperature. So initially set 500C temperature and after attaining set temperature, gradually increase the temperature by 50°C step by step up to set point.
- In the mode of main operation you can adjust the heating time, quench time, cooling time and quench pressure with the mouse without entering the system parameters pace.
- Before glasses enter the furnace, make an analog signal with hand to check the coupled movement of the loading table, furnace door, cooling section, unloading table, air pressure and data signal on the monitor.
- Send the load into the furnace and inspect the outer and inner of the glass after tempering, so as to reset the parameter of necessary.



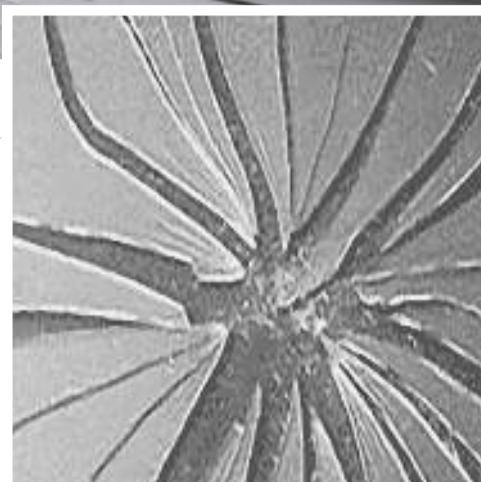
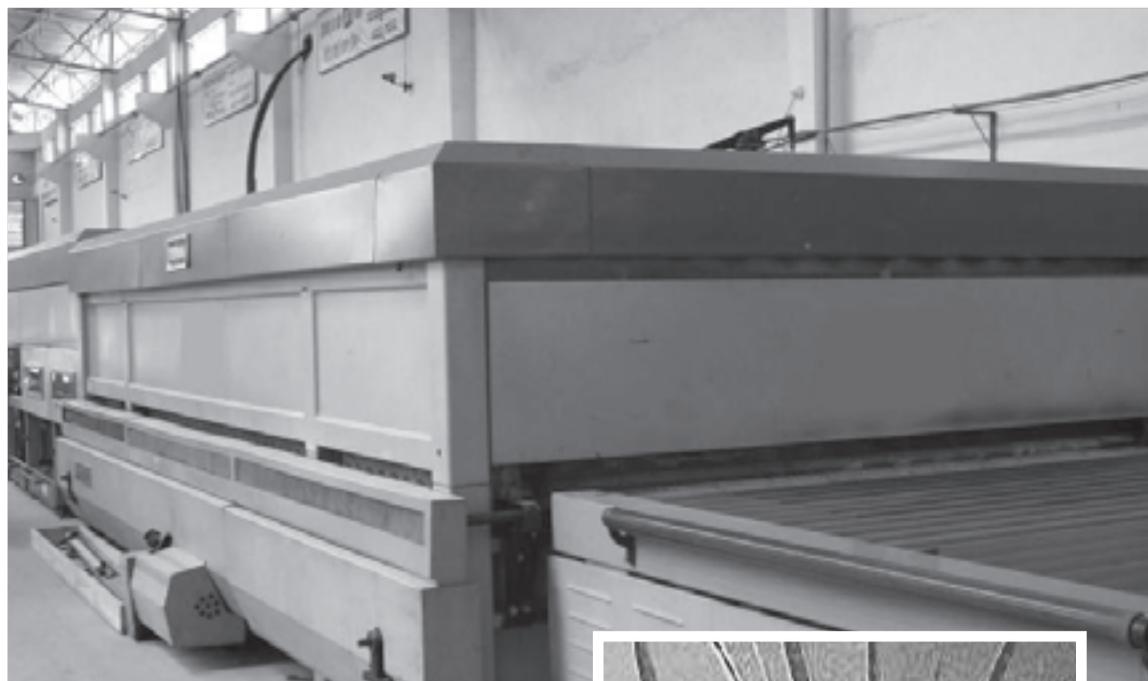
### 09A(xvi). Application of Processed Glass

- Fully tempered glass is used for doors, windows, side lights, shower and tub enclosure and interior partitions.
- Manufacturing industry use tempered glass in furniture, ovens, shelving, fire place screens, and refrigerator.
- In construction industry, they are used for front elevation, escalators, show room shelves, balustrades, spider fitting etc.
- In automobile industry the usage include windows and wind shields
- Because of high resistance to thermal stress and small missile impact, tempered glass is used in sky lights and sloped-glazing.

## 09B. HEAT STRENGTHENING

### 09B(i). Introduction

A process by which the mechanical strength and resistance to thermal breakage of glass is increased through heat treatment. Its breakage characteristics are similar to ordinary annealed glass. The process of heat strengthening is similar to the process of toughening except that the cooling is done at a much slower pace. Heat strengthened glasses are twice as strong as annealed glass, and have increased resistance to mechanical and thermal stress (130°C).



Heat Strengthened Glass - Breakage Pattern

### 09Bii. Features of Heat Strengthened

1. Heat strengthened glass is 2~3 times stronger than the raw annealed glass.
2. Its breakage pattern is similar to annealed glass as the quenching is slow compared to tempering. Consequently the compressive stress developed is not as intense as in fully tempered glass.
3. The term toughened glass is generally used to describe fully tempered glass but is sometimes used to describe heat strengthened glass as both types undergo a thermal 'toughening' process.
4. There are two main types of heat treated glass, heat strengthened and fully tempered. Heat strengthened glass is twice as strong as annealed glass while fully tempered glass is typically four to six times the strength of annealed glass and withstands heating in microwave ovens. The difference is the residual stress in the edge and glass surface.

### 09B(iii). Procedure Is Same As Tempering with a difference

The heat-strengthening process parallels the process of tempering, except that the cooling cycle is less rapid, therefore, creating surface compression levels less than fully tempered glass.

### 09B(iv). Application of Heat Strengthened Glass

- Heat strengthening is carried out where optical requirement is very high.
- Heat strengthened glass is intended for general glazing where additional strength and/or resistance to mechanical and/or thermal strength are desired.
- Heat strengthening is widely used in coated glass to minimize the waviness in the glass after insulating the glass with another piece of glass.

# HEAT SOAKING

10

## 10C. Introduction

The presence of Nickel Sulphide (NiS) is adventitious in most glass. It has been estimated that in normal float glass production, NiS inclusions occur at a frequency of about one per 8 tonnes of raw glass. Heat soaking process is one method of reducing the incidence of NiS induced failure in tempered glass by causing the phase change to occur before the glass panel is installed in the building.

Heat soaking is a destructive process in which a pane of tempered glass is subjected to temperatures up to 280 c for several hours over a specific temperature gradient to induce fracture. This test ensures that if there is a probability of breakage, then the infected panes break inside the furnace at the factory itself. up to 95% NiS infected glass panes are usually destroyed inside the heat soak chamber and hence reduce the chances of onsite breakages. This test is mandatory in developed countries.



## 10A. Pre Startup Procedure

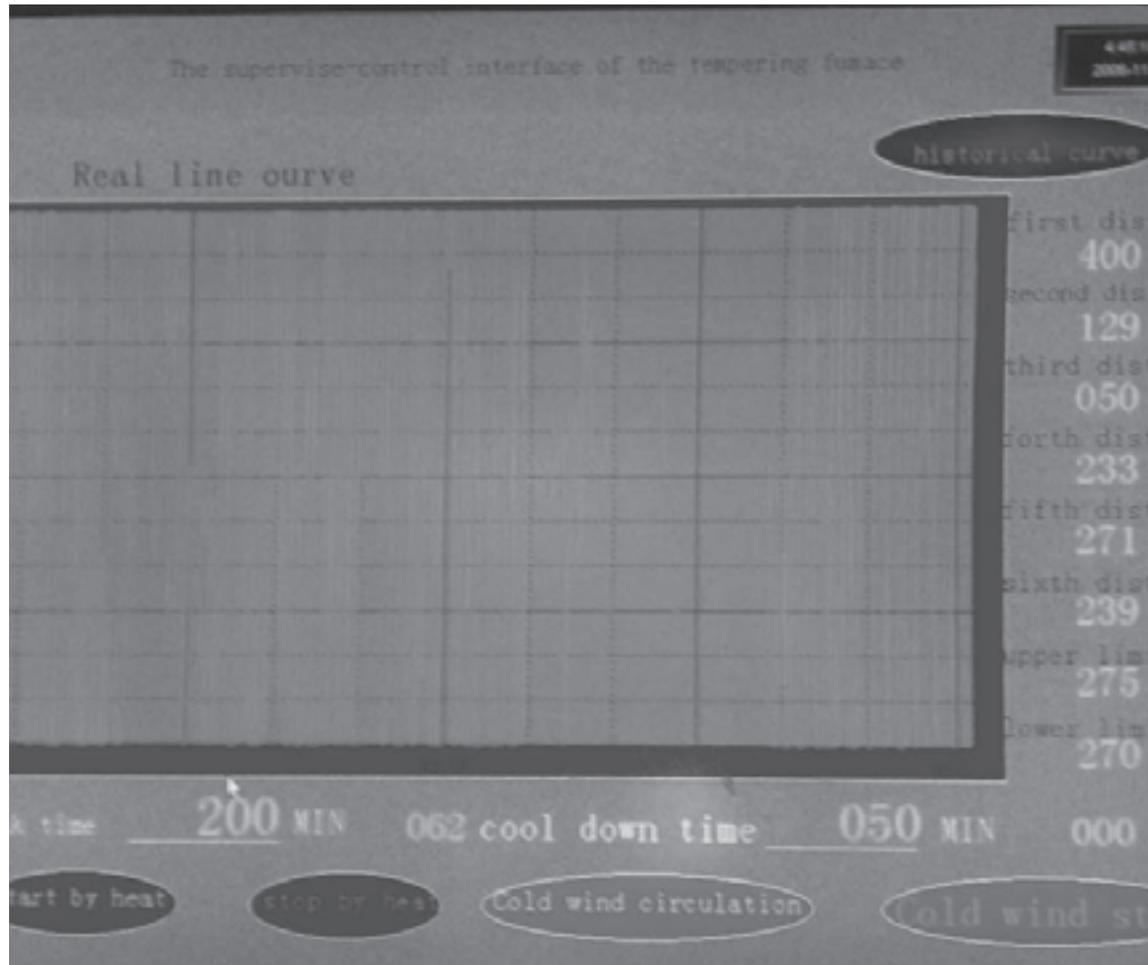
- Keep 20 - 25mm distance between the glass when keeping them on the trolley. You can put the high temperature resistance asbestos of 25 mm thickness between the glass, fasten the glass with the high temperature – resistance polyamide string after all the glass are ready.
- Check the air gates regularly. Close them tightly if they not.
- Check and adjust the position of the cold air gate's route-switch in order to achieve the best cooling effect.
- Check the air leakage of pipes in the air route.
- Check the quantity of cold water's in the warm air machine when the heat soak furnace works. If it is not sufficient, add more water.

## 10B. Startup Procedure

- The two heating pipes start up to heat from the room temperature.
- When the temperature rises up to the specified degree of 270° C., the heating stage will be finished.
- 1 hour later (set the heat preservation length according to need) stop heating completely.
- Open cold air gate and air expelling gate and start the cooling circulation system.
- Open the gate of the furnace as the temperature decrease to 700°C. After several minutes, stop to finish the heat soak course and take out the glass.

## 10B(I). To avoid NiS Inclusion

- NiS inclusion can be avoided if the glass is heat soaked.
- Glass is heated to a temperature of 290C for a period of 4 hours and cooled slowly. Any glass with NiS Inclusion will break inside the furnace itself. In this method 99.9% of NiS can be avoided from reaching the site.
- Though Heat soak is not a fool proof test to avoid NiS inclusion the breakage can be greatly avoided after this test. There is no ASTM standard available for heat soak test



# FROSTING

11

## 11A. Introduction

**F**rosted glass is glass which has been rendered opaque through a process which roughens or obscures the clear surface of the glass. There are numerous applications for frosted glass in both homes and businesses.

Frosting of glass is usually done through acid etching or sandblasting.

Sandblasting is used to frost an entire sheet of glass, for installation in places like bathrooms and other areas where people might want privacy.

Acid etching is used to make frosted glass with a pattern. Patterned glass sometimes appears in ornamental windows, as well as in glasses, mirrors, vases, and other glassware around the house. The pattern can be simple or extensive, and it may include floral or geometric elements.



# LAMINATION

## 12

### 12A. Introduction

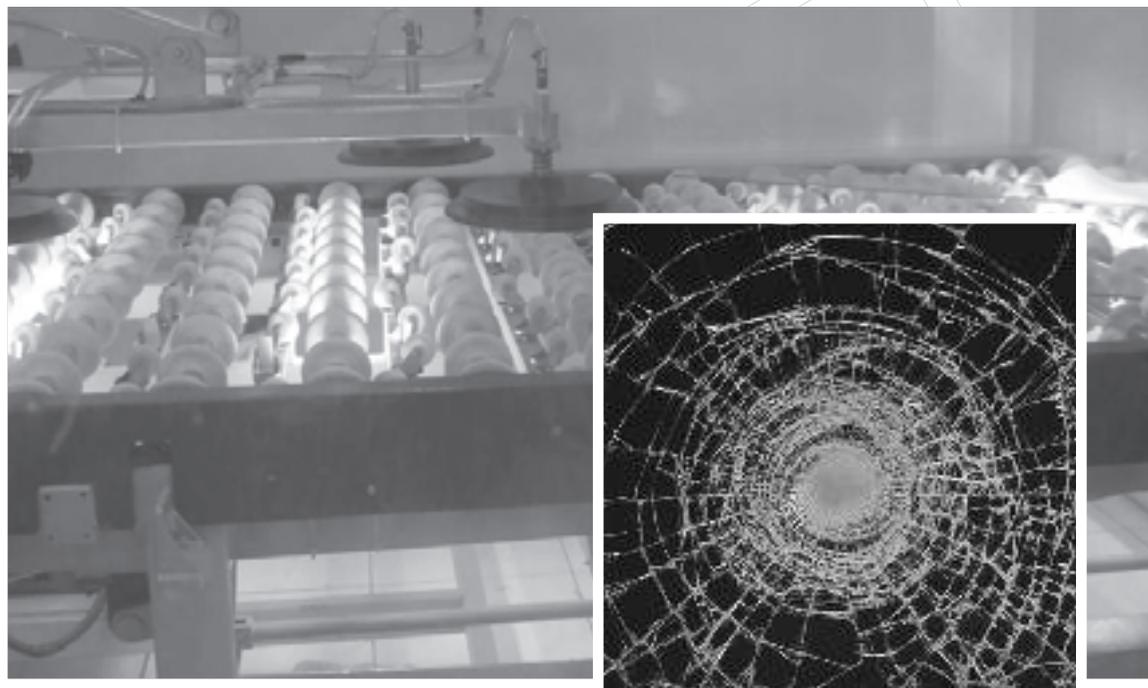
Laminated glass is made of two or more layers of glass with one or more “interlayers” of polymeric material bonded between the glass layers.

Laminated glass is produced using one of two methods.

Poly Vinyl Butyral (PVB) laminated glass is produced using heat and pressure to sandwich a thin layer of PVB between layers of glass. On occasion other polymers such as Ethyl Vinyl Acetate (EVA) or Polyurethane (PU) are used.

For special applications, Cast in Place (CIP) laminated glass is made by pouring a resin into the space between two sheets of glass that are held parallel and very close to each other.

PVB laminated glass is produced using a heat and pressure process, sandwiching a flexible interlayer between layers of glass. Generally, the interlayer has a thickness of 0.38mm, except for applications such as automotive windscreens, which use a 0.76mm thick interlayer.



Laminated Glass - Breakage Pattern

Laminated glass has the advantage over standard glass in that it will not shatter as the polymeric interlayer is not subject to brittle failure as is the glass. Furthermore, the interlayer provides a barrier against penetration. Tinted interlayer materials can be used to help minimise heat transmission, while the polymeric material also acts as a sound deadening layer, damping sound transmission in a manner equivalent to glass twice as thick.

#### Key Properties

- Increased safety factor compared to standard float glass
- Resistant to shattering
- Improved acoustic damping properties compared to standard float glass

### 12B. Preparation

- Prepare the pair of glass.
- Prepare the clean room (dust free) prior 2 hours of start.
- The room should be clean and the temperature and the humidity should be maintained.
- Maintain the temperature between 20 and 25° C
- Monitor the Rh and Temperature every Hour.
- Maintain Humidifier to 18% (Min 18% to Max 25%)
- Set the Pressing Machine Heaters as per the glass & PVB Thickness.

### 12C. Washing Machine

- Check water level in the tank & refill if necessary.
- Check the ph level of water.
- Check the conductivity of the water before starting and write it down.
- Check quality standard of the glass as per the work order.
- Place the glass on the loading table.
- Set the thickness & speed of conveyer in the control panel.
- Speed of conveyer with the glass thickness should be set before starting.
- Start the air blower by pressing the start button.
- Start the conveyer by pressing the start button.
- The glass should be checked before feeding into the washing machine for scratches and coating burns and bubbles.

## 12D. PVB Lamination Clean Room

- Wear the necessary clean room dress (cap, gloves, overcoat)
- Check the room condition and maintain temperature between 20 and 25 degrees and humidity level between 18% to 25%.
- Monitor the Rh and temperature every hour even in idle condition.
- Check the glass visually and make sure it is as per the work order. Once the first glass has been received, lay the PVB film on the glass with side trims 6mm along side, as per the specifications.
- Place the second glass using vacuum catchers above the first glass and PVB layer.
- Check the uniformity of the PVB layer before sending it to the pressing section



## 12E. Pressing Machine

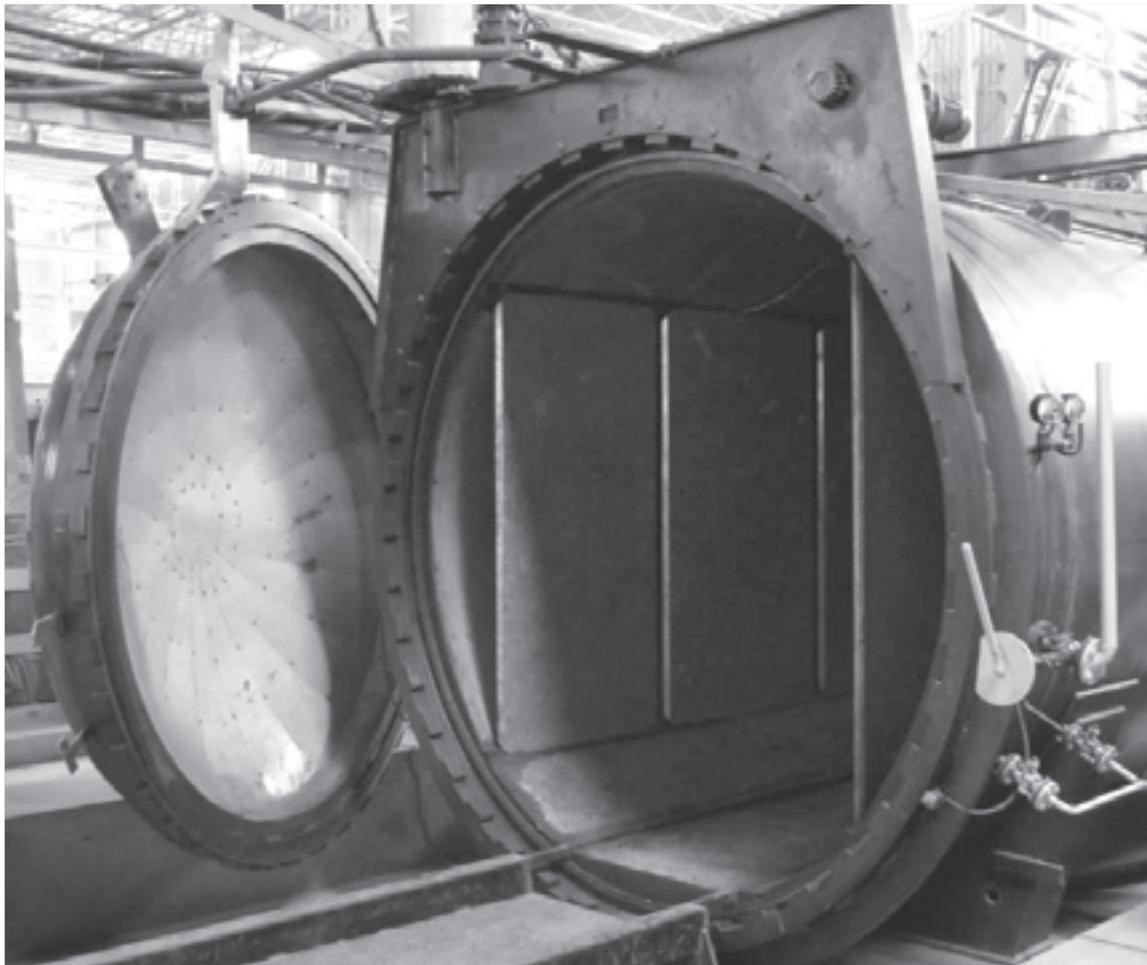
- Start the conveyer by pressing the start button.
- Temperature to be set as per thickness of glass & pvb.
- This should be less, normally @ 100°C max.
- Set the speed of conveyer from 1.2mtrs/min to 2.2mtrs/min based on the thickness of glass.
- The speed of the conveyer and thickness should be checked before sending the glass. Ex as below:
  - a. Set the 1st roller  $(4+0.38+4) = 8.38$  (8.18)
  - b. Set the 2nd roller  $(4+0.38+4) = 8.38$  (7.18)
- Set the right pressure for pressing rolls
- Glass passes through temperature treatment and the pvb layer melts and is fixed between glasses.
- At the time of unloading check the pressing quality & use vendor clips to the edges of the glass panel.
- Place the glass panel on to the auto clave trolley secured with proper heat resistance material.



## 12F. Autoclave

### 12F(I). Introduction

**A**utoclave machine produces heat and vacuum inside the vessel in a controlled environment. This heat and pressure are applied to a sandwich of two sheets of glass and a PVB interlayer which in the process becomes a clear shatterproof glass. To ensure the safety in the production of laminated glass, several factors have to be taken into consideration. The operator must be qualified to operate the machine and also react well in different non-standard situations that may occur. As for the danger of high pressures and temperatures generated inside, autoclave must be certified to meet the safety standards. The autoclave doors and locks mechanisms are of special importance as they are constructed adequately to prevent any accidental opening during the process.



### 12F(ii). Procedure

- Check and make sure the air pressure in the air receiver tank is 12.5 kpa.
- Push the trolley inside the auto clamp & secure the glass.
- Before closing the door check inside the auto clamp.
- Lock the door by rotating the yellow handle.
- Check and set the temperature to 135 degree & pressure to 12.5 kpa on the control panel.
- Door casket has to be sealed and locked by opening the air valve.
- Check the water level in the cooling water tank.
- Press the start button to start the auto clamp cycle
- After the heating temperature reaches 135 degrees, set the holding time for as per the standards of the glass.
- After completing the cooling cycle time the air pressure valve must be released
- Check for air pressure inside the auto clamp in the dial gauge. If any pressure is present, release the pressure manually.
- Release the door casket seal by closing the air valve.
- Open the door after confirming the pressure inside.



### 12G(iii). Final Inspection

1. Check the glass for any air bubbles & defects
2. Trim the glass after quality check is over

## 12G. Application of Laminated glass

1. Laminated glass can resist intrusion because the PVB interlayer continues to safe guard the building even after the glass itself is broken.
2. Laminated glass cannot be cut from one side, so ordinary glass cutters are useless in cutting laminated glass.
3. Laminated glass is an excellent barrier of noise. This property makes it ideal for environments like near airports, highways or for recording rooms.
4. Laminated glass can be manufactured with additives to screen out all UV rays. UV rays are responsible of colour fading in clothes and also cause Skin Cancer.
5. Ordinary glass shatters under fire. Laminated glass will not disintegrate like ordinary glass when exposed to heat, so it confines the fire for longer duration making evacuation and fire control easier.

### Building Industry

Many building applications require a glass exterior but at the same time need to minimise sound transmission, such as a restaurant on a busy street. For this reason, laminated glasses with good acoustic dampening properties are used. Such glasses also offer many of the advantages outlined in 'security applications' below.

### Transport Industry

Laminated glasses are used for windscreens for all forms of transport from cars to trains. They are typically PVB laminated glass using a thicker interlayer of about 0.76mm. This gives the material a good resistance to penetration from rocks etc while at the same time providing excellent light transmission.

### Security Applications

Many applications require transparent panels for viewing purposes. At the same time they may also need to keep out burglars or bullets, or just provide a safer alternative to float glass. In these cases laminated glasses can provide the solution due to their resistance to shattering and penetration. Safety applications (e.g. shower screens) may use thicknesses as low as 6.38mm (comprising 2 layers of 3mm thick glass with a 0.38mm interlayer), while burglar resistant grades may utilise similar structures, but thicker glass panels. Bullet resistant glasses range in thickness from 24mm to 53mm, depending on what type of weapon they are trying to stop. These glasses may involve several layers of glass each separated by a polymeric interlayer.

## INSULATING (DOUBLE GLAZING) 13

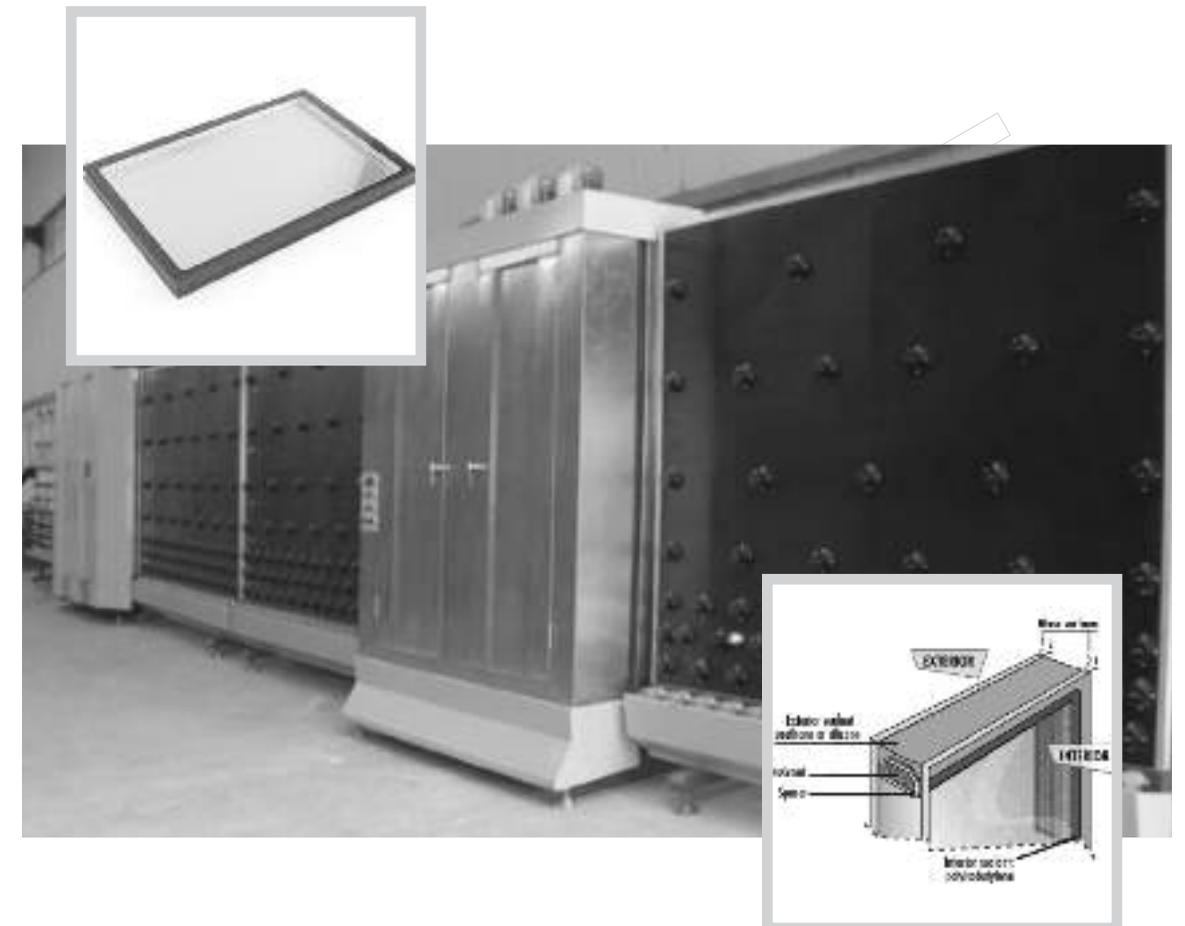
### 13A. Introduction

Glazing is the fusion of two panes of glass for acoustic or thermal insulation. In this process, two panes of glass are separated by a cavity and hermitically sealed, to provide thermal insulation. The air between the glasses is dry which enables lesser heat transfer into the building. Sometimes the medium will be filled with inert gas like Argon which enables better thermal insulation compared to normal air.

Normal U-value in single glazing= 5.7 W/m<sup>2</sup>K.

Conventional double glazing(4-8-4mm unit)= 3.1 W/m<sup>2</sup>K.

The same double glazed unit if filled with argon= 1.6 W/m<sup>2</sup>K.



## 13B. Start Up Procedure:

- Make the pair of glass 1 & 2.
- Check the quality of DM water Example:- pH level & TDS.
- Check water level in the tank & refill if necessary
- Wash the glass
- Check the conductivity of the water before starting the test and write down.
- Check the quality standards of the glass against work order.
- Place the glass on the loading table.
- Set the thickness & speed of conveyer in the control panel.
- Keep the glasses into washing machine for cleaning.
- Check the brushes and water circulation line in washing machine.
- Switch on the washing machine
- Switch on the lightings to inspect the washed glasses.
- 100% visual inspection should be done for any scratches, coating burns, chip off etc.
- Do the molecular sieve test in baker with equal quantity of desiccant and water. Check the temperature and make sure it is more than 45°C.
- Cut the aluminum channels as per work order standard.
- Fill the molecular sieves in the aluminum channel and make the complete frame.
- Check the temperature 132°C in butyl extruding machine.
- Apply the primary sealant on the aluminum channel (Butyl).
- Fix the frame on the glass after leaving 6mm gap all the four side of the glass.
- Fix the aluminum frame in between two glass and send this unit for pressing.
- Set the pressure for pressing. Time will be determined by the sensor.
- Switch the sealant gun and set the proper adjustments to give the good result in sealant mixing.
- Apply the secondary sealant of Poly sulphide / silicon uniformly on edges using the gun provided in machine.
- Ensure the sealant in properly finished without any gap or air bubbles.
- After sealant work completion, it has to be dried 24 Hours before dispatch.
- Cleaning and inspection should be carried before dispatch.



### Butyl in Insulated Glass

It is a primary sealant fix to the aluminium spacers.

It will hold on to the glass until the secondary sealant is applied.

Aluminium spacers will be uniformly holded on to the glass.

Heat is transferred through insulating units via radiation. Conductive or convective heat transfer routes. The use of low -E(low emissivity) coatings has dramatically improved the radiation heat transfer through glass by selectively allowing only some types(or wavelengths) of radiation to pass.

### Slump Test

A slump test should be run on every lot of silicone sealant to ensure that the sealant will not slump out of the insulating glass unit joint after tooling or wet packing. Failure of the sealant to remain non-slump can cause excessive and unnecessary waste in time, labor, and material.

### Adhesion Test

An adhesion test should be performed to ensure that the sealant gives acceptable adhesion to glass and spacer surfaces. A production-grade clean piece of glass or spacer should be used. Apply a bead of silicone sealant to the clean surfaces. The testing can be performed on a peel adhesion sample containing a mesh screen that can be pulled back at 180° or a tooled bead of sealant that can be pulled back with your finger. Allow the sealant to cure for a specified time. After the specified time period, pull on the sealant and visually inspect for the mode of sealant failure. “Cohesive failure” where the sealant tears within in itself and remains adhered to the substrate is desirable versus “adhesive failure” where it completely pulls away from the substrate. Perform adhesion testing on every sealant lot used in production. The sealant should yield cohesive failure, not adhesive failure, at the bond surface. Adhesive failure can result from inadequate surface cleaning, variability in the glass or spacer surface, or an unacceptable sealant lot. One way to trouble shoot if adhesive failure was caused by inadequate cleaning of a substrate is to perform adhesion testing with a production-grade clean substrate side-by-side with a production grade substrate that has been solvent cleaned.

### Butterfly Test

Butterfly tests should be performed with multi-component sealants at least every time a pump is started, if not intermittently throughout the day's production. The purpose of the butterfly test is to check for an adequate mix of base and curing agent components. The test is performed by dispensing a bead of sealant onto a piece of paper or cardboard, folding the paper in half, smearing down the sealant bead, and then reopening the paper. Visually inspect the sealant smear. When a pump is first started up, the smear will appear predominantly white. This is because the equipment lines should have been base purged at the previous shutdown. Continue to make sealant smears and inspect for white streaks. When the sample appears to be uniform in color with no white streaks, the sealant is fully mixed.

## 13C. Desiccant Filling

Desiccant filling must be done to remove moisture content inside the Insulated glass. It must be filled inside the aluminum frame channel before sealing the glass.

### 13Ci. Desiccant Filling Machine

- Clean and lubricate the machine.
- Clean the machine table thoroughly using cotton cloth
- Open the lid to check the quality of molecular sieves with Thermometer Gel test. If this is less than the standard it must be removed to fill new stock.
- Fill the molecular sieve properly in container.
- Switch on the machine and turn the key to start the machine.
- Set up the machine properly and press start button for drilling and filling of silica gel.
- Change the drill if necessary and check the holder condition. If not suitable, change immediately.
- Press the drill button to make the hole.
- Also check the channel frequently.
- If all settings are found ok then you can go to auto mode by turning button. For every operation just press leg pad to start auto. After filling gel check the level and close the hole by applying butyl paste.

#### Sealant Application Recommendations

A combination of factors determines the long-term success or failure of an insulating glass unit. These factors include: sealant pre-testing and qualification, insulating glass production workmanship, and inhouse quality control testing.

#### Sealant Pre-Testing

Contact the silicone sealant supplier's technical service and development group to outline any sealant testing that is necessary to confirm that a particular silicone sealant will work properly in a unit before using the sealant in production. Each silicone sealant supplier can perform a variety of tests.

For example, a silicone supplier can test a particular silicone sealant for adhesion to any new spacers or glass coatings. This up-front adhesion testing can prevent unexpected sealant adhesion loss in units after installation in the field. Certain sealant tensile strength or modulus requirements can also be tested. If there are specific sealant cure rate requirements, the silicone sealant supplier can advise you as to which sealant or mix ratio to use (multi-component sealants).

#### Production Workmanship

Production workmanship is critical to the success of sealing with silicone sealants. Proper cleaning, assembling, and equipment maintenance of other insulating glass unit components used in conjunction with the silicone sealant are essential. An partial list of component key points to remember when assembly units include:

#### Corner Keys

Corner keys must be dry and clean.

Corner keys must fit tightly into the spacer bar.

Soldering or butyl injection of corner keys is recommended.

#### Spacers

Spacers must be clean, dry, and free of grease, etc.

Spacers must be properly aligned on the glass.

#### Desiccant

Proper amounts of desiccant should be used.

Desiccant must be dry at the time of installation; do not use already spent desiccant.

#### Glass

Glass surfaces must be properly cleaned and free of fingerprints. Proper maintenance of glass

cleaning equipment and solution is essential.

Glass lites should have no edge defects or inconsistencies.

Glass lites must be properly aligned with the spacer.

#### PIB Primary Seal

Primary seal must be applied in a continuous, uninterrupted bead, free of voids or skips. No excess

PIB should protrude into the secondary seal cavity.

Primary seal must be uniformly and sufficiently pressed to give an even thickness and good adhesion to the glass and spacer surfaces.

#### Silicone Secondary Seal

Multicomponent sealants must be fully mixed and used at the proper mix ratio.

Sealant must be applied in a continuous, uninterrupted bead, free of skips or voids.

Sealant should be tooled into position immediately.

## 13Cii. Argon Gas

The purpose of gas filing is typically to reduce the heat transfer and improve the energy efficiency of the insulating glass unit. Gas filling can also be a means of reducing the sound transfer through an insulating glass unit and improving the acoustical properties.

- To avoid moisture content air entering into the insulated glass after DGU Argon Gas is filled.
- Clean & lubricate the machine.
- Close the air pressure valve before connecting Air tubes to machine control.
- After connecting release the valve slowly and check for any leakage in supply. If found, close the valve and tight all connections.
- Make one hole at edge and fill the gas with nozzle. Check with air gap gauge and make sure Air gap is less / equal to the spacer thickness.

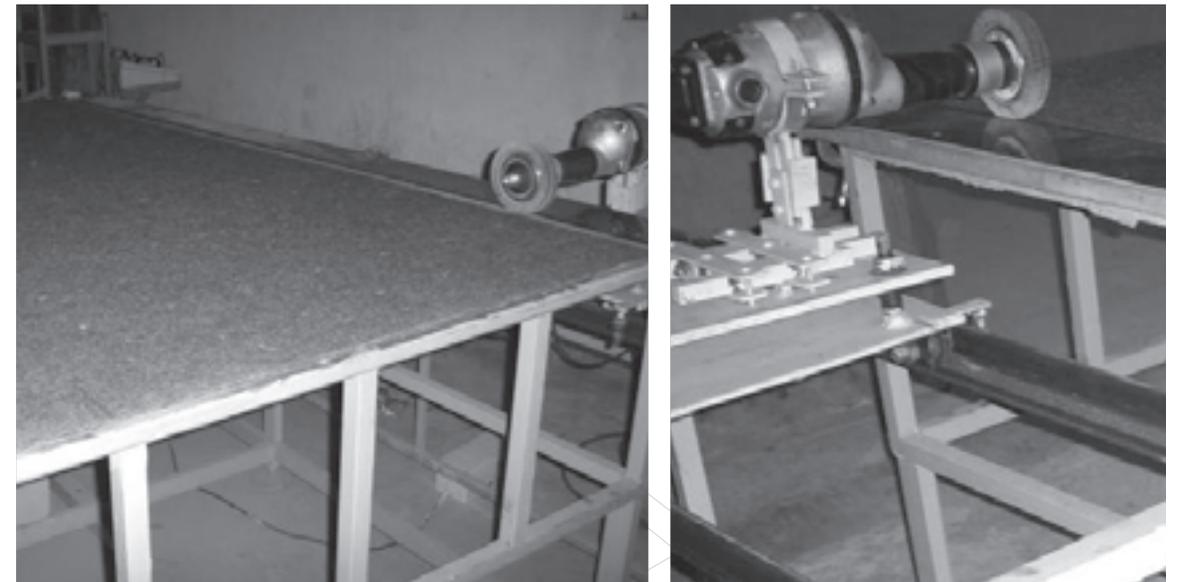
## 13D. Edge Deletion Machine

This is used for removing the low-e perimeter (softcoat) surface coating from the edge of a glass panel prior to its use in an insulated glass sealed unit. Edge deletion is necessary because the low-e coating on the glass surface affects adhesion with insulated glass sealants. Removal of the edge coating means that the sealant can bond directly to the glass.



## 13D(I). Procedure

- Clean the machine table thoroughly using Air gun and Lubricate the machine
- Check the quality of wheel. Make sure that proper grade is selected.
- Insert the energy wheel to machine spindle frequently and check the arrow direction.
- Insert the chuck nut and tighten it to give proper torque.
- Switch on the machine main switch.
- Release the C clamp to set the guide.
- Align guide as per required edge deletion in the edger of the glass
- Load the glass with coating on top. Switch on the blower to adjust the glass in table guide level
- Start the grinding machine to move across the edges of coated glass.



## 13D(ii). Application of Insulated Glass

- Insulated glass can be used in facade of the building. Insulated glass is also used in Train Coaches.
- Insulated glass can be used, where ever a heat loss minimization is a must, like refrigerator.
- Insulated glass is much better in sound reduction compared to a single toughened glass of same thickness.=

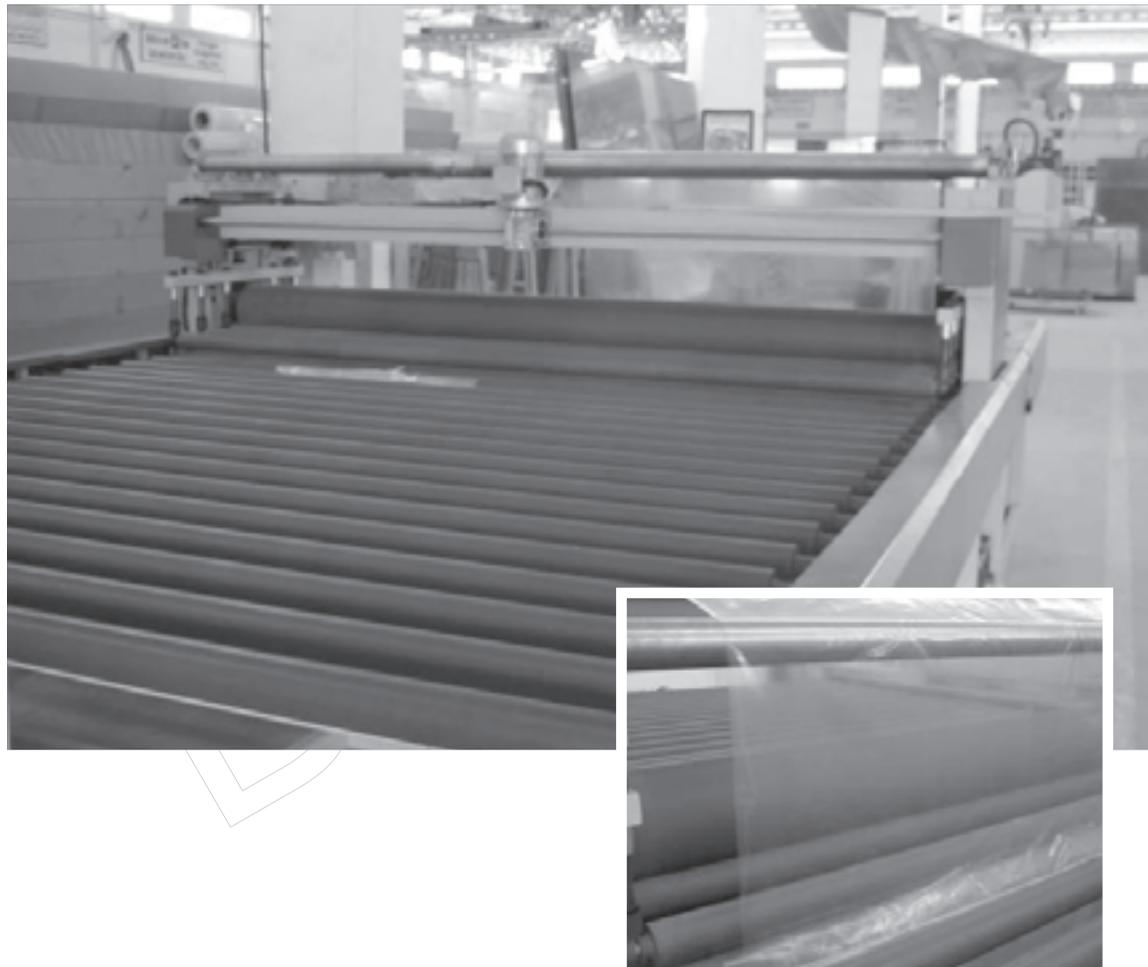
## SURFACE PROTECTION FILM

14

### 14A. Introduction

Surface protection film is self adhering, and is applied to glass after the processing. This film protects the glass during transportation, fabrication and installation. Unprotected glass panels have higher chances of getting scratches and other damages.

To avoid cement, paints and dust in the construction working area directly sticking or accumulating on the glass. Insulated glasses can be clean easily of extra sealant spread on the glass. To protect the coated glass like reflective glasses, ceramic frit glasses from scratches and dirt.



## DISPATCH

15

### 15A. Introduction

Ensuring the processed glass is checked and dispatched to the customers in time is most crucial for any glass processing unit. Follow the guidelines given here to run an efficient dispatch section.



## 15B. Procedure

- Work Orders Copy
- Visual inspection of the glass for chip outs, scratches, polish Finishing.
- Check the dimension of the glass with size, drawings, colour of the glass, type of the glass, thickness of the glass.
- As per customer specification processed glass has to be checked thoroughly along with drawings.
- Suitable vehicle has to be arrange as per the sizes of the glass.
- While loading the glass into the vehicle use separators in between two glass to avoid scratches.
- If customers requires the glass to be packed & sealed follow as per the instructions given by them.
- Dispatch the material once quality inspector has given the approval to dispatch.
- No partial dispatch to be done.
- Along with the invoice copy packing slip submitted thickness to the customer.
- Once the glasses are loaded separators has been fixed use belt strings to secure the glasses to the vehicle.
- Load the bigger dimension glasses on to the vehicle first then smaller dimension glasses to be loaded.
- Individual glasses has to be identified with marked stickers which will be giving full details of glass size, specification, colour, type of glass and process of glass.
- Confirm with the customer before dispatching of the material for the availability of their personnels at the delivery spot to handover the same.



# SAFETY

16

## 16A. Introduction

**S**AFETY is part of everyday living. It is an important consideration for everyone in everything he/she does, in the home, at work or play, on streets and highways – wherever he/she goes. Safe operating practices and procedures are vital in the Glass Processing Industry because the work is hazardous, which involves massive machinery, heavy tools and great physical strength.

When accidents do occur, the work can cause serious damages to limb and life. Glass Processing Staff must know how to work safely on a rig in order to protect themselves & costly equipment. More than 90 % of all accidents are avoidable, being caused by human error rather than by mechanical failure.

## 16B. Safety Factors

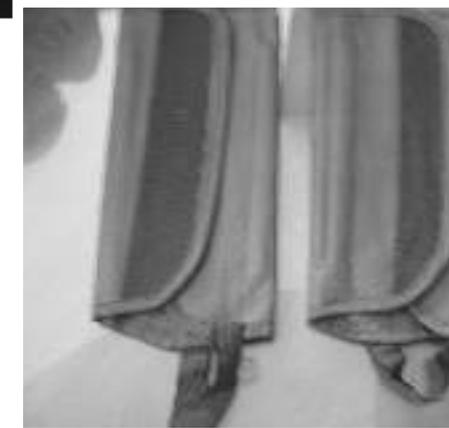
### Factors Responsible for Accidents in Technical Jobs

The following are the common causes:

- Inadequate knowledge of the job.
- Lack of suitable working environments and proper facilities for work
- Urge to do a job hurriedly.
- To work more than one's capacity.
- Urge to earn maximum money in minimum time.
- Lack of proper machines and tools.

### Safety Tips

- While working in a workshop, one must wear only fit clothes and avoid wearing loose ones like dhoti, kurta, pajama etc, because loose clothes carry the risk of being caught in the running belts of machines.
- Use of neckties, muffler, shawls etc must be avoided
- Personal protective equipments required for each department
- Helmet is mandatory for everyone working in the factory.
- Arm guard is mandatory as cut injuries are possible due to lifting of cut glass.
- Gloves are mandatory handling glass.
- Leg guard is mandatory as it can damage the ankle.
- Safety shoes are mandatory for all the shop floor personnel.



## 16C. What is Safety

Some preventive measures of plans for freedom from risk of injury to body, risk of impairment of health and Damage to Property. OR  
Freedom from the risk of Accident.  
Freedom from – Personal Injury, Property damage, Losses of various kinds.

## 16D. IMPORTANCE OF SAFETY

Safety is important because – Accidents cause pain and sufferings.  
Accidents are costly.  
Accidents lower morale and decrease productivity.  
Accidents reflect poorly on the management.  
Cost of prevention of accident is lower than cost of handling them ( after they have occurred).

## 16E. COST OF ACCIDENT

### Direct Cost

- Damage to building, M/c, contents etc.
- Injuries & Death
- Payment by way of compensation to the accident victims
- Medical Expenses

### Indirect Cost

- Loss of payment to the injured person
- Loss of expertise and skill of the victims
- Loss of schedule & income
- Loss of profit due to business interruptions
- Continuing expenses
- Loss of market etc.

## 16F. Why Safety

Unsafe conditions and unsafe acts result in one or more of following:

- 
- Loss of production / project for the management.
- Loss of the employee's earnings.
- Damage to plant and machinery.
- Premature death of employee.
- Pain / sufferings / hardships to the injured employee and his family.
- Expenses on medical aid.
- Expenses of recruitment and training of new employees.
- Deterioration in employer – employees relations.
- Loss of employees morale.
- Drop of productivity of the organization.
- Loss of reputation.

All these losses are undesirable and can be minimized by making plant safer and safer.

- Safety in industry helps in – Improving production / productivity.
- Reducing production cost.
- Reducing damage to plant and machinery.
- Preventing premature death of skilled workers (loss to the society).
- Avoiding needless pain and suffering to the employees and their families.

## 16G. What is Your Role ?

- Investigate accidents immediately
- Provide HR with investigation report within 24-30 hours of accident
- Provide leadership
- Provide safety training
- Conduct safety meeting
- Provide written rules
- Assess Personal Protective Equip.
- Provide Personal Protective Equip.
- Follow Safety & Health Regulations
- Provide Emergency Preparedness
- Perform Incident Investigations
- Use Safety Consultations
- Review & Revise Safety Program

## 16H. PPE

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Personal protective equipment should not be used as a substitute for engineering, work practice, and/or administrative controls.

Personal protective equipment should be used in conjunction with these controls to provide for employee safety and health in the workplace.

Personal protective equipment includes all clothing and other work accessories designed to create a barrier against workplace hazards. Selection of the proper personal protective equipment for a job is important.

Employers and employees must understand the equipment's purpose and its limitations. The equipment must not be altered or removed even though an employee may find it uncomfortable.

## 16I. Training

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Before doing work requiring use of personal protective equipment, employees must be trained to know; when personal protective equipment is necessary; what type is necessary; how it is to be worn; and what its limitations are, as well as know its proper care, maintenance, useful life, and disposal.

In many cases more than one type of personal protective equipment will provide adequate protection. In those instances employees should be given a choice.

Employers are required to certify in writing that training has been carried out and that employees understand it. Each written certification shall contain the name of each employee trained, the date(s) of training, and identify the subject of the certification.