Miilux Protection
WORKSHOP RECOMMENDATIONS

Cutting recommendations

Miilux Protection plates should be cut under controlled conditions as described below. Before cutting is started plate temperature must be at least 20 °C.

Protection 400:
- Up to 25 mm cutting by gas, plasma, abrasive waterjet or laser
- 25–40 mm gas cutting with reduced speed, gas cutting plus preheating at least 100 °C, abrasive waterjet or laser

Protection 400T/450
- Up to 20 mm cutting by gas, plasma, abrasive waterjet or laser
- 20–40 mm gas cutting with reduced speed, gas cutting plus preheating at least 100 °C, abrasive waterjet or laser
- Above 40 mm gas cutting plus preheating at least 150 °C or abrasive waterjet

Protection 500
- Up to 20 mm cutting by gas, plasma, abrasive waterjet or laser
- 20–40 mm gas cutting with reduced speed, gas cutting plus preheating at least 100 °C, abrasive waterjet or laser
- Above 40 mm, gas cutting plus preheating at least 150 °C or abrasive waterjet

Protection 600
- Up to 10 mm plasma, abrasive waterjet or laser
- 10–20 mm laser, gas gutting plus preheating at least to 150 °C or abrasive waterjet

Welding recommendations

Miilux Protection steel grades are manufactured by hardening, and thus attention should be paid on their heat input and preheating. Protection steels must be welded with filler material a with a low hydrogen content. Protection plates can be welded by any conventional welding method. All Protection grades can be welded to other weldable steel.

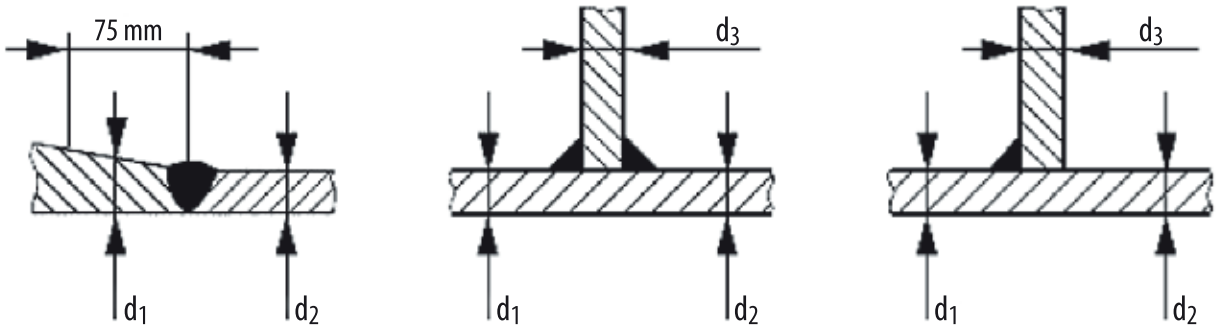
Working temperatures and heat input
Table 1 show the recommended working temperatures of certain heat input values Q. The pre-heating temperature of the plate must be a minimum of 70 % of the working temperature, and the temperature of the plate must not exceed the recommended working temperature by much over 30 % (maximum working temperature for Miilux Protection 600 is 180 °C). Thin plates in particular tend the heat too much, which will cause Protection steel lose their good properties.

Table 1. Recommended working temperatures

Steel grade	Q kJ/mm	Combined plate thickness		
		20 mm	30 mm	40 mm
Protection 400	1			100 °C
Protection 400	2			75 °C
Protection 400	3			75 °C
Protection 400T/450	1		100 °C	125 °C
Protection 400T/450	2		100 °C	100 °C
Protection 400T/450	3		75 °C	100 °C
Protection 500	1	100 °C	125 °C	150 °C
Protection 500	2	100 °C	125 °C	125 °C
Protection 500	3	100 °C	100 °C	125 °C
Protection 600	1	150 °C	150 °C	150 °C
Protection 600	2	150 °C	150 °C	150 °C
Protection 600	3	150 °C	150 °C	150 °C

Above mentioned test results are according to EN 1628 and Stanag 4569, but we have tested also other classes e.g. MIL-A 46100.
Ask for more information about delivery-specific tests from technical customer service and sales.

Figure 1 | Calculation of joint plate thickeness



d_1 = Average thickness in 75mm long section. Compined plate thickness = $d_1 + d_2$

Both sides are welded simultaneously. Combined plate thickness = $1/2 \times (d_1 + d_2 + d_3)$

Combined plate thickness = $d_1 + d_2 + d_3$

Groove preparation and shape
Cleaning the weld grooves from swarf, dirt and grease before welding is important in groove preparation. Carbon arc gouging should be avoided when manufacturing the grooves because it causes carbonization of the melt created during gouging and its hardening properties, due the high carbon content, may be critical.

The need for carbon arc gouging can be avoided by using sufficiently large root opening (2-4 mm) in the groove. A smaller root opening and, for example, one sided V-groove sufficient when welding a thin plates. In case of joining thick and thin plates by welding, the groove should always be on the side of the thinner plate.

Fillet welds in Protection steel present a risk. The joint tends to crack under the fillet. If using fillet welds cannot be avoided, the weld must be made as robust and solid as possible.

Good engineering must be used in order to avoid difficult corner welds in Protection. Accessibility should be thus be taken into account when designing weld joints.

Remember that groove must be finished by grinding.

Selection of consumables
When welding Protection steels, it is often beneficial to use consumables that are soften than basic material and use engineering in order to avoid locating welded joints in parts that are most loaded or exposed to high stress. It is also recommended to select low-hydrogen consumables to keep hydrogen level sufficiently low.

The commonly used consumables for Protection 400, 400T, 450 and 500 are ESAB OK 48.00 and OK Autrod 12.51. If high strength in the welded state is required from the consumables, it is recommended to use the OK 75.75 or OK Autrod 13.10/13.12 consumables. Equivalent consumables can also be found from other suppliers, such as Elga, Lincoln and Oerlikon.

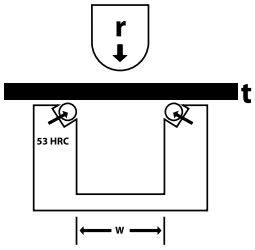
Miilux Protection 600 must be welded with austenitic consumables. Austenitic consumables can be used with other Protection grades welding too. ESAB 67.45/67.52 and OK Autrod 16.95 or equivalent consumables are recommended.

Welding order and finishing
When welding Protection steels, two superimposed passes must always be used. This way, the lower pass can be annealed (hardness decreased but tensile strength increased). Consecutive measures can be considered after two passes have ween welded. The harder the material, the more important it is to have two superimposed passes. The last pass should be left incomplete rather than overfilled. Filling the weld transversally is not recommended under circumstances.

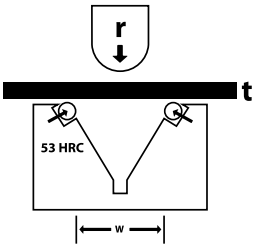
Temperature control is very important in welding. Welding but be completed properly (from hefts to grinding using the same temperatures), because welding on top of a cooled pass will multiply welding stress, which increases the total stress of the work. This in turn exposes the weld and the welded work to breaking in use. Welding is completed only when the joints are filled and surfaces and corners have been round.

Bending recommendations

Bending should be done with one press. Slow pressing speed is recommended. Lower tool should be roller-type (see drawings). Cold forming of Miilux Protection 600 is not recommended.



Free bending



Bottoming

Cold forming

Cold forming directive limits for Miilux Protection steel grades

Steel grade	Plate thickness (mm)	Free bending < 90° rounding radius of press/ plate thickness R/t Bending line to rolling direction		Free bending -Free hole width/plate thickness W/t		Bottoming 90° -Free hole width/ plate thickness W/t
		Transverse	Longitudinal	Transverse	Longitudinal	
Protection 400	5–20	3	4	9	11	~15,0
Protection 400T	5–20	5	6	12	13	~15,0
Protection 400T	>20	6	7	13	14	~15,0
Protection 450	5–20	4,0	5,0	11,0	13,0	~15,0
Protection 500	2,5–20	~10,0	~12,0	23,0	27,0	

Bending should be done with one press | Slow pressing speed is recommended | Lower tool should be roller-type (see drawings)

Machining

Miilux Protection 400, 400T, 450 and 500 can be machined with rapid steel and hard metal (HSS) drills with a satisfactory life if the drill advance and cutting speed are correspondingly accommodated. Miilux Protection 600 machining is possible with special hard metal (HSS) tools.

Tips to machining:

- minimize the distance between the column and the drill as well as the drill tip and the workpiece
- always use metals supports
- clamp securely
- use coolant

The safe handling of hard plates

Lifting

Ensure that your lifting equipment is suitable for the handling of hard plates. Ordinary grippers, designed for engineering workshops, are suitable for lifting plate which have a maximum hardness of 300 brinells. The hardness of Miilux ballistic steels is between 320 and 640 brinells. Hard plates will not be properly gripped by ordinary grippes and therefore risk coming loose during the lifting process. We recommended lifting hard plates with screw clamps, chains, lifting magnets or lugs.

Welding

It must be noted that hardened Miilux ballistic steels are sensitive to cracking during welding and, in practice, normally require some preheating. This is critical stage when welding lifting lugs, for example. If preheating is omitted, the lug may become detached from the plate during lifting process.

Bending

All ballistic steel must be bent using the recommended bending radii. It is recommended to use bending tools equipped with rolls. The use of sharp-edge tools, in particular, must be avoided. Bending must be completed with one press. Special care must be taken when bending of ballistic steel grades, bending must be carried out from the side of the machine, behind safety mesh.

Miilux®
Hard from edge to edge

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