UHS 960 QL

TECHNICAL PRODUCT SHEET

The Ultra-high-strength steel grade UHS 960 QL are thermo-mechanically rolled fine-grain structural steels with excellent workshop abilities, such as : welding and cold formability

MEKA steel distributes quenched (Q) and cold formable (C) ultra-high strength steels. The alloying concept provides very low carbon contents and low carbon equivalents, which aims in very good weld ability. The high strength provide special advantages in areas, where weight savings are of great importance, e.g. for mobile cranes, concrete pump cars and vehicles.

UHS 960 QL **delivery condition**

Plates of are delivered in a thermo-mechanically rolled condition with accelerated cooling and tempering. Unless otherwise agreed upon ordering, 40 t of a heat or a smaller portion is used as test unit for the mechanical properties.

UHS 960 QL **mechanical composition**

Yield strength Rp0,2	960 MPa
Minimum Tensile strength Rm	980 – 1,150 MPa
Minimum Elongation A5	10 %
Notch Impact energy (min.)	30 J

1) Tensile test in accordance with EN 10002 on transverse samples.
2) Notch impact bending test in accordance with EN 10045 on Charpy-V longitudinal samples at –40 °C. The mean value from 3 individual samples must reach the specified requirements. No individual value may be below 70% of the guaranteed mean value. For thicknesses < 10 mm, samples similar to Charpy-V with dimensions of 10 x 7.5 mm or 10 x 5 mm are tested. The guaran teed value is reduced in proportion to the sample cross-section.

The mechanical properties are according to EN 10025-6 for steel grade S960QL.

Quality testing includes the tensile test. The notch impact bending test is carried out on longitudinal samples at –40 °C.

A different sample position or testing temperature must be agreed on request. The heat analysis is provided as proof of the chemical composition.

UHS 960 QL **chemical composition**

C	max. 0.12 %
SI	max. 0.60 %
Mn	max. 1.70 %
P	max. 0.02 %
S	max. 0.01 %
Cr	max. 1.50 %
Ni	max. 2.00 %
Ti	max. 0.05 %
CEV (1)	max. 0.56 %
CET (2)	max. 0.31 %

1) The total of Nb, V und Ti must not exceed 0.22%.
2) CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15, according to IIW
3) CET = C + (Mn + Mo)/10 + (Cr + Cu)/20 + Ni/40, according to SEW 088
4) PCM = C + Si/30 + (Mn + Cu + Cr)/20 + Ni/60 + Mo/15 + V/10 + 5*B, according to API 5L

The chemical composition is according to EN 10025-6 for steel grade S960QL.

UHS 960 QL **delivery program**

Actual limited dimensional range:

Thickness:	6.0	–	15.0 mm
Width:	1500	–	2.500 mm
Length:	2000	–	12.700 mm

Unless otherwise agreed, tolerances pursuant to EN 10029 (thickness tolerance according to class A, flatness tolerance according to class N), and surface finish according to EN 10163-A1 are valid.

Type of certificate according to EN 10204.

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UHS 960 QL **process instructions provided by steel producer**

Cold forming
Ultra-high strength steel plates provide good cold forming properties. On condition that cut edges have been ground very smooth and that the bending process is done skill-fully 90°-bending without cracks is guaranteed for die-radius of minimum 4x plate thickness.

Hot forming and heat treatment
Heavy plates are in thermo-mechanically rolled condition and are intended for cold forming. Hot forming and stress relief annealing are possible up to 580 °C. For optimum toughness properties of the weld we recommend stress relief annealing up to max. 520 °C. Normalizing and quenching and tempering deteriorate the microstructure of TMCP-steels and therefore are not to be processed.

Welding
Thermo-mechanically rolled high-strength and ultra-high-strength have excellent weld ability, which results of a low carbon equivalent (CEV), and in particular, a low carbon content (C). The low CEV and C values provide reduced hardening in the heat-affected zone (HAZ) of welds. This leads to greater resistance to cold cracking. However, despite this advantage, in view of the high yield point of the steel grade, it is advisable to take extra care during welding. The generally valid and accepted rules for the welding of low-alloyed, higher-strength fine-grain structural steels according to EN 1011-2 and STAHL-EISEN Werkstoffblatt (SEW) 088 must be observed.

Weld preparation, thermal cutting
Weld preparation can take the form by machining or thermal cutting. In the case of the latter, preheating is not required for plate thickness up to 20 mm at a work piece temperature above +5 °C. Prior to welding the weld edges must be dry and clean.

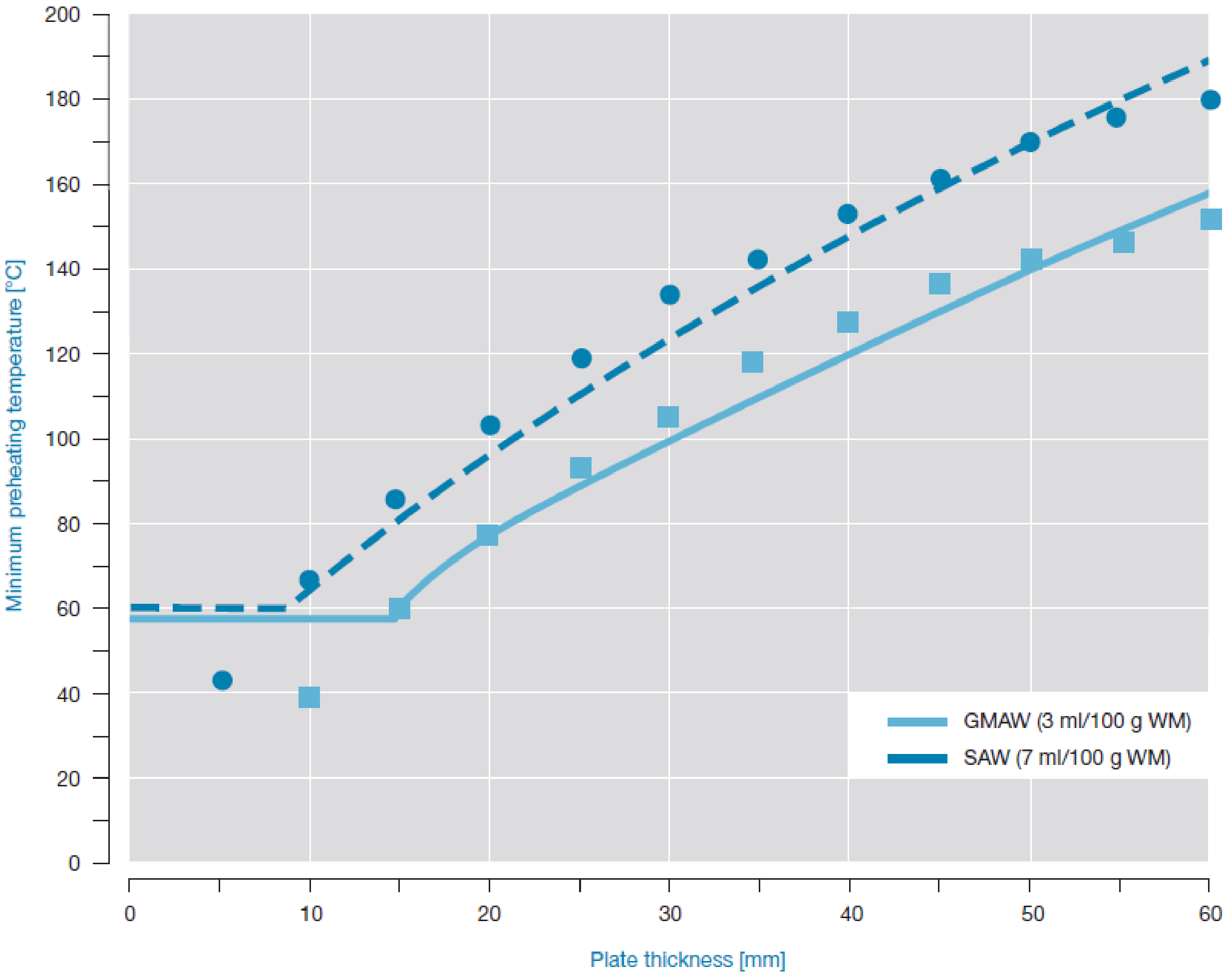
Welding process
All standard automatic and manual welding processes can be employed. Inert gas shielded welding (GMAW, IGSW) with solid wire has the advantage of providing very low hydrogen content in the weld material and is also especially suitable with regard to cold cracking resistance. Filler materials and welding conditions (preheating, welding parameters). The selection of the filler materials should result in a weld that matches the chemical composition and the mechanical-technological properties of the base material.

Recommended filler materials are:

- SMAW welding Phoenix SHNi2K130
- GMAW welding Union X96/X90

You will find more information at www.boehler-welding.com and www.t-put.com. Experienced welding engineers are at your disposal.

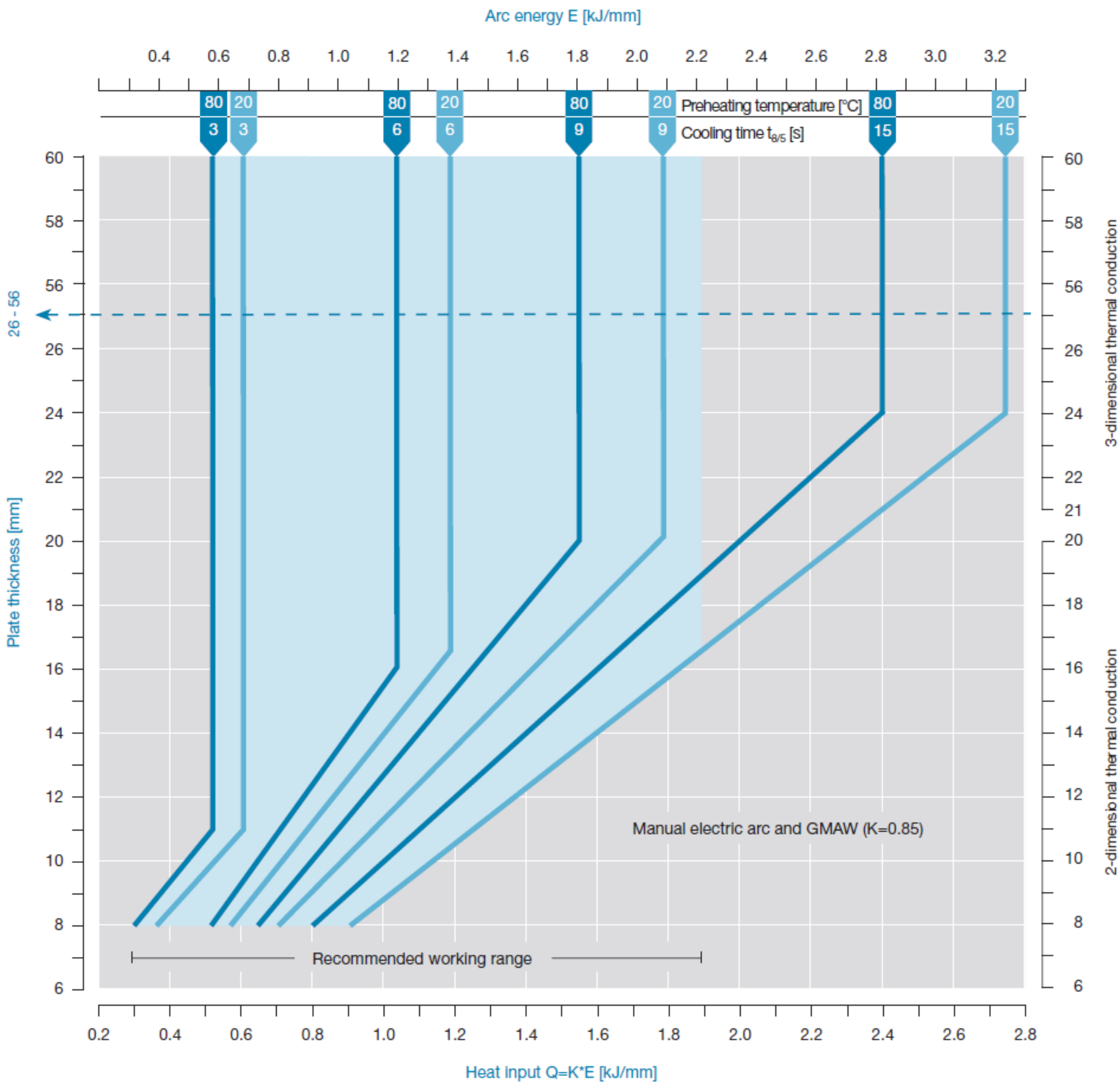
As a result of their high strength, such welded joints show a higher tendency to cold cracking, which can be minimised by the selection of suitable welding conditions. The tendency to crack formation in the HAZ, in general, is distinctly lower than in the weld metal due to the lower hardening characteristics of the base metal. For reasons of cold cracking prevention, the hydrogen content in the weld material should be very low (HD < 3 ml/100g WM). This is guaranteed by inert gas shielded welding with solid wire. Basic electrodes and welding powder for submerged arc welding must be subjected to secondary drying. The instructions of the manufacturer concerning drying and the method of use to obtain the required hydrogen criterion must be adhered to. The risk of cold cracking can be minimised by moderate preheating in accordance with picture hereunder, even in case of unfavourable combinations between heat input and plate thickness.



To ensure the high strength and impact properties of the weld (base material, HAZ and filler metal) cooling times t8/5 of 3 - 15 seconds and inter pass temperatures of < 150 °C are desirable. Cooling times t8/5 above 15 seconds are permitted under special conditions (e.g. overmatching, ...) but are to be proven by the welder in every case. Standard values for the arc energies to maintain the given cooling times are contained in the picture on the next page.

Precondition for high notch impact energy in the welded joint is multi-layer welding, in which the number of weld layers is calculated on the basis of the following approximation:

$$\text{Minimum number of weld layers} \quad = \text{(on average)} \quad \frac{\text{Sum plate thickness (mm)}}{3}$$



Following appropriate checking (e.g. using process tests according to EN 15614-1), other welding conditions can be selected, if the properties of the welded joint correspond with the requirements made on the component.