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**Lecture - 50**  
**Quality Testing Part II**

Now, we are going to understand the quality plans that will be helpful during the process. We will be going through each of the quality plans let us take cutting, quality standards we follow.

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QUALITY PLAN ( CUTTING ) AS PER EN 572/ EN 1096/ EN1863/ EN12150					
REV NO:4.0			DATE:01.01.2017		
METHOD	REQUIREMENT				FREQUENCY OF TEST
VERNIER CALIPER / MICRO METER	THK TOLERANCE FOR GLASS TYPE				
	THK	FLOAT	PATTERNED	DRAWN SHEET	
	3	±0.2	±0.5	±0.2	NOT MANUFACTURED
	4	±0.2	±0.5	±0.2	±0.3
	5	±0.2	±0.5	±0.3	NOT MANUFACTURED
	6	±0.2	±0.5	±0.3	±0.3
	8	±0.3	±0.8	±0.4	NOT MANUFACTURED
	10	±0.3	±1.0	±0.5	NOT MANUFACTURED
	12	±0.3	±1.5	±0.6	NOT MANUFACTURED
	15	±0.5			
19	±1.0				
15	±1.0				

So, basically in cutting we are basically dealing with the raw glass. So, it covers EN 572 which is for clear glass EN 1096 for colour glass and EN 1863 and 12150 for the treatment process where the glass is undergoing. Now, let us take each parameter, what we need to check in the cutting department.



Now, let us take the thickness tolerance for every float glass; let us take the thickness is from 3 mm up to 6 mm. My glass thickness is 3 to 6 mm, the allowable thickness tolerance is plus or minus 0.2 and the frequency of testing shall be for every 2 hours or whenever there is a change of thickness. Now, if my thickness is from 8 to 12 mm, the thickness tolerance is plus or minus 0.3 mm.

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1	THICKNESS (mm)	EN 1863-1:2011 (E), PG8, CL.NO. 6.1	VERNIER CALIPER / MICRO METER	5	±0.2	±0.5	±0.3
				6	±0.2	±0.5	±0.3
				8	±0.3	±0.8	±0.4
				10	±0.3	±1.0	±0.5
				12	±0.3	±1.5	±0.6
				15	±0.5		
				19	±1.0		
2	WIDTH & LENGTH (mm)	EN 1863-1:2011 (E), PG9, CL.NO. 6.2.3	MEASURING TAPE	DIM. OF SIDE		TOLER/	
					THK s8		
				≤2000		±2.0	
				2000 < DIM. ≤ 3000		±3.0	
				>3000		±4.0	
		DIM.	THK s8				
		≤2000		±4			

And if it is for 15 mm thickness that the thickness tolerance is plus or minus 0.5, and for 19 and 25 the thickness tolerance is plus or minus 1.0. Now, let us take the next test parameter that is dimension, width and height. If you see the width and length the method that; the test method what we follow is the measuring tape.

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		DIM. OF SIDE	TOLERANCE		
PG9, CL NO. 6.2.3	MEASURING TAPE		THK ≤8	THK >8	ONCE IN 2HRS
		≤2000	±2.0	±3.0	
		2000 < DIM. ≤ 3000	±3.0	±4.0	
		>3000	±4.0	±5.0	
PG10, CL NO. 6.2.3	MEASURING TAPE	DIM.	THK ≤8	THK >8	ONCE IN 2HRS
		≤2000	±4	±6	
		2000 < DIM. ≤ 3000	±6	±8	
		>3000	±8	±10	
PG13, CL NO.7.4	MEASURING TAPE	TYPES	MAIN AREA	EDGE AREA	ONCE IN 2HRS
		>75 mm	NOT ALLOWED	ALLOWED AS LONG AS THEY ARE SEPARATED BY > 50 MM	
		< 75 mm	ALLOWED AS LONG AS LOCAL DENSITY IS NOT VISUALLY DISTURBING	ALLOWED AS LONG AS LOCAL DENSITY IS NOT VISUALLY DISTURBING	
		TYPES	MAIN AREA	EDGE AREA	

And it is based on for example, my panel size is less than or equal to 2000 mm and my glass thickness is less than or equal to 8 mm, the dimensional tolerance allowed is plus or minus 2 mm. And for the thickness more than 8 mm, the dimensional tolerance allowed is plus or minus 3 mm.

In the same way if my panel size is between 2000 and 3000 mm, for the glass thickness less than or equal to 8 mm, the thickness allowed is plus or minus 3 mm and for the thickness more than 8 mm the dimension tolerance allowed is plus or minus 4 mm. If my panel size is more than 3000 mm and my thickness is less than or equal to 8 mm, the dimensional tolerance allowed is plus or minus 4 mm. And for the thickness more than 8 mm the dimension tolerance allowed is plus or minus 5 mm and the frequency of testing shall be for every 2 hours. Next let us take the diagonal measurement; the test method what we follow is the measuring tape.

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		2000 < DIM ≤ 3000	> 3000	±3.0	±4.0	
		±4.0	±5.0			
		DIM	THK ≤ 8	THK > 8		
G10, CL NO. 6.2.3	MEASURING TAPE	±4.0	±6	±8		ONCE IN 2HRS
		2000 < DIM ≤ 3000	> 3000	±8	±10	
		TYPES	MAIN AREA	EDGE AREA		
PG13, CL NO.7.4	MEASURING TAPE	> 75 mm	NOT ALLOWED	ALLOWED AS LONG AS THEY ARE SEPARATED BY > 50 MM		EV
		< 75 mm	ALLOWED AS LONG AS LOCAL DENSITY IS NOT VISUALLY DISTURBING	ALLOWED AS LONG AS LOCAL DENSITY IS NOT VISUALLY DISTURBING		
		TYPES	MAIN AREA	EDGE AREA		
PG13, CL NO.7.4	MEASURING TAPE	> 3 mm	NOT ALLOWED	NOT ALLOWED		EV
		> 2 mm and < 3 mm	ALLOWED IF NOT MORE THAN 1/M2	ALLOWED IF NOT MORE THAN 1/M2		
			MAIN AREA	EDGE AREA		

And for this; if my panel size is less than or equal to 2000 mm and my thickness is less than or equal to 8 mm, the diagonal tolerance allowed is less than or equal to 4 mm. And for the thickness more than 8 mm, the diagonal tolerance allowed is less than or equal to 6 mm. If my panel size is between 2000 and 3000 mm and the thickness is less than or equal to 8 mm the diagonal tolerance allowed is less than or equal to 6 mm, and for the thickness more than 8 mm, the diagonal tolerance allowed is less than or equal to 8 mm.

If my panel size is more than 3000 mm and the thickness is less than or equal to 8 mm, the diagonal tolerance allowed is less than or equal to 8 mm and for the thickness less than or equal to 8 for the thickness greater than 8 mm the diagonal tolerance allowed is less than or equal to 10 mm and the frequency of testing shall be for every 2 hours. Next let us discuss on scratches pinholes and clusters. Describe the standards what we follow is EN 1096 and it is measured through measuring tape.

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MEASURING TAPE	TYPES	MAIN AREA	EDGE AREA
2000-DIM. ≤ 3000		≤ 6	≤ 8
> 3000		≤ 8	≤ 10
-I-1998 (E), PG13, CL NO.7.4	> 75 mm	NOT ALLOWED	ALLOWED AS LONG AS THEY ARE SEPARATED BY > 50 MM
	< 75 mm	ALLOWED AS LONG AS LOCAL DENSITY IS NOT VISUALLY DISTURBING	ALLOWED AS LONG AS LOCAL DENSITY IS NOT VISUALLY DISTURBING
-I-1998 (E), PG13, CL NO.7.4	> 3 mm	NOT ALLOWED	NOT ALLOWED
	> 2 mm and < 3 mm	ALLOWED IF NOT MORE THAN 1M <sup>2</sup>	ALLOWED IF NOT MORE THAN 1M <sup>2</sup>
-I-1998 (E), PG13, CL NO.7.4		NOT ALLOWED	ALLOWED AS LONG AS NOT IN AREA OF THROUGH VISION

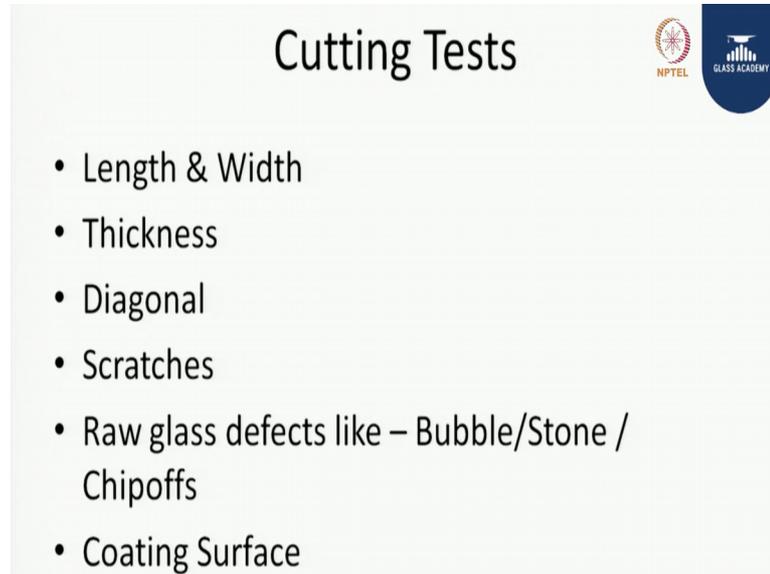
And for in order to measure the scratches we need to consider whether the scratch is in the main area or edge area and based on the intensity, whether it is a medium scratch or a heavy scratch or a light scratch, we need to analyze. If my scratch length is more than 75 mm, in the main area it is not allowed; and if you see the edge area it is allowed as long as the scratches are separated by a distance of more than 50 mm and the frequency of testing shall be for every glass. If my scratch length is less than 75 mm, in the main area it is allowed as long as the density is not visually disturbing and in the edge area it is allowed as long as the scratch is allowed as long as it is not visually disturbing.

When you see the spots or the pinholes, the standard what we follow is EN 1096, and the tool what we use is a measuring tape and again if you see the spots or pinholes we need to understand with respect to main area and the edge area. If my spot or pinhole length is more than 3 mm in the main area it is not allowed, and in the edge area also it is not allowed. If you see my spot or pinhole length is between 2 to 3 mm, in the main area it is allowed if it is not more than 1 by square meter or it is allowed only if it is not more than 1 by square meter.

When you see the clusters the standard what we follow is EN 1096 and again the tool what we use is a measuring tape, in the main area it is not allowed as we will as in the edge area it is allowed as long as the visual intensity or the vision is not disturbed and

these tests will be done on every glass. Now, we will be understanding the various lab tests, that a glass undergoes, let us take cutting test.

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The slide is titled "Cutting Tests" and features a bulleted list of tests. In the top right corner, there are two logos: NPTEL (National Programme on Technology Enhanced Learning) and Glass Academy.

- Length & Width
- Thickness
- Diagonal
- Scratches
- Raw glass defects like – Bubble/Stone / Chipoffs
- Coating Surface

What are the test that a glass goes in cutting department. Generally in cutting department the glass goes through the below test, first one is the length and width we need to measure the dimensions of the glass with respect to height and width that for that we will be using a measuring tape.

Next we will be checking the thickness of the glass with the help of vernier caliper next we need to check the diagonal to avoid the mismatch of the glass at the right angles, we need to see visually the scratches and also the raw glass defects like bubbles, stones and chip offs, and coating surface identification should be always there and the coating should be at a top of the bed. This is a test that we are going to do it cutting section.

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<b>Cutting</b>	
PURPOSE	To check - Thickness, Dimension, Diagonal, Coating surface & Visual checks on glass
1	 <p>&lt;1&gt; Glass Thk is measured using Thickness meter, like- Vernier Caliper / Micro Meter. &lt;2&gt; The measurement shall be taken at the centres of the 4 sides. &lt;3&gt; The acceptable Thk tolerance are -  <math>\pm 0.2</math>mm for 3-6mm thk, <math>\pm 0.3</math>mm for 8-12mm thk, <math>\pm 0.5</math> for 15mm thk, <math>\pm 1.0</math>mm for 19&amp;25mm thk</p>
2	 <p>&lt;1&gt; Glass Width &amp; Length are measured using Measuring Tape &lt;2&gt; In general, the first dimension shall be the Width, and the second dimension the Length &lt;3&gt; The acceptable tolerance on Width &amp; Length are : <math>\pm 2.0</math> mm for thk <math>\leq 8</math> &amp; <math>\pm 3.0</math> mm for thk <math>&gt; 8</math>mm for dim. <math>\leq 2000</math>mm , (i) <math>\pm 3.0</math> mm for thk <math>\leq 8</math> &amp; <math>\pm 4.0</math> mm for thk <math>&gt; 8</math>mm for dim. <math>2000 &lt; B</math> or <math>H \leq 3000</math>, (ii) <math>\pm 4.0</math> mm for thk <math>\leq 8</math> &amp; <math>\pm 5.0</math> mm for thk <math>&gt; 8</math>mm for dim. <math>&gt; 3000</math>mm</p>
3	 <p>&lt;1&gt; Glass Diagonal are measured using Measuring Tape &lt;2&gt; The acceptable tolerance for the difference between diagonals: <math>\leq 4</math> mm for thk <math>\leq 8</math> &amp; <math>\leq 6</math> mm for thk <math>&gt; 8</math>mm for dim. <math>\leq 2000</math>mm , (ii) <math>\leq 6</math> mm for thk <math>\leq 8</math> &amp; <math>\leq 8</math> mm for thk <math>&gt; 8</math>mm for dim. <math>2000 &lt; B</math> or <math>H \leq 3000</math>, (iii) <math>\leq 8</math> mm for thk <math>\leq 8</math> &amp; <math>\leq 8</math> mm for thk <math>&gt; 8</math>mm for dim. <math>&gt; 3000</math>mm</p>

Let us take cutting; in cutting section; we are going to focus on thickness of the glass, dimensions of the glass, diagonal we will be focusing on coating as well as we will be focusing on visual inspection like spot or linear defects on chip offs. So, let us understand everyone in detail.

Let us take glass thickness. So, the glass thickness based on the customer enquiry, we will be measuring with vernier caliper our micrometer, the measurement shall be taken at the center of the 4 sides. The acceptable thickness tolerance is plus or minus 0.2 for 3 to 6 mm thick plus or minus 0.3 for 8 to 12 mm thick and plus or minus 0.5 plus 15 mm thick and plus or minus 1 for 19 to 25 mm thickness.

Next let us understand the dimensions phenomenon. The glass width and length are measured using a measuring tape that the first dimension shall in general be width followed by the dia length. The acceptable tolerances for width and length are plus or minus 2 mm for the thickness less than or equal to 8 mm, and plus or minus 3 mm for the thickness more than 8 mm when my dimension of the panel is less than or equal to 2000 mm.

When it is plus or minus 3 mm for the thickness less than or equal to 8 mm, and plus or minus 4 mm for the thickness more than 8 mm when my panel dimension is between 2000 and 3000 mm. And it is plus or minus 4 mm for the thickness less than equal to 8

mm and plus or minus 5 mm for the thickness more than 8 mm when my dimension is more than 3000 mm now, let us understand the diagonal phenomenon.

The glass diagonals are measured using a measuring tape; the acceptable tolerances for the difference between the diagonals is less than or equal to 4 mm for the thickness less than or equal to 8 and less than or equal to 6 mm, and it is less than or equal to 6 mm for the thickness more than 8 mm. So, the dimensions less than 2000 mm and the diagonal difference is less than or equal to 6 mm for the thickness less than or equal to 8 mm and less than or equal to 8 mm for the thickness more than 8 mm if the if my panel size is between 2000 and 3000 mm. And it is less than or equal to 8 mm for the thickness less than or equal to 8 mm and less than or equal to 8 mm for the thickness more than 8 mm when my panels or dimension is more than 3000 mm; when my diagonal dimension measures more than 3000 mm.

Next point of inspection in cutting is coating surface identification. If you say in the figure, if you take any glass a single glazing unit it will have two surfaces namely surface 1 and surface 2. We can call it as a coating surface and non-coating surface. These are simple method identification of the coating surface by pencil test. Just we need to place the pencil on the top of the glass surface if you are able to feel a single point of impression, that indicates it is a coating surface. When you are able to see multiple infractions or images of the object it indicates it is a non-coated glass or surface.

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**Cutting**

4	Identification of the coated face - Pencil test: bring the tip of a pencil to bear on the glass. If the reflection is double, pencil is pointing on the glass side. If the reflection is single, it is pointing on the coating side	5	Visual Inspection for Spot / Linear defects / Chip offs
RESULTS		In accordance with EN 572 / 1096 / 1863 / 12150	

Next coming is your visual inspections like spots linear defects or chip offs in the kind of chipping or scratches. That we will be measured based on the intensity of the defect and at a particular distance what is the distance it is visible; whether it is from 1 meter, 2 meter and 3 meter and the intensity is light, medium or heavy. So, this concludes our cutting inspection.

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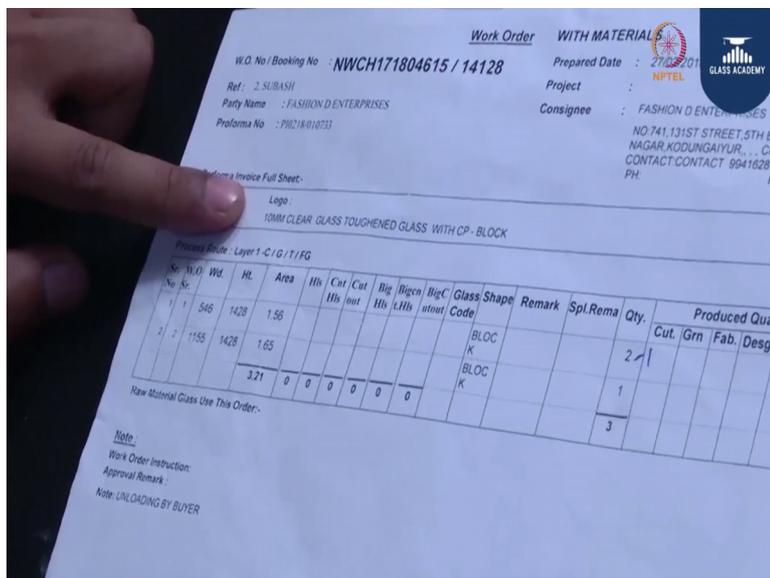
Which is the (Refer Time: 10:43) they are going to place a (Refer Time: 10:46) and they are going to pick up the (Refer Time: 10:49) you can see the (Refer Time: 10:53) one glass (Refer Time: 11:12) taking cutting belt now it is going to cutting bend, now it is getting aligned with the cutting table.

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Through the conveyed belt, now it is moving to cutting belt. Now the glass in the cutting belt you can see one more (Refer Time: 11:46) is getting lifted with autoloader.

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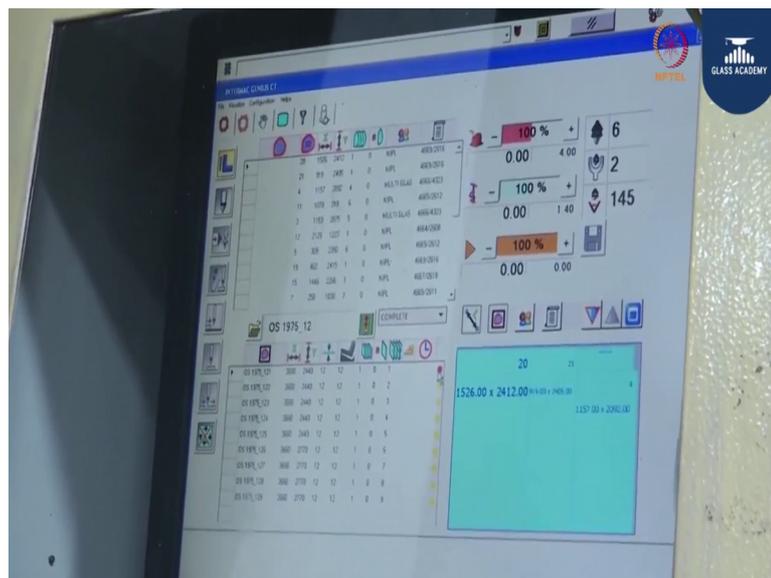


Say this is the order what cutting (Refer Time: 12:10). You say this is the work order, the tracing of this order is done through the (Refer Time: 12:15) work order. In the work order sometimes it might be different display, because this slipping number will give you the traceability. And next one the if this is the particular marketing reference, marketing person who has referred to the particular order, and the customer name is fashion d

enterprises and the billing address is this is the billing address instead of market name is there (Refer Time: 12:35) mentioned here and these are (Refer Time: 12:36) delivery date (Refer Time: 12:38) go to the customer. If you see this is the specification of the glass which describes, but thickness of the glass is 10 mm and the type of glass is clear glass and during the problem it has to be done toughening and the type of edge grinding is CP and it is a rectangular glass.

In this particular order if you see the width and height are given, and the area square meter is given here; if at all the glass is having holes or cut outs, that will be mentioned here and the shape it is a rectangular glass and the quantity is 2. During the process the, doing the process this is the good card, you can say cutting grinding fabricate and design tempering laminated Dgu and dispatch. So, through this process the glass is going to get and ready for dispatch.

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Now, we are going to create the sizes in the CNC machine, here the intention the main purpose of the cutting operator is to maximize the yield and minimize the wastage. So, the proper selection of heat and the feeding of the (Refer Time: 13:33) will give you the wastage any percentage. You can see that is the perfect cut this is a software used for optimization, you can see the sheets and the sizes of that is parent and (Refer Time: 13:43) designing frequency; totally 4 sizes are coming in this particular sheet.

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Now, first head will be positioned in home position and now it is getting just pouring over the help of cutting oil, it will do impression to the glass. It will have cutting wheels inside the that head, based on glass thickness different cutting deals can be used for 12 mm thickness gives 155 angle cutting wheel.

Now it is making the marking on the glass. Now it is moving to the breaking table through the gun wear, now it is going to moving to the breaking table. You can see the glass is moving through air; you can see the bottom you can find blower and it is moving through on air. Now with the help of tool they are able to break the excess glass; these are punching tool pinching tool which will be used to remove the excess (Refer Time: 15:46).

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Now, he is writing the remarks or sizes on the glass.

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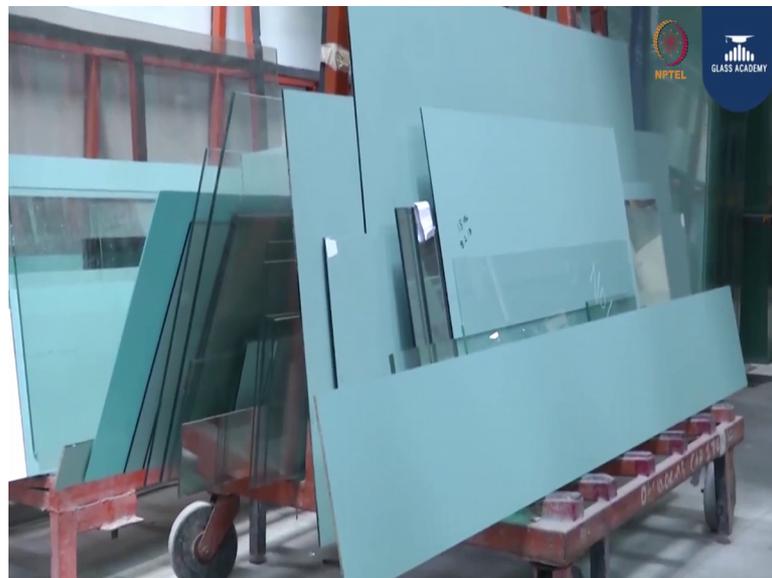


So, here we need to make sure that all the operators who are lifting glasses are wearing aprons, arm guards, gloves and safety shoe. Now you see they have switched on the blower for the air and the movement of the glass, with help of pedal they are going to break the glass that is the breaker. Now you see he is removing the excess (Refer Time: 16:37) on the glass. Wait come this side, we need to make sure that the cutting belt is

always free from debris to avoid scratches on the glass. This is of cut where they are going to is the scrap material.

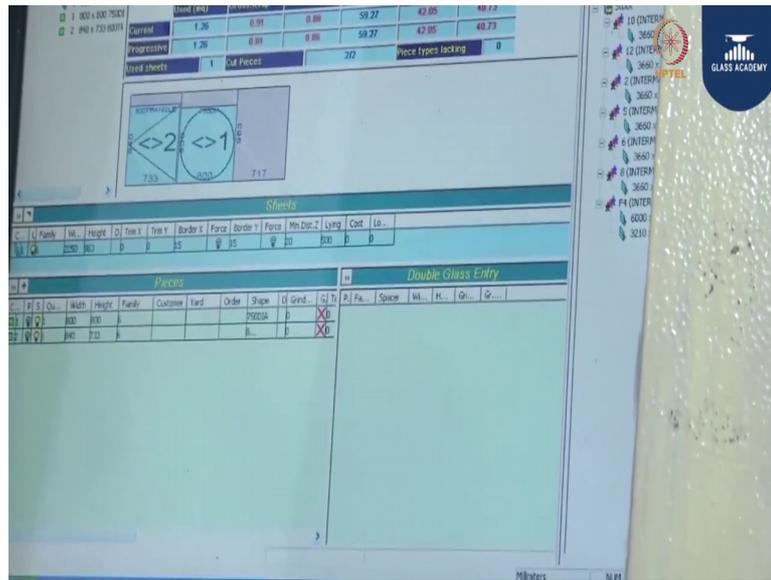
Now, you see in cutting they will be measuring the dimensions, that is weight they will be measuring the height, they will be checking even diagonal also. So, they will be noting the measurement whether it is as per the customer requirement or not. If you see they are using paper as a interleaving to avoid the direct coordinate to the glass. If you see the edges are sharp, now it is going for grinding section.

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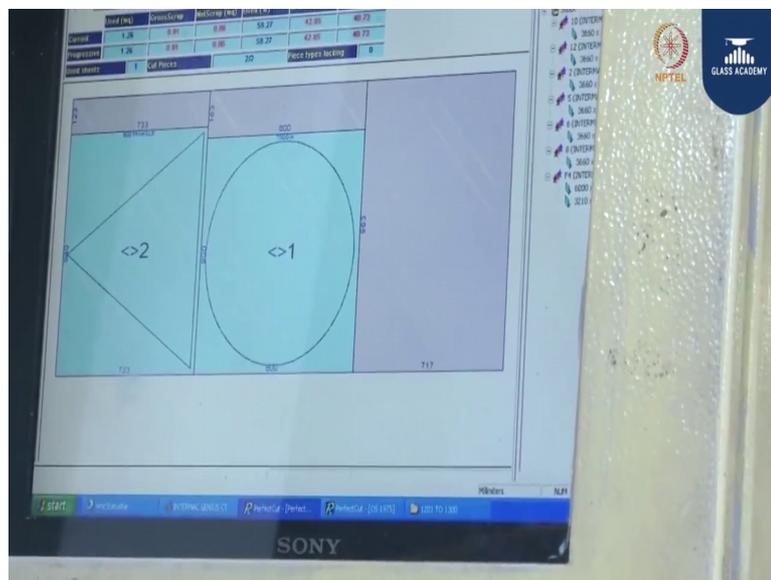
If you see in there all after glasses (Refer Time: 19:32) parent sizes.

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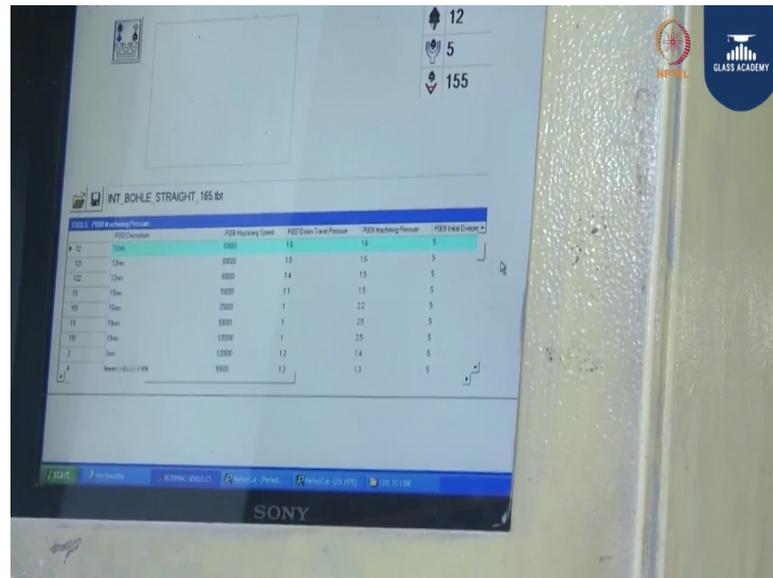
And the (Refer Time: 19:36) sizes (Refer Time: 19:42). Now he is going to do a tape cutting, he is giving the border. To the glass he is selecting appropriate drawing and giving the border to the glass, you can see the layout that is going to be get cut.

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It is the triangle and a circle that is going to be exhibited now.

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Now, he is stating the exhibit (Refer Time: 20:49). Cutting is done basically with one to two bar pressure, and appropriate selection of the cutting wheel based on the glass thickness.

Now, you can see now with the help of cutting edge and the (Refer Time: 21:19) glass is getting marked. So, it is picking the tool. So, it is doing marking, you can say it is taking a shape now. The shape is a circular shapes, it is circular shape, now it is taking a triangle shape tool. So, in this with this machine we can do all types of shape that is required.

Once the marking is done, now it is going to breaking the edges. Now it is going to breaking the edges, you can see the impression you can see the impression. Now he is going to break the proper (Refer Time: 22:20). So, that is the circular glass.

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Now this is that is the manual cutter; with the help of manual cutter they are going to break the glass. That is the manual cutter if you see. See how he is breaking, he is making sure that is the time of breaking the glass not get damaged. So, now, you can see the circular glass has been cut. So, (Refer Time: 23:18) blower for the (Refer Time: 23:21) movement of the glass.

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So, excess glass he is removing you can see this is a triangular glass. Now you can see this is the triangular glass, the glasses having sharp edges that will be grinded in the next

stage. Now online inspection will be done, here he is measuring the dimensions of the glass as per the customer requirement or not. Now if you see for this particular circular glass is measuring the dia; he is measuring the dia for the circular glass.