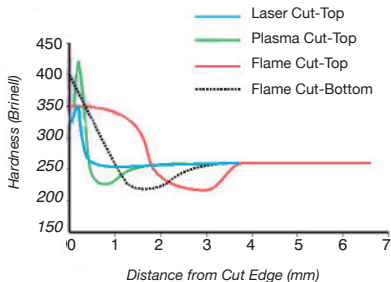


CUTTING BISPLATE®

FLAME CUTTING, PLASMA CUTTING, LASER CUTTING, WATERJET CUTTING AND SAWING RECOMMENDATIONS

All grades of BISPLATE® quenched and tempered steel can be cut by either thermal cutting, laser cutting, waterjet cutting or power saw operations. The cutting operations can be carried out either in the workshop or, in the case of flame cutting, in field conditions. Both the high strength structural grades and the wear and abrasion resistant grades can be cut using the same type of equipment employed in cutting plain carbon steels.

Figure 1a:



Effects of flame, plasma and laser cutting on plate hardness for a 6mm AS3597 Grade 700 steel (BISPLATE® 80). Hardness tests were conducted using the Vickers method and converted to Brinell hardness values (HB).

CUTTING OPERATIONS

Dependant on the grade and thickness being cut, the following operations can be used on BISPLATE® grades.

Flame Cutting (Oxy-LPG and Oxy-acetylene)

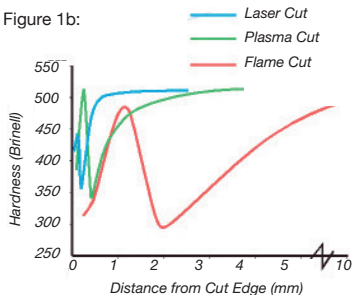
Plasma Cutting

Laser Cutting

Waterjet Cutting

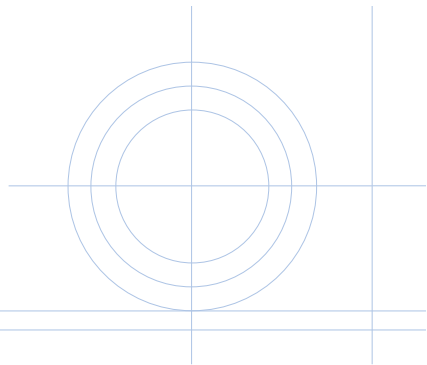
Power Sawing

Figure 1b:



Effects of flame, plasma and laser cutting on plate hardness for a 6mm BISPLATE® 500. Hardness tests were conducted using the Vickers method and converted to Brinell hardness values (HB).

Note: Some variations to the hardness profiles of fig: 1a and 1b will occur with changes to cutting speed and plate thickness.



FLAME CUTTING

Both Oxy-LPG and Oxy-acetylene processes are acceptable for sectioning all thicknesses of BISPLATE®. With these processes, the following techniques are recommended:

- Gas pressure to be the same as for cutting the equivalent thickness in plain carbon steel
- Reduce travel speeds by 30% when compared to the equivalent thickness plain carbon steels when using a standard cutting nozzle
- Nozzle size to be the same as for equivalent thickness plain carbon steel
- Correct selection of nozzle size for the plate thickness being cut is important to ensure efficient cutting and to minimise the width of the heat affected zone (HAZ)

As with all plate steels, the smoothness of the cut is affected by surface scale. If this is present, it is advisable to remove it prior to cutting (BISPLATE® is normally supplied in the shotblasted condition).

Under normal Oxy cutting conditions, the total heat affected zone adjacent to the flame cut edge will extend into the plate approximately 2-3mm, as shown in figure 1a for BISPLATE® 80. It should be noted that the heat affected zone produces a 'hard' layer adjacent to the flame cut edge, with a 'soft' layer inside this. The original plate hardness returns after the 2-3mm distance from the cut edge. For BISPLATE® 500 the HAZ may extend as much as 4-5mm into the plate as shown in figure 1b.

Preheating BISPLATE® steel prior to flame cutting will minimise the hardness of the flame cut edge and also reduce the risk of delayed cracking from this cut edge. This is particularly important in cold environments where plate temperature is less than 20°C and for the high hardenability grades of BISPLATE® 500.

Table 1 below, gives guidance on the preheat requirements. It is recommended that the zone to be preheated should extend at least 75mm either side of the line of cut, with the temperature being measured on the opposite surface and at a distance of 75mm, as shown in figure 2.

RECOMMENDED MINIMUM PREHEAT TEMPERATURES FOR FLAME CUTTING OF BISPLATE® GRADES

Table 1:

BISPLATE® GRADE	PLATE THICKNESS (mm)	MINIMUM PRE-HEAT TEMPERATURE (°C)
60, 70	8 - 32	20
80, 80PV	5 - 31	20
	32 - 100	50
320, 400	5 - 31	20
	32 - 100	50
450	6 - 20	20
	21 - 50	50
500	8 - 20	50
	21 - 100	100

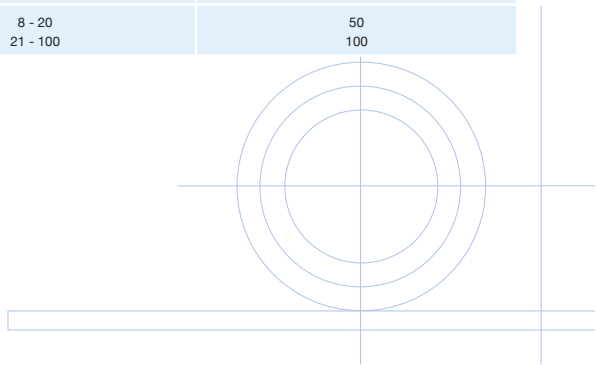
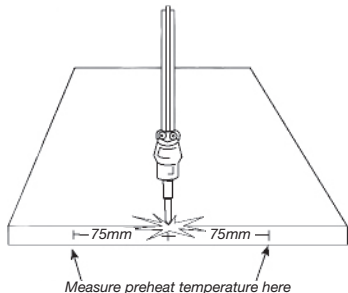


Figure 2: Recommended preheat zone and location of preheat measurement.



If the flame cut surface is to be the face of a welded joint, the heat affected zone from the flame cutting need not be removed. However, all slag and loose scale should be removed by light grinding, and prior to welding, the cut surface should be dry and free from organic matter such as oil, grease, etc (as directed by good workshop practice).

When stripping plates, the use of multiple cutting heads will help to minimise distortion of the cut pieces. Correct nozzle size, gas pressure and travel speed will also minimise distortion during cutting. Softening on edges can also occur when flame cutting small strips, eg. 50mm wide x 50mm thick plate.

Quench cutting of BISPLATE® grades to minimise distortion is not recommended, cooling in still air is preferred. The technique of stacking plates during profile cutting should also be avoided.

For component cutting and/or profiling of small parts an increase in temperature can occur and may affect the mechanical properties of the steel.

SUMMARY OF FLAME CUTTING RECOMMENDATIONS

- For oxy processes use gas pressures and nozzle sizes as for an equivalent thickness of plain carbon steel
- For oxy processes use cutting speeds two thirds of that recommended for an equivalent thickness of plain carbon steel
- Flame cutting produces a heat affected zone on all grades. The risk of delayed cracking is reduced by using preheat especially for thick plate and for BISPLATE® 500 grade
- Use multiple cutting heads when stripping plates
- Still air cooling after cutting
- Do not stack cut
- Do not quench cut plates
- Use thermal crayons or surface thermometers to measure preheat temperatures

REFERENCES/FURTHER READING

WTIA Technical Note 5 “Flame Cutting of Steels.”

PLASMA CUTTING

Plasma cutting is an acceptable method of sectioning all grades of BISPLATE®. The process offers particular advantages of productivity over flame cutting in thicknesses up to 20mm using currently available equipment. For instance, the cutting speed of 6mm BISPLATE® 400 may be up to 9 times that recommended for conventional flame cutting techniques.

The cut quality may be inferior, however, due to rounding of the top edges and difficulty in obtaining a square cut face of both edges. Guidance on the optimum settings for nozzle size, gas pressure, gas composition and cutting speeds will be provided by the equipment manufacturer. BISPLATE® with low alloy contents should be treated similarly to conventional structural steels.

The heat affected zone from a plasma cut is narrower than that produced from flame cutting but peak hardnesses are generally higher. General recommendations for the removal of this hardened zone are outlined below.

HARDNESS PROFILE CHARACTERISTICS FOR PLASMA CUTTING

Table 2:

PLATE THICKNESS (mm)	RECOMMENDED DEPTH OF REMOVAL (mm)	PEAK HARDNESS (HB)		
		BISPLATE® 60, 70, 80, 320, 400	BISPLATE® 450	BISPLATE® 500
5 - 8	0.4 - 0.5	430	480	540
>8 - 12	0.6 - 0.8	450	480	540
>12 - 20	1.0 - 1.2	450	480	540

The plasma cut HAZ typically extends 0.5 – 1.0mm into the plate under normal conditions. As is the case for flame cutting, complete removal by grinding is recommended if cold forming of the cut plate is contemplated.

All other comments for flame cutting regarding preheating, removal of the HAZ, stripping and stack cutting of plates would apply to plasma cutting.

LASER CUTTING

Laser cutting is a productive method for sectioning all grades of BISPLATE® up to 12mm thickness, particularly where high levels of accuracy and minimal distortion is required. Currently, with thicknesses above 12mm, productivity levels drop when compared with other processes.

The laser cutting process is unlike other thermal cutting in so far as the material is essentially vapourised from the kerf rather than melting and removal by kinetic energy.

The laser concentrates its energy into a focused beam resulting in low levels of excess heat. This results in very small HAZ areas (0.05 – 0.15mm) and small kerfs (0.3mm).

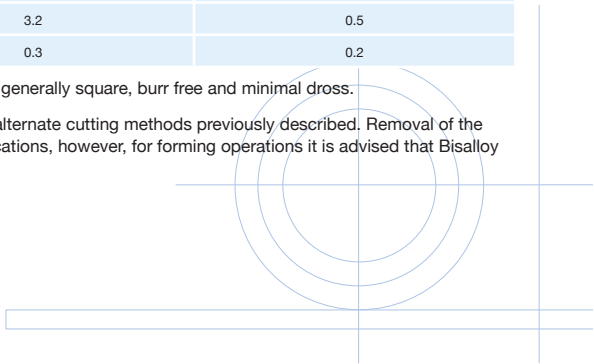
COMPARISON OF FLAME, PLASMA AND LASER CUTTING ON 6MM BISPLATE® 400

Table 3:

PROCESS	KERF WIDTH (mm)	HAZ WIDTH (mm)
Flame cutting	0.9	1.5
Plasma cutting	3.2	0.5
Laser Cutting	0.3	0.2

Cutting speeds are typically 5000mm/min and the edge is generally square, burr free and minimal dross.

Peak hardness levels are lower than those obtained from alternate cutting methods previously described. Removal of the HAZ is generally not considered necessary for most applications, however, for forming operations it is advised that Bisalloy Steels® are contacted for guidance.



POWER SAWING

All BISPLATE® grades can be cut with power saws, provided lower blade speeds and blade pressures up to 50% higher than those used for cutting plain carbon steel are used. Best results have been achieved using power saw blades normally recommended for cutting stainless steel (generally, blades having 4-6 teeth per 25mm). Sawing directly onto a flame cut surface should be avoided where possible.

WATERJET CUTTING

Waterjet cutting can be performed on all grades of BISPLATE®, although its widespread use is limited due to the current machines available in Australia and their low cutting speeds.

A key advantage of water jet cutting is that it leaves the surface free of HAZ. Cutting without heat protects against metallurgical changes in the plate, ensuring original plate mechanical properties are maintained.

Recent tests performed by the CSIRO Division of Manufacturing Technology on waterjet cutting 8mm BISPLATE® 500 at 40mm/min resulting in near perfect cut edges. Speeds to 75mm/min are possible but with reduced smoothness of the cut edge.

The waterjet cut shows no change in material structure at the edge of the cut. The laser cut edge shows a distinct change in structure to a depth of 0.2mm.

Both laser cutting and waterjet cutting are industrial processes which should be considered by structural designers and fabricators as alternate means to avoiding problems associated with fit up, cut edge squareness, shape precision, dross and gross HAZ's which can occur with conventional thermal cutting processes.

Bisalloy Steels® wish to thank the Australian Welding journal, CSIRO-DMT, Ian Henderson, CRC for Materials Welding and joining and Rory Thompson, CSIRO Industry Liaison Manager for information pertaining to laser and waterjet cutting contained in this publication.

