Technical Guide for Glass Cutting
Section 2 - Three Basic Categories of Cutting

Three basic categories of glass cutting represent the majority of cutting applications – straight-line machine cutting, machine pattern cutting and hand cutting. In this section each category has a brief description of the various cutting functions. There are also listings of process considerations when setting up the cutters, cutting wheel selection guides for the various glass thickness and, some typical in-plant problems associated with the cutting process.

Part 2 – Machine Pattern Cutting

Description of Machine Pattern Cutting

The great bulk of glass that is pattern cut is used in the automotive and truck market for windshields, sidelites, and backlites. Other large markets are furniture table tops (rounds, ovals, etc.), automotive and truck mirrors, architectural shapes, mirror shapes, picture frame shapes, lighting fixtures, optical shapes, etc. Most of the glass used is in the thickness range of 3/32" through 1/2" thick.

Pattern cutting uses both types of cutting – conventional cutting and pressure cutting. Ease of break out will usually determine which type of cutting is used. Ease of break out depends upon two factors – pattern shape and the thickness of the glass in relation to the size of the pattern. Pattern shapes that have corners with small radii or with acute included angles are extremely hard to break out. Also, small pattern shapes using heavier glass are also hard to break out. With these two factors in mind, it is easy to see why pressure cutting is the predominant type of cutting in use.

There are any number of machines of different designs in use today used for pattern cutting glass. These include the still common die ring and template machines that trace the pattern either manually or automatically. Newer machines use digitized pattern shapes either on numerical controllers or computerized numerical controllers. With either tape machines (NC) or computerized machines (CNC) the path of the tool (cutter head) is controlled in terms of direction and speed. In the older template or die ring cutters, the glass is transported into cutting berth and positioned under the pattern and scored. In

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the new CNC/XYZ cutters the glass is transported into the cutting berth where the X and Y drives control the pattern shape and the Z drive controls cutter head rotation. There are any number of methods in use today for pattern break out. Most of these methods use relief cuts placed in certain locations around the perimeter of the pattern. These cuts are scored on the trim or salvage outside the pattern. Relief cuts run from the pattern score to an outside edge but do not intersect with a pattern score or an outside edge. Some machines apply the relief cut in the cutting berth; others apply the relief cuts in the next birth. The sequence of breaking out is normally to open the pattern score first and then open the relief cuts to free the pattern from the trim. The purpose of this sequence is to allow the pattern to be lifted out of the salvage without damage to the pattern edges.

Conventional cutting is used when shallow (8-10% of thickness) fissures will still allow easy break out. This will yield good quality edges and may not require subsequent edge work.

Pressure cutting, on the other hand, results in deeper (17-20% of thickness) fissures and fracture extension of the fissure deeper into the glass. This will make the break out possible and easier but usually requires some kind of edgework. All glass that is to be bent and annealed, bent and tempered, flat and tempered requires either edge seaming or edging.

Break out in the corners of patterns is an ever-present problem. Scoring velocity is a dominant variable because it adds applied load to the cutting wheel resulting in fracture extension down into the thickness. At the corners the cutter head must slow, losing the velocity component of the cutter load, resulting in no fracture extension. To compensate, some machines can program cutter pressure to increase in the corners to create a similar effect. This technique helps but is not totally effective.

There are two very important elements of pattern scoring which greatly effect break out and quality. The first is to start and stop the pattern score at the same point. Stopping short of the start point causes an irregularity in that distance along the opened edge. Overscoring or stopping beyond the startpoint causes destruction of the score in that distance. This results in an edge defect in that distance. The second is to both start and stop at full scoring pressure. Starting to score at a reduced pressure or stopping at a reduced pressure can result in incomplete break out.

Process Considerations for Cutting Set Up for Machine Pattern Cutting (Conventional Cutting)

Check List:

- *Cutting Support* – maximum support directly under path of pattern cutter head. Any voids under path of cutter can result in breakage or shallow fissure depths.
- *Cutting Assembly* – cutting head properly aligned so that wheel is presented perpendicular to glass. Check wheel mount, inserts, and axles for wear - also check linkage (if any) on cutting head.
- *Cutting Wheel* – select cutting wheel diameter and wheel angle from either a predetermined specification or from the "Recommended Wheel Angle" table for the scheduled glass thickness. Assemble cutting wheel in a clean insert and lubricate. Select wheel load from either a predetermined specification or from the "Recommended Wheel Load Chart" for the glass thickness scheduled.
- *Cutting Wheel Finish* – the cutting wheel finish will more than likely be predetermined as "regular grind" (220x). Special products may require a higher finish (800x) or a coarser finish 180x).
- *Cutting Wheel Speed* – pattern scoring speed can be extremely fast but it is important to check to see that the cutter is at full load at both the start and stop positions. With high product throughputs, more glass interleaving particles can collect in the insert/axle/wheel assembly and cause the wheel to drag and not score. The insert should be pulled and cleaned periodically.
- *Glass Cutting Fluid* – if a cutting fluid is used for scoring and to retard healing, the fluid flow should be checked. If a lubricant is used for the wheel assembly only (dry cutting), the wheel assembly has to be pulled out periodically to clean and lubricate the wheel/axel/insert assembly.
- *Cutting Wheel Life* – pattern cutting is a hard service cutting operation. Check to see that cutter head set down is not abusive. Hard set downs will shorten wheel life – also, extremely hard set downs can cause the axle to break. Relief cut scores should start outside the pattern score by at least 1/8" and run toward an outer edge and stop short of the edge. It is important that the retract switch be operational for the glass thickness being processed. If there is no switch or if the switch is not operational, severe damage can be done to the cutting wheels, mount or even the entire cutting head. Glass puncture, breakage or running off of an edge will activate the retract switch.

Process Considerations for Cutting Set Up for Machine Pattern Cutting (Pressure Cutting)

Check List:

- *Cutting Support* – for single bridge CNC/XYZ cutting machines, the glass is normally transported into and out of the cutting berth on a belt running on a good, solid metal surface. Machines with cut out openings for glass transport rolls can expect quality problems when thin glass is scored over these voids. Cutter head supports or cutter head bridges should be rigid enough to resist the upward reaction force from the cutting head.
- *Cutting Assembly* – the cutter head should be properly aligned so that the cutting wheel is presented perpendicular to the glass. Check wheel mount, insert, and axle for wear.
- *Cutting Wheel* – select cutting wheel diameter and wheel angle from either a predetermined specification or from the "Recommended Wheel Angle" table for the glass thickness schedule. Some operations prefer a smaller diameter wheel for patterns with very small radius corners.
- *Cutting Wheel Finish* – based on preference and experience either a regular grind (220x) or a coarse grind (180x) finish may be used.
- *Cutting Wheel Speed* – speed is no problem for the cutting wheel or the wheel mount. It is, however, a major process variable that promotes score fracturing. Check to see that the cutter is at full load at both the start and stop positions. With high product throughputs, more glass interleaving particles can collect in the insert/axle/wheel assembly and cause the wheel to drag and not score. The insert should be pulled and cleaned periodically.
- *Glass Cutting Fluid* – a cutting fluid must be used with pressure cutting – preferably a lubricating oil. Check fluid flow and periodically pull the insert to clean the wheel/axle/insert assembly.
- *Cutting Wheel Life* – cutting wheel life will depend on whether the wheel is abused. Hard set downs will shorten wheel life – also, extremely hard set downs can cause the axle to break. It is important that the retract switch be operational for the glass thickness being processed. If it is not operational or if there is no switch, severe damage can be done to the cutting wheel, mount or even the entire cutting head. Severe damage can occur when puncture breakage or running off an edge occurs.

The following guidelines are divided into two types of cutting – conventional cutting and pressure cutting. Recommendations are for glass ranging from 3/32" thick through 1/2". The cutting wheel angles shown in the tables are intended as starting points to achieve the "target fissure depth" for each glass thickness. For conventional cutting rough figures are shown for applied cutter head force. (in pounds, not psi)

Wheel Selection Guides for Machine Pattern Cutting
(Conventional Cutting)

Most pattern cutting operations follow the guideline of producing the best quality glass edges. In order to achieve this, most machine operators set up their lines or machines to score no deeper than necessary to achieve successful score opening and eliminate or minimize seaming or edging.

All glass in this group is assumed to be float glass with conventional cutting. Target fissure depth is 8-10% of glass thickness. The recommended cutting wheel diameters, cutting wheel angles and wheel loads through the range of 3/32" to 1/2" glass thickness are shown in the table below. The wheel angles and wheel loads are only intended to be starting points to develop quality cutting.

	Glass Thickness						
	in.	.0938	.1250	.1875	.2500	.3125	.3750	.5000
Wheel Code	mm.	2.381	3.175	4.762	6.350	7.938	9.525	12.700
732		128° 3-4 lbs.	134° 4-5 lbs.	138° 6-7 lbs.	145° 10-12 lbs.	148° 14 lbs.	152° 18 lbs.	152° 26 lbs.
532		134° 3-4 lbs.	140° 4-5 lbs.	145° 6-7 lbs.	152° 10-12 lbs.	152° 14 lbs.	154° 18 lbs.	154° 26 lbs.

Notes: Pyrolytic coated glass may have a hard surface and require sharper wheel angles.

Common Processing Problems	**Possible Causes**
• Defect at start/stop	Check for gap between start and stop. Check for pattern score overrun.
• Break out hard – poor edge quality	Check fissure depth all around. Check scoring pressure.
• Break outruns out to edge	Trim too narrow Check fissure depth.

Wheel Selection Guides for Machine Pattern Cutting
(Pressure Cutting)

Pattern cutting operations using pressure cutting follow the guideline of producing the best quality glass edges in spite of deep fissure scoring. In order to achieve this, most machine operators set up their machines or lines to score no deeper than necessary to achieve successful score opening and minimize seaming or edging.

All glass in this group is assumed to be float glass with pressure cutting. Target fissure depth is 17-20% of glass thickness. The recommended cutting wheel diameters and cutting wheel angles through the thickness range of 3/32″ to 1/2″ glass are shown in the table below. The wheel angles are only intended to be starting points to develop quality cutting.

		Glass Thickness						
	in.	.0938	.1250	.1875	.2500	.3125	.3750	.5000
Wheel Code	mm.	2.381	3.175	4.762	6.350	7.938	9.525	12.700
500		--	--	--	--	145°	152°	157°
380		--	--	--	--	152°	157°	160°
732		145°	145°	148°	154°	157°	--	--
532		148°	152°	154°	154°	--	--	--
125		150°	154°	--	--	--	--	--

Common Processing Problems	Possible Causes
• Break out hard to open in spots	Check fissure depth in those spots Check break out method
• Defect at start/stop	Check for gap at start/stop. Check for pattern score overrun.