Processing information

Cutting

DILLIMAX

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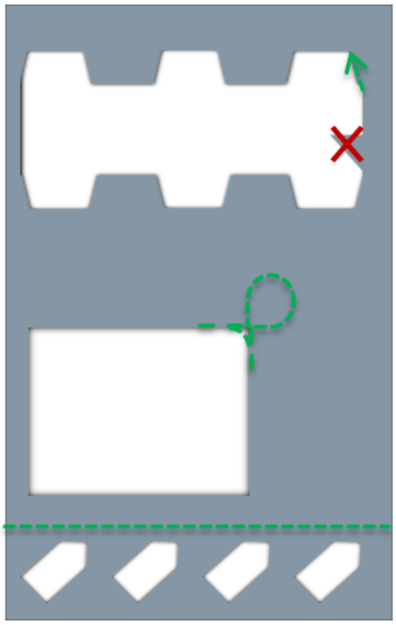
High strength DILLIMAX steels are very suitable for processing due to their exceptional homogeneity as well as their cleanness. Increasing plate thickness requires higher alloy components and careful treatment of the plates. In the following, Dillinger provides information on autogenous cutting, plasma cutting and laser cutting.

The information on DILLIMAX cutting has been developed to the best of Dillinger's knowledge and experience. It is intended to support the manufacturer in developing his own processing procedure for DILLIMAX. The proper working method must be carried out with suitable tools. Since different manufacturers have developed varying tools, the instructions should be observed carefully (nozzle selection, gas pressures, working method, speed, etc.).

In addition to the selection of the appropriate cutting process, the suitable cutting path and the cutting sequence also determine the subsequent quality of the contour piece: We recommend avoiding sharp edges or notches facing inwards and possibly cutting an additional curve, especially in the case of large plate thickness (see graphic 1).



Keep the contour piece connected to the plate as long as possible.

Sharp contours should be avoided, sufficient radii e.g. ≥ 25 mm

If the plate is processed on the next working day, a clean separation cut should be considered.

Graphic 1 Cutting path

Cut component DILLIMAX 690

Thermal cutting

During thermal cutting, the heavy plate is strongly heated close to the cut edge. This results in a so-called heat affected zone (HAZ) close to the cut edge. The width of the zone varies depending on the cutting process. Due to the short and intensive heating followed by rapid cooling, a softening zone is created under the hard cutting edge of DILLIMAX plates. It varies depending on the process and cutting parameters. Just like the actual cutting process, the delivery condition (heat treatment) and the chemical analysis affect the properties of the HAZ.

Table 1 Thermal cutting processes

Method	Description	Plate thickness	Kerf
Oxy-fuel	Burning with oxygen, blowing out oxygen compounds (oxides)	> 10 mm*	Approx. 2 up to 9 mm
Laser	Vaporisation (in small thickness) or burning with oxygen	Up to approx. 30 mm	< 1 mm possible
Plasma	Melting using gas, Blowing out using gas nozzle	Up to approx. 60 mm	Approx. 2 up to 7 mm

*Typical

Effect of different flame cutting processes on the heat affected zone

Metallographic section of the HAZ of a 10 mm thick plate after laser, plasma, oxy-fuel cutting

laser

plasma

oxy-fuel cutting

The surface condition of the plate also has a significant influence on the flame cutting conditions and the achievable quality of the cut surface, especially in laser cutting. Where high demands are placed on the quality of the cut face, it is necessary to clean the top surface of the workpiece in the cut area to remove scale, rust, paint and other impurities.

Oxy-fuel cutting

The oxy-fuel cutting of DILLIMAX is almost without limits, at least in terms of plate thicknesses when processed properly. Oxy-fuel cutting is used in a wide thickness range from approx. 10 mm up to very high thickness. A suitable cut helps to avoid stress cracks (see graphic 1).

Cold cracks can be prevented by:

- Preheating,
- Suitable cut guidance,
- Reduced cutting speed (attention: wider HAZ),
- Postheating (allows hydrogen introduced during oxy-fuel cutting to diffuse out).

Decreasing the cooling rate of the cutting edge or the entire cutting piece reduces shrinkage strain. Critical oxy-fuel cut parts should ideally remain in the firing grid after oxy-fuel cutting so that they can cool down slowly in the composite. Stresses introduced there also increase the possibility of cracking. Cold cracks may appear only 48 hours after the flame cut.

In general, the temperature of the workpiece during oxy-fuel cutting should not be below room temperature (15 °C) and at the same time the recommended preheating temperatures should not be understepped during the entire cutting process. The entire component must be heated through.

DILLIMAX steels are not allowed to be heated above the maximum temperatures given in table 2. In the case of very thick flame cut pieces, reheating at approx. 200 °C or a slow cooling down, e.g. by covering the flame cut pieces with thermal blankets, can minimize the risk of cracking and reduce residual stresses.

Table 2 The following preheating temperatures for DILLIMAX should be observed

Plate thickness* [mm]	< 20	20 ≤ t < 50	50 ≤ t < 100	100 ≤ t < 200	200 ≤ t < 290	Max. Temp.
DILLIMAX 500/550		50 °C	100 °C	150 °C		400 °C
DILLIMAX 690		50 °C	100 °C	150 °C	180 °C	400 °C
DILLIMAX 890/965	50 °C	100 °C	150 °C			400 °C
DILLIMAX 1100	75 °C	125 °C				150 °C

*Indicative values

From a metallurgical point of view, preheating in the furnace is the best solution. However, it is often not feasible in practice. Therefore, please note the following information:

Preheating of DILLIMAX

Preheating:
The entire plate should be preheated, preferably by heating the underside with a soft flame and measuring the temperature on the top. The top of the plate can be covered with thermal blankets.
In any case, heating must be done by heating torches:

- No local overheating (see Table 2).
- Avoid large temperature gradients to create as minimal thermal stresses as possible.
- Consistent heating is necessary.

After cutting, the flame-cut parts must be cooled down slowly under controlled conditions.

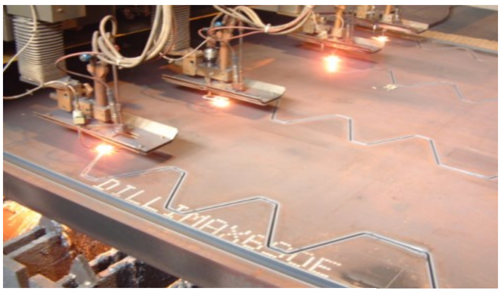
During oxy-fuel cutting, excessive heating of the flame-cut piece can be controlled by maintaining sufficient distance between the cutting edges and the plate edge, as well as between the cutting edge and the next flame-cut piece. A distance of 200 mm usually prevents overheating with plate thicknesses of 30 mm or more.

For smaller distances, laser or plasma cutting is more suitable than flame cutting, whereby the methods that are not critical in terms of temperature, such as waterjet cutting, are to be preferred.

For this reason, additional cooling rather than preheating should be used for flame-cut parts that cannot dissipate heat quickly enough, such as small components, screen plates, lamellae, knife edges, etc.

Cutting using second torch for preheating

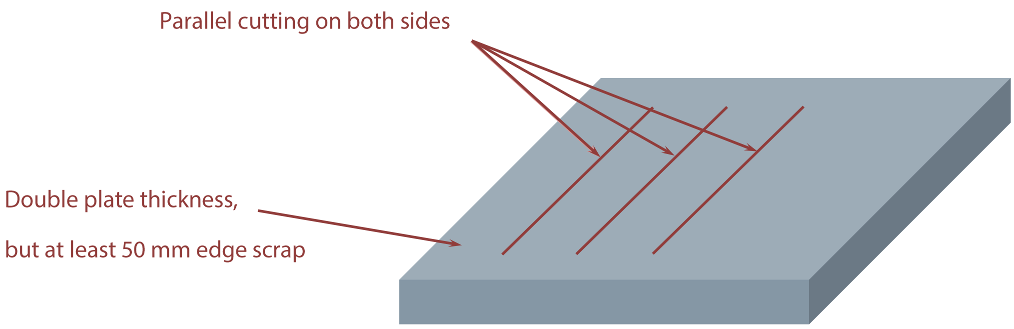
Experienced users can minimize or avoid the specified preheating temperatures by using additionally torches as shown in the picture for pre- and/or after running and reduced cutting speed. However, preheating and reheating remain the proven methods of first choice. Recommendations for preheating and temperature control during flame cutting based on the actual analysis and further data can be taken from the Dillinger E-Service.



Cutting DILLIMAX 690 E

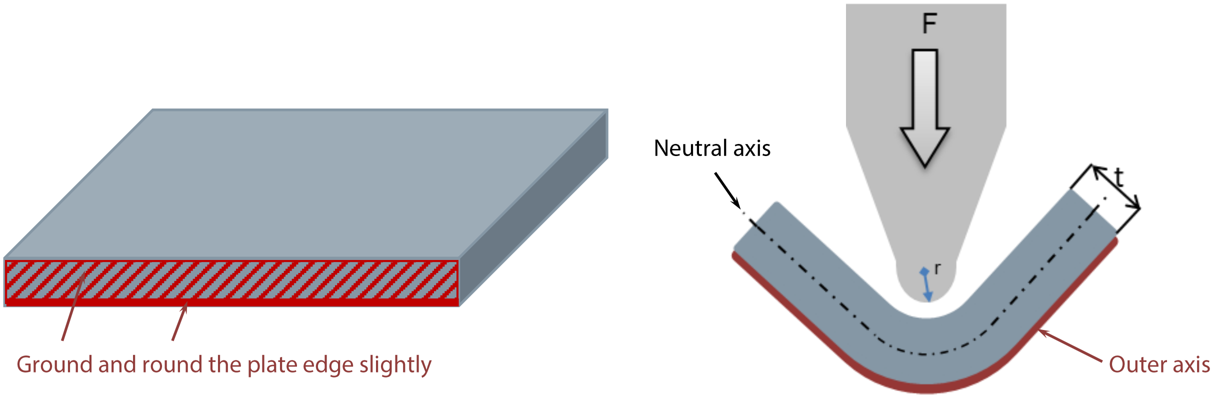
When cutting long narrow flame-cut parts, it is state of the art to make certain process adjustments to avoid distortion. These include, on the one hand, ensuring a symmetrical heat flow, e.g. by cutting the lamellae parallel on both sides, and on the other hand, providing sufficient edge scrap, e.g. twice the plate thickness, but at least 50 mm (see graphic 2).

Before cutting off the lamellae, it is helpful to let the flame-cut parts still connected to the rest of the plate for finally cool down.



Graphic 2 Cutting long narrow flame cut parts

If the cut edges are cold formed during further processing, for example by bending or folding, the hardened cut edge area must be ground in the case of higher strength DILLIMAX steels. It is also advisable to round the plate edge slightly on the outer axis, which is on the outside when bending.



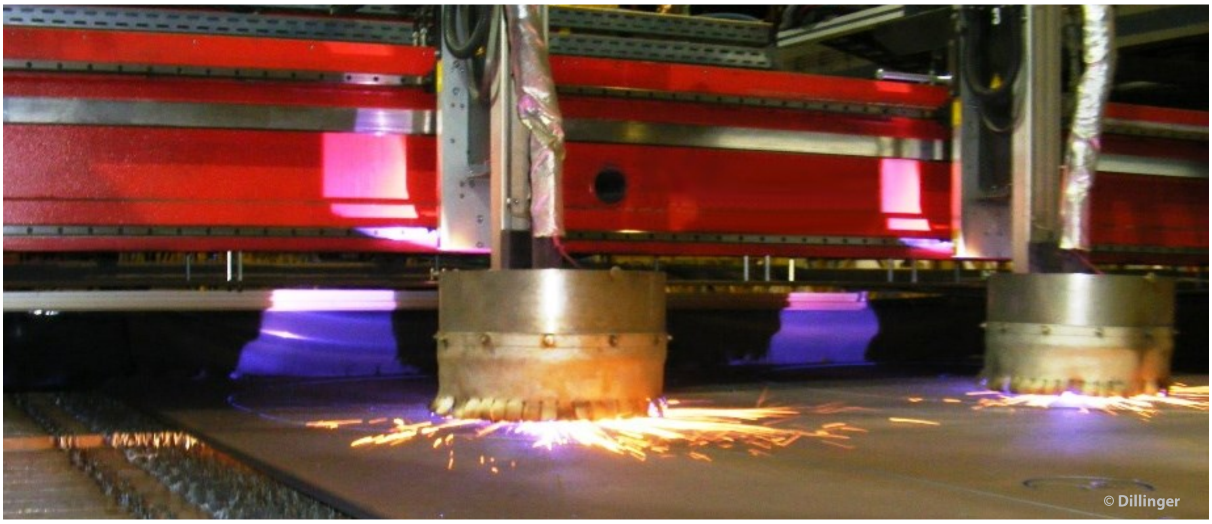
Graphic 3 Bending

Laser and plasma cutting

The major advantages of laser and plasma cutting are the higher cutting performance and the narrower heat affected zone, along with minimum heat input. With both cutting processes, it is possible to cut even the smallest parts, lamellae and screen plates without distortion.
With these methods, it is also possible to avoid preheating. Exceptions are very large plate thicknesses in the limit range of plasma cutting. In these cases, the preheating temperatures of oxy-fuel cutting must be used.

DILLIMAX

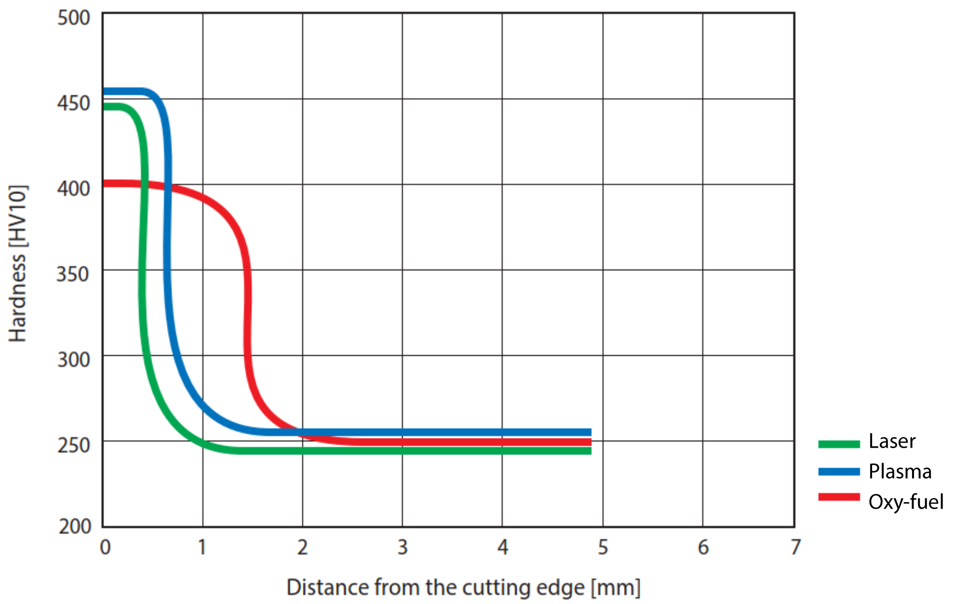
A perfect surface of the plate is a fundamental precondition for successful laser cutting. DILLIMAX can also be supplied shot blasted and shop-primered especially for this case on request (please see Dillinger's brochure "Raincoat included").



Plasma cutting

Plasma cutting is also suitable for plate thicknesses up to 60 mm. However, the heat affected zone is somewhat wider.

With plasma and laser cutting, the hardness values can generally be slightly higher than with oxy-gen-acetylene flame cutting due to the higher cooling rates.



Graphic 4 Typical effect of different flame cutting processes on the hardness of the heat affected zone of a water quenched, fine grained structural steel with a yield strength of 690 MPa.

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