Hypertherm®

Understanding the Heat-affected Zone

Cutting processes that use intense heat, like oxyfuel cutting and plasma arc cutting, produce thermal effects near the edge of the cut that lead to microstructural and metallurgical changes in the metal. The portion of a metal work-piece that has been so altered by heat is termed the "heat-affected zone" or HAZ. All thermal cutting processes create an HAZ in the cut metal.

The changes induced by heat can include:

- Altering the microstructure of particular steels, leading to an increase in the hardness of the cut edge relative to the un-cut metal.
- Altering the microstructure of particular steels, leading to a decrease in the strength of the cut edge.
- The formation of nitrides on the cut edge, which can affect the weldability of the cut face.
- Darkening or discoloration of the surface of the metal next to the cut face ("heat-tint").
- Distortion of the metal being cut.

Some changes, such as heat-tint, are cosmetic and do not matter in some applications. For other applications, discoloration may matter a great deal.

The width of the heat-tint is influenced by the surface condition of the metal. Any surface contaminant or coating, such as paint, oxidation, oil, and even fingerprints, will affect the formation of heat-tint. HAZ width is influenced only by the thermal history of the metal. While the change in the coloration of the metal may by chance approximate the width of the heat-affected zone, heat-tint width can be either larger or smaller than the HAZ. It is important to remember that the HAZ is inside the metal and you cannot see it.

Other changes to the metal, like warping or hardening, affect weldability and usefulness of the metal after the cut. The HAZ may need to be partially or totally removed (by grinding or some other process) before the metal part can be used.

The width of the HAZ is influenced by:

- Cut speed – in general, faster speeds result in a smaller HAZ.
- Amperage (when using plasma) – for a given thickness of metal, a higher amperage (and consequently a faster cut speed) results in a smaller HAZ.
- The type of metal being cut. Different metals transfer heat at different rates and respond to differently to elevated temperatures. Increased temperatures and longer cutting times will result in a wider HAZ. As an example, a Plasma arc cutter can be used to cut any electrically-conductive material, but all things being equal it will create a different width HAZ on aluminum than on mild steel of the same thickness.

Another thing to note about the HAZ is that when cutting thicker metals the width of the zone may be smaller at the top of the cut edge and wider at the bottom.