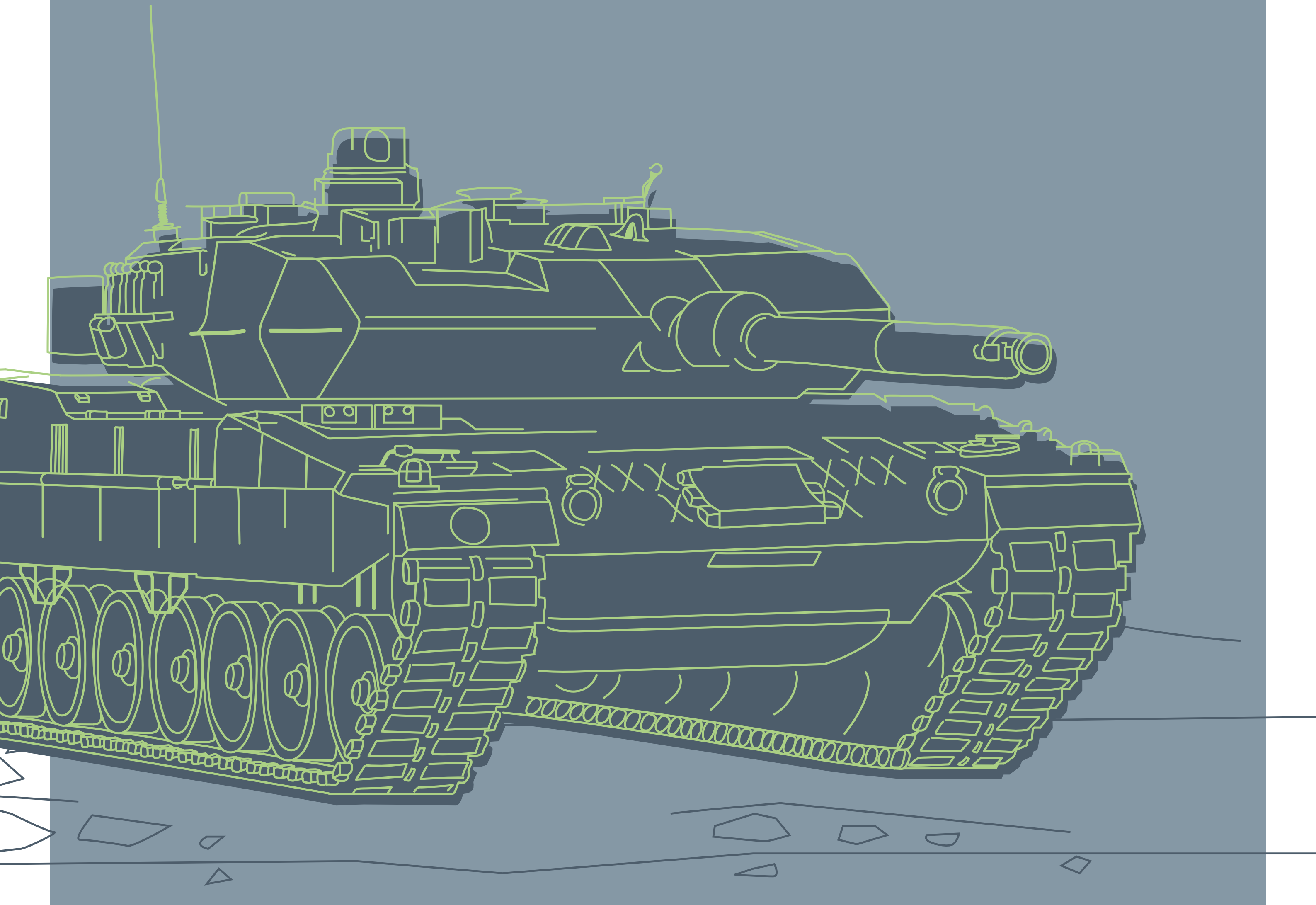
DIFENDER

For safety and protection

Processing recommendations



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DILLINGER

We are Pure Steel+

Dillinger
Pure steel, pure future

For more than 333 years, we have put pure expertise and innovation in steel into practice. We are committed to progress, the climate, and future generations. Europe's leading heavy plate manufacturer is achieving great things – together and for each other.

Steel is the future

Steel is unique: Its strength, elasticity and processing properties enable a wide range of applications and impressive constructions. Its 100% recyclability makes it unbeatable when it comes to sustainability. As a reliable partner to our customers, we design excellent products for key industries such as steel construction, mechanical engineering, and the energy sector. Our steel plates are already accelerating the energy transition – in offshore wind turbines and in storage and solar power plants.

Pure future

Our aim is to ensure a sustainable future today as well as tomorrow. We are committed to achieving carbon-neutrality by 2045 and are actively accelerating the development and use of technologies such as hydrogen and electric steel production. Our decarbonization project Power4Steel is an important milestone in this regard and is paving the way for a climate-neutral tomorrow. We already offer carbon-reduced heavy plate under the D-PURE+ label, and we will be producing carbon-reduced steel on the new DRI-EAF production route starting in 2027/28.

Pure quality

At Dillinger, the entire manufacturing process – from research to steel production to the rolling mill – is focused solely on the heavy plate product. This specialization gives us unparalleled expertise, which we use to benefit our customers. We use our knowledge, the latest technology and state-of-the-art AI applications to produce our steel plate to a consistently high quality and to advance the development of our products and services. Dillinger offers an incomparable product portfolio with more than 2,000 different types of steel and an impressive range of dimensions. Personalized customer advice and an increasingly digital range of services perfectly complete our range of services.

Pure commitment

We take responsibility together and for each other. For our employees, our environment, our products, and our future. Our cooperation is defined by partnership and a culture of appreciation. We are the backbone of a reliable power supply and secure infrastructure. Inquisitive and open-minded, flexible and focused on solutions – we are creating the future for generations to come. We are "Made in Europe" – and prove our value worldwide.

We are Dillinger. We are Pure Steel+

Dillinger
at a glance

More than **333** years of experience in steel

Expert advice for more than **10** diverse fields of application

Over **2,000** different grades

More than **200** international approvals, certificates and materials qualifications

Plate weight up to **52** t

Heavy plates up to **28** m length and **500** mm thickness

Technical information on processing DIFENDER steels

General

Despite their great hardness, DIFENDER steels possess good workability. It is nonetheless necessary to adhere to certain processing rules when working these steels. The user must take care to ensure that his or her calculation, design and working procedures are appropriate to the material, represent the state-of-the-art and technical standard to be met by the processor, and are appropriate to the ultimate intended application. Military clients can choose to exclude certain working and processing operations for the production of military equipment.

A number of fundamental correlations are explained below, and practical notes provided on the working and welding of DIFENDER.

Cold forming

Despite their great hardness and mechanical strength, DIFENDER steels are well suited to cold forming by means of bending. It should be noted here that the energy needed for forming of the same wall thicknesses increases as the steel's yield strength rises. Resilience also increases. Cut edges in the area intended for cold forming should be polished, in order to eliminate the risk of cracking proceeding from the edges. Slight bevelling off of the plate edge located on the outer side during bending is also advisable.

The various minimum bending radii shown in table 1 result for the various DIFENDER steels. The minimum bending radii perpendicular to the direction of rolling are also lower than in the longitudinal direction, due to the forming process which takes place during rolling. The minimum bending radii in table 1 may be used as guide values for the DIFENDER range of steels. Forming rate must be less than 10% elongation of the outer fibre per second.

Due to its low elongation and high hardness, DIFENDER 550 and DIFENDER 600 is not suitable for cold forming (bending). Attempts at bending could cause a danger of injury as a result of breakage of the workpiece.

Hot forming

The term „hot forming“ is generally used to designate forming of metals at temperatures at which metallurgical changes are to be expected. Due to the special hardening process applied, this limit is around 200° C in the case of DIFENDER steels, for Difender 600 it is around 150° C. The special hardness of DIFENDER steels is the result of accelerated cooling from the steel's austenitisation temperature and hot forming without loss of hardness is possible only provided the workpiece is subsequently re-hardened.

This rule applies unless the hardening process can be implemented, by means of appropriate design of the mold, during the forming process. Only lower cooling rates can generally be attained compared to the original production of the plate, due to the user's differing heat-treatment facilities and differing component geometries.

The original hardness and through hardening imparted by the producing steel mill can generally not be restored. This fact must be taken into account in the design of the security solution. There is, in addition, the danger of distortion.

Table 1: Minimum bending radii (r/t) for cold forming

DIFENDER		Plate thickness [mm]	
		t ≤ 8 mm	8 < t < 15 mm
270	longitudinal	5	6
	transverse	3	4
300	longitudinal	5	6
	transverse	3	4
350	longitudinal	5	6
	transverse	3	4
400	longitudinal	7	9
	transverse	5	7
450	longitudinal	5	6
	transverse	4	5
500	longitudinal	8	10
	transverse	6	8
550	*	-/-	-/-
	*	-/-	-/-
600	*	-/-	-/-
	*	-/-	-/-

* not intended for bending, please contact Dillinger

Bending angle < 90°, Forming time > 2 s (< 10 % strain of outer fibre per second)

Cutting

Flame cutting, laser, plasma or water-jet cutting of DIFENDER steels, given expert working procedures, is possible without difficulty provided tools that are in excellent condition and are suitable for the specific work are used. The various manufacturers have developed a differentiated range of tools, and users should therefore adhere to the settings and notes provided by the respective manufacturer in the form of cutting tables (nozzle selection, gas pressures, working procedure, rate of cutting, etc.).

The surface condition of the plates also has a pronounced influence on conditions for flame cutting and on the attainable cut-surface quality. Where high requirements are made on cut-surface quality, the top side of the workpiece should be cleansed of scale, rust, paint and other fouling at and around the site of the cut to be made.

For coated plates, Dillinger uses zinc silicate shopprimers. They are excellent to process in terms of weldability and cuttability. Due to processing conditions, an adjustment of the process parameters may be necessary.

Oxy-fuel flame cutting

In this thermal-cutting process, the steel is heated to its ignition temperature by a gas+oxygen flame and then combusted in a jet of cutting oxygen. Only a very narrow zone (< 1 mm) adjacent to the cut edge is heated to hardening temperature (austenitised) and transformed to hardening microstructure, due to the extremely high heat flux into the surrounding cold material. This flow of heat may reach the cooling rates encountered in water quenching. The adjacent areas are tempered. The term „heat-affected zone“ (HAZ) is also used in this context. The great temperature differences can generate stresses and, under unfavourable conditions, hardening cracking Flame cutting of DIFENDER steels demands greater care than that of conventional structural steels, especially as thickness and alloying-element content increase.

Flame cutting must be conducted at an adequately high temperature, in order to avoid cracking. Rate of cooling is thus diminished, with the result that the austenitised zone is less overhardened and that shrinkage stresses are significantly reduced. The minimum preheat temperatures listed in the table have proven their worth in oxy-fuel flame cutting. Re-entrant corners should be cut with a radius, in order to reduce their notching effect.

Where the cut edges are to be cold formed during further processing - by means of bending, for example - the overhardened zone resulting from flame cutting should, in all DIFENDER steels, be eliminated by means of surface grinding in the deformation zone (see the „cold forming“ section).

Table 2: Minimum preheat temperatures for thermal cutting

DIFENDER	Minimum preheat temperature	Plate thickness [mm]					
		6 ≤ t ≤ 10	10 < t ≤ 15	15 < t ≤ 25	25 < t ≤ 50	50 < t ≤ 80	80 < t ≤ 150 mm
270	Tv [° C]	RT	RT	60	-	-	-
300	Tv [° C]	RT	70	90	120	150	170
350	Tv [° C]	120	140	160	170	190	-
400	Tv [° C]	RT	70	90	130	190	-
450	Tv [° C]	60	70	90	150	-	-
500	Tv [° C]	115	130	160	170	180	190
550	Tv [° C]	150	160	170	-	-	-
600*	Tv [° C]	160	170	180	180	-	-

* < 150°C, max. 180° C for short times only

Max. heating temperature: < 200° C, 250° C for short times only
Oxygen (O2) pressure: 5 bar
Ethylene (C2H4) pressure: 0.2 bar

Hardness values similar to those achieved in water quenching are reached here. This hardness quickly regresses to the workpiece's original hardness level, however. In DIFENDER steels, the flame-cut edge again reaches the hardness of the initial water-hardened material. Between this is located a narrow softened zone which is somewhat wider close to the surface, due to the broader heating flame.

DIFENDER steels should not be heated for a prolonged time above 200° C (DIFENDER 600 not over 150° C), since they will otherwise suffer significant losses of hardness. For this reason, flame-cut components which are not capable of removing heat sufficiently rapidly - smaller components, for example - should rather be additionally cooled than preheated.

This can be accomplished, for example, by cutting in a water-bath, such that two thirds of the plate to be cut are submerged in the water and the heat input is then rapidly removed via the water. The resultant shrinkage forces are significantly lower in this case, with the consequence that there is no danger of cracking, due to the narrow HAZ. A further benefit is the top-grade dimensional tolerance which can be achieved using this flame-cutting method.

Laser and plasma cutting

The main benefits of laser and plasma cutting can be found in their higher cutting rates and narrow cut gaps and simultaneously ultra-low heat inputs. Both cutting methods make it possible to cut ultra-small components with only low distortion and without loss of hardness. It is also possible to dispense with preheating when these methods are used. The vital precondition for laser cutting is a plate surface in excellent condition, since the laser beam must be absorbed in concentration and with no disruption in the so-called focal point on the plate surface, with no losses due to reflection.

All DIFENDER steels can also be supplied on request in blasted and coated condition specifically for this cutting case. The achievable cutting speeds depend to a great extent on laser output power and the thickness of the plate to be cut. Cutting speeds of up to 2000 mm/min are attainable for a plate thickness of 10 mm and a laser output of 2-3 kW.

In some cases, cutting speed can be improved even further by means of appropriate treatment of the plate surface.

Unlike laser cutting, plasma cutting is also suitable for plate thicknesses of > 30 mm. The heat-affected zone is somewhat wider, however. The following figure shows the typical influence of the various cutting processes on the heat-affected zone of a water-hardened protection steel.

Table 3: Recommended cutting methods

Cutting Method	Description	Plate thickness [mm]
Abrasive waterjet*	Ultra high pressure water – often mixed with abrasive	> 6 mm
Laser beam cutting	Vaporization (in small thickness) or burning with oxygen	up to approx. 30 mm
Plasma Cutting (Plasma underwater)	Melting using gas, blowing out using gas nozzle	up to approx. 50 mm
Flame cutting**	Burning with oxygen, blowing out oxygen compounds (oxides)	> 10 mm

* Abrasive Waterjet can be applied to all DIFENDER plates and is the preferred method, because the absence of HAZ eliminates the risk of cracking.
** with preheating; for thicker plates post heating is recommended

Water-jet cutting

This process is particularly suitable for the cutting of DIFENDER steels, since it involves no thermal influences which could cause metallurgical changes in the material. The properties of the component are therefore not impaired or otherwise modified. Cutting speeds are somewhat lower, however.

Welding

Weldability

As alloying elements increase, the working of the steels, and heat input during welding, in particular, require special care.

Provided the general rules of welding (EN 1011) and the following notes are adhered to, DIFENDER steels are well suited for welding using the customary welding processes: shielded metal arc welding and gas metal arc welding. Dillinger hereby expressly points out that the following recommendations for welding are purely for information purposes.

The diversity of welding conditions, specific design and the welding-filler materials used have a significant influence on the quality of the completed weld. Since the specific working conditions at the particular location cannot be known, it is also not possible to guarantee from the inception the mechanical properties and freedom from defects of the completed welds. Practical experience does, however, document the attainment of good results, provided suitable welding conditions are assured.

Weld preparation

Weld preparation can be accomplished by means of subtractive machining or by means of thermal cutting using oxy-fuel, plasma or laser methods.

The weld area must be metallically bright, dry and free of flame-cutting slag, rust, scale, paint and all other fouling before welding is started.

Eventhough our shop primer is weldable, it might be helpful to remove it in the weld seam area. Please note that some specifications exclude an overwelding of the primer coat and therefore it has to be removed prior to welding.

Weld-filler materials and consumables

Weld-filler materials must be selected on the basis of the requirements for mechanical properties.

In most cases it is sufficient to use a „soft" weld filler material with a lower mechanical strength and lower hardness than the parent material for fillet welds and butt welds not subjected to limit loads (yield strength ≤ 460 MPa). This is advisable only in cases in which the welds can be positioned by means of design provisions in less stressed locations, in order that no disadvantages arise with regard to the safety of the welded components during service. Stick electrodes with a lime (low hydrogen) coating should be used in all cases of shielded metal arc welding, to assure protection against cracking. Basic coated stick electrodes possess two outstanding properties: the deposited metal has a higher toughness, and hydrogen input, at around 5 ml/100 g of deposited metal, is lower than with all other coating types (approx. 10 to 15 ml/100 g of deposited metal). The danger of cold cracking is therefore significantly reduced. Redrying and storage in accordance with the manufacturer's specifications are mandatory here, since basic coatings absorb moisture from the air. It may under certain circumstances be possible to dispense with preheating if austenitic or nickel-based electrodes are used.

Typical influence of different flame cutting processes
Macrosections of the HAZ on a 10 mm heavy plate from laser, plasma and autogenous flame cutting.

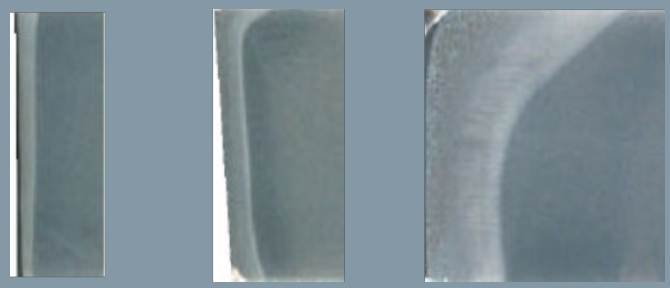


Table 3: „Ferritic“ weld filling materials and welding consumables

Shielded metal arc welding		
Designation	**Standard**	**Manufacturer**
Tenacito	DIN EN 499 E 42 6 B 42 H5 - AWS A 5.1 E 7018	Lincoln Electric
Phoenix 120 K	DIN EN 499 E 42 5 B 32 H5 - AWS A 5.1 E 7018	THYSSEN
Fox EV 50	DIN EN 499 E 42 4 B 42 H5 - AWS A 5.1 E 7018	BOEHLER
OK 48.00	DIN EN 499 E 38 2 B 42 H5 - AWS A 5.1 E 7018	ESAB

Gas metal arc welding		
Designation	**Standard**	**Manufacturer**
Fluxofil 30	DIN EN 758 T 42 2 B C 3 - AWS A 5.20 E 70 T-5	Lincoln Electric
Fluxofil 31	DIN EN 758 T 42 4 B C 3 - AWS A 5.20 E 70 T-5	Lincoln Electric
Union K 52	DIN EN 440 G 42 A C G3 Sil - AWS A 5.18 ER 70 S-6	THYSSEN
OK Autrod 12.51	DIN EN 440 G 42 5 M G3 Sil - AWS A 5.18 ER 70 S-6	ESAB

Other parameters:

Preheat temperature Tv: 145 - 150° C

Interpass temperature Tz: max. 160° C

$t_{8/5}$: 10 - 20 sec

Table 4: „Austenitic“ weld filling materials and welding consumables

Shielded metal arc welding		
Designation	**Standard**	**Manufacturer**
INOX29/9	DIN EN 1600 E29) R 12	Lincoln Electric
Supranel SR	DIN EN ISO 14172: E Ni 6062 (NiCr15Fe8Nb)	Lincoln Electric

Gas metal arc welding		
Designation	**Standard**	**Manufacturer**
Fluxinox M 307	EN 12073 T18 8 Mn M M 1	Lincoln Electric
Fluxinox 312	EN 12073 T29 9 R M 3	Lincoln Electric

Other parameters:

Preheat temperature Tv: Room temperature

Interpass temperature Tz: max. 160° C

$t_{8/5}$: 10 - 20 sec.

Avoidance of cold cracking

Like all hardened steels, DIFENDER grades also have a proneness, under unfavourable conditions, to cold cracking in the hardness microstructure in the vicinity of the weld.

Such cracks occur only several hours after welding, and inspection for cracking should therefore be performed not earlier than 48 hours after completion of welding. Cold cracking can, however, be avoided in principle provided appropriate precautions are implemented for welding and, above all, provided the two factors which favour cold cracking are eliminated: hydrogen in the deposited metal and residual stresses. A third influencing factor - overhardening in the heat-affected zone of DIFENDER steels - can be controlled only to a limited extent, due to the grade-dependent elevated alloying-element contents of the parent material and the weld-filler materials.

The incorporation of hydrogen atoms at the grain boundaries of the deposited-material microstructure and at the fusion line bears primary responsibility for cold cracking. The hydrogen is imported in moist weld-filler materials, from moisture films on the weld edges or from the atmosphere surrounding the electric arc. Importation of hydrogen must be reduced by selecting appropriate weld-filler materials and storing them in correct dry conditions and, above all, by warming up of the component/the immediate area of the weld. The higher temperature results in slower cooling of the weld after welding, allowing more time for the hydrogen to diffuse out of the metal. This process takes place mainly in the temperature range between 300 and 100° C.

Controlled heat input should be understood to signify not only heating of the area of the weld at the start of welding, but also the maintenance of a certain minimum temperature throughout the welding operation (working temperature). Gas metal arc welding transfers only comparatively small quantities of hydrogen into the deposited metal (< 2 ml/100 g), with the result that it is frequently possible to dispense with preheating of DIFENDER steels if welding wire electrodes of low mechanical strength are used.

Preheat and interpass temperatures for welding are shown below the tables 3 and 4. These show the recommended minimum preheat temperatures as a function of plate thickness and thus of the CET carbon equivalent and of the hydrogen content of the molten deposited metal.

The preheat temperature should be uniformly reached throughout the length of the weld before welding is started. A zone of around 100 mm or not less than the fourfold plate thickness should be heated to preheat temperature on both sides of the weld. The preheat temperature must also be maintained as the minimum interpass temperature in the case of multi-pass welds.

The danger of the occurrence of cracking in welds as a result of residual stresses is particularly great in the case of only partially filled weld cross-sections. For this reason, cooling down to below the specified working temperature must be avoided throughout the entire welding operation. Abrupt cross-section transitions and the clustering of numerous welds must be avoided, in order to assure low residual stresses. Please also assure good geometrical matching of the components to be welded and the most notch-free execution of the welds. Residual stresses can also be reduced by means of a well-harmonised welding sequence.

The welding sequence should in all cases be selected in such a way that the individual components are able to shrink without restraint for as long as possible.

Root and tack welds should be made sufficiently thick and with adherence to the necessary minimum preheat temperatures.

Machining

Despite their high mechanical strength and hardness, DIFENDER steels are suitable for chip-removing machining processes. Certain fundamental rules must be obeyed in the machining of these hardened steels, however. In particular, vibrations should be avoided to the greatest extent possible. It is therefore recommendable to machine the steels on the stiffest machine tool possible, and to keep the distance between the workpiece and the machine (column) as short as possible. Firm clamping of the workpiece to the table is also advisable. Adequate cooling, appropriate to the machining operation, should also be assured. Please adhere to the tool manufacturers' corresponding notes and recommendations.

The recommendations provided in the following tables (5 to 11) concerning selection of tools and the machining of DIFENDER steels are guidelines which may produce differing results, depending on the machine used. Their validity should be checked on the spot at the location by the user.

Drilling

Despite their great hardness, DIFENDER steels are well suited to drilling. The appropriate tools take the form of cobalt-alloyed HSS twist drills, twist drills with brazed-on metal-carbide cutters, solid carbide twist drills (with internal cooling where required) and indexable insert drill bits. With robust drill bits, advance at the start of drilling should be selected slightly higher, in order to quickly attain stable cutting. This also assists in reducing vibration. Infeed should be stopped briefly before the drill bit exits the material.

This relieves the strain on the machine and the tool, and avoids breakouts at the cut edges. Information concerning the selection of tools, cutting rates and advance rates can be found in the following tables.

Table 5: Guideline data for drilling

DIFENDER	Tool	V_c [m/min]	f_z [mm]	Notes
270	Manganese steel bit Manufacturer: Cleveland Designation: HSSCo8	8-12	0.1	Adequate service-life Cooling not absolutely necessary
	Cobalt-alloyed HSS twist drill Manufacturer: Stock Designation: HSS-Co V66	4-13	0.08-0.13	Low service-life Good cooling necessary
	Solid carbide Manufacturer: Iscar Designation: SCD 110-056-120 ACP5 908	25-42	0.05-0.07	Good cooling necessary
300	Manganese steel bit Manufacturer: Cleveland Designation: HSSCo8	8-12	0.1	Adequate service-life Cooling not absolutely necessary
	Cobalt-alloyed HSS twist drill Manufacturer: Stock Designation: HSS-Co V66	4-13	0.08-0.13	Low service-life Good cooling necessary
	Solid carbide Manufacturer: Iscar Designation: SCD 110-056-120 ACP5 908	25-42	0.05-0.07	Good cooling necessary
350	Solid carbide Manufacturer: Iscar Designation: SCD 110-056-120 ACP5 908	25-40	0.05-0-07	Good cooling necessary
	Cobalt-alloyed HSS twist drill Manufacturer: Stock Designation: HSS-Co V66	4-12	0.08-0.12	Low service-life Good cooling necessary
	Manganese steel bit Manufacturer: Cleveland Designation: HSSCo8	8-10	0.1	Adequate service-life Cooling not absolutely necessary

Table 5 (continuation)

DIFENDER	Tool	V_c [m/min]	f_z [mm]	Notes
400	Solid carbide Manufacturer: Iscar Designation: SCD 110-056-120 ACP5 908	25-40	0.05-0.07	Good cooling necessary
	Cobalt-alloyed HSS twist drill Manufacturer: Stock Designation: HSS-Co V66	10-12	0.08-0.1	Low service-life Good cooling necessary
	Manganese steel bit Manufacturer: Cleveland Designation: HSSCo8	8-12	0.1	Adequate service-life Cooling not absolutely necessary
450	Solid carbide Manufacturer: Iscar Designation: SCD 110-056-120 ACP5 908	25-35	0.05-0.07	Good cooling necessary
	Cobalt-alloyed HSS twist drill Manufacturer: Stock Designation: HSS-Co V66	-/-	-/-	Possible only to a limited extent
	Manganese steel bit Manufacturer: Cleveland Designation: HSSCo8	8-10	0.1	Adequate service-life Cooling not absolutely necessaryy
500	Solid carbide Manufacturer: Iscar Designation: SCD 110-056-120 ACP5 908	20-30	0.05-0.07	If chip fragmentation poor, reduce Vc Good cooling necessary
	Cobalt-alloyed HSS twist drill Manufacturer: Stock Designation: HSS-Co V66	-/-	-/-	Not possible
	Manganese steel bit Manufacturer: Cleveland Designation: HSSCo8	-/-	-/-	Possible only to a limited extent
550	Solid carbide Manufacturer: Iscar Designation: SCD 110-056-120 ACP5 908	20-30	0.05-0.07	If chip fragmentation poor, reduce the Vc Good cooling necessary
	Cobalt-alloyed HSS twist drill Manufacturer: Stock Designation: HSS-Co V66	-/-	-/-	Not possible
	Manganese steel bit Manufacturer: Cleveland Designation: HSSCo8	-/-	-/-	Possible only to a limited extend
600	Solid carbide Manufacturer: Iscar Designation: SCD 110-056-120 ACP5 908	20-30	0.05-0.07	If chip fragmentation poor, reduce the Vc Good cooling necessary
	Cobalt-alloyed HSS twist drill Manufacturer: Stock Designation: HSS-Co V66	-/-	-/-	Not possible
	Manganese steel bit Manufacturer: Cleveland Designation: HSSCo8	-/-	-/-	Possible only to a limited extend

Table 6: Guideline data for thread cutting

DIFENDER	Tool	V_c [m/min]	f_z [mm]	Notes
500	Solid carbide Manufacturer: Reime Noris Designation: DRILLREX HR 10,4	40	0.11	Good cooling necessary
	Thread tap: solid carbide Manufacturer: Reime Noris Designation: Twin HT HM Altin M12	2		Emulsion 8%

Milling

DIFENDER steels can be machined using tools consisting of high-speed steel (HSS, TiN, TiCN) and using tools fitted with indexable inserts. Please note that flame-cut edges may have significantly higher hardnesses. The first cut should therefore penetrate not less than 2 mm deep, i.e., sufficiently far below the hardened heat-affected zone (HAZ). The use of round indexable inserts is recommendable for the milling of DIFENDER steels. It has become apparent that this geometry is superior to that of the face milling cutter geometry (with 45° angle). The use of indexable inserts with a wide cutting edge bevel also additionally minimises wear. Dry machining, rather than cooling with emulsion, is recommended in this case. The use of compressed air or minimum quantity lubrication can also achieve a further increase in service-lives, however. Metal-carbide indexable inserts are sensitive to vibration. Vibrations must therefor be reduced by means of all possible provisions, including, for example, stable clamping of the workpiece. Alternating machining of the plate on both sides is recommendable if large surface areas are to be machined, since this procedure makes it possible to avoid distortion of the workpiece. Guide figures for cutting rate and infeed for face and edge milling are shown below, along with other parameters for face, edge, square-shoulder and groove milling.

Table 7: Guideline data for face milling 45°

DIFENDER	Tools	V_c [m/min]	f_z [mm]	ap [mm]	ae [%]
270	Iscar: H690 FWN D 100 11-32-R07 Indexable insert: H690 WNMU070512PNNMM IC808	35-40	0.1-0.13	2	80
	Pramet: 125 A 10R S45 HN09 CCF Indexable Insert: OEHT0604AEER-MM	32-65	0.07-0.11	2	70
300	Iscar: H690 FWN D 100 11-32-R07 Indexable insert: H690 WNMU070512PNNMM IC808	35-40	0.1-0.13	2	70
	Pramet: 125 A 10R S45 HN09 CCF Indexable Insert: OEHT0604AEER-MM	32-65	0.07-0.11	2	60
350	Iscar: H690 FWN D 100 11-32-R07 Indexable Insert: H690 WNMU070512PNNMM IC808	35-40	0.1-0.13	2	70
	Pramet: 125 A 10R S45 HN09 CCF Indexable Insert: OEHT0604AEER-MM	30-65	0.07-0.11	2	60
400	Iscar: SOF45 D125-10-40-R13 Indexable Insert: S845 SNHU 1305ANR-MM, IC 808	70-90	0.12-0.16	3	60
	Iscar: FFQ4 D080-7-27-12 Indexable Insert: FFQ4 SOMT120516T, IC 808	90-110	1.2-1.4	1	60
	Pramet: 125A10R S45HN09C CF Indexable Insert: HNGX 0906ANSN-R M8230	71-90	0.12-0.17	3	60
	Fette: FCP V12.100AN-IWR Indexable Insert: XCNT 120520EN-TR LC280QN	70-90	1.0-1.2	1	70
450	Iscar: SOF45 D125-10-40-R13 Indexable Insert: S845 SNHU 1305ANR-MM, IC 808	60-80	1.0-1.2	3	60
	Iscar: FFQ4 D080-7-27-12 Indexable Insert: FFQ4 SOMT120516T, IC 808	70-90	1.20-0.16	1	60
	Pramet: 125A10R S45HN09C CF Indexable Insert: HNGX 0906ANSN-R M8230	61-80	0.12-1.4	3	60
	Fette: FCP V12.100AN-IWR Indexable Insert: XCNT 120520EN-TR LC280QN	60-80	1.0-1.2	1	70
500	Iscar: SOF45 D125-10-40-R13 Indexable Insert: S845 SNHU 1305ANR-MM, IC 808	50-65	0.12-0.16	3	60
	Iscar: FFQ4 D080-7-27-12 Indexable Insert: FFQ4 SOMT120516T, IC 808	60-70	0.6-1.0	1	60
	Pramet: 125A10R S45HN09C CF Indexable Insert: HNGX 0906ANSN-R M8230	51-65	0.12-0.17	3	60
	Fette: FCP V12.100AN-IWR Indexable Insert: XCNT 120520EN-TR LC280QN	50-60	0.6-1.0	1	70
550	Iscar: SOF45 D125-10-40-R13 Indexable Insert: S845 SNHU 1305ANR-MM, IC 808	50-65	0.12-0.16	3	60
	Iscar: FFQ4 D080-7-27-12 Indexable Insert: FFQ4 SOMT120516T, IC 808	60-70	0.6-1.0	1	60
	Pramet: 125A10R S45HN09C CF Indexable Insert: HNGX 0906ANSN-R M8230	51-65	0.12-0.17	3	60
	Fette: FCP V12.100AN-IWR Indexable Insert: XCNT 120520EN-TR LC280QN	50-60	0.6-1.0	1	60
600	Iscar: FFQ4 D080-7-27-12 Indexable Insert: FFQ4 SOMT 120516T, IC 808	60-70	0.75-0.85	1	100
	Pramet: 125A10R S45HN09C CF Indexable insert: HNGX 0906ANSG-R M9315	50-65	0.13-0.17	3.5	80
	Fette: FCP V12.100AN-IWR Indexable insert: XCNT 120520EN-TR LC280QN	50-60	0.5-0.7	1	100

Table 8: Guideline data for edge milling

DIFENDER	Tools	V_c [m/min]	f_z [mm]	ap [mm]	ae [%]
270	Iscar: H690 FWN D 100 11-32-R07 Indexable Insert: H690 WNMU070512PNNMM IC808	35-40	0.1-0.13	2	4
	Pramet: 125 A 10R S45 HN09 CCF Indexable Insert: OEHT0604AEER-MM	30-65	0.07-0.12	3	4
300	Iscar: H690 FWN D 100 11-32-R07 Indexable Insert: H690 WNMU070512PNNMM IC808	35-40	0.1-0.13	2	4
	Pramet: 125 A 10R S45 HN09 CCF Indexable Insert: OEHT0604AEER-MM	30-65	0.07-0.12	3	4
350	Iscar: H690 FWN D 100 11-32-R07 Indexable Insert: H690 WNMU070512PNNMM IC808	32-40	0.1-0.12	2	4
	Pramet: 125 A 10R S45 HN09 CCF Indexable Insert: OEHT0604AEER-MM	30-60	0.07-0.11	3	4
400	Kyocera: MECH 050-W40-11-7-AT Indexable Insert: BDMT 170408ER-N3	80-100	0.2-0.3	25	3
450	Kyocera: MECH 050-W40-11-7-AT Indexable Insert: BDMT 170408ER-N4	65-85	0.2-0.3	25	3
500	Kyocera: MECH 050-W40-11-7-AT Indexable Insert: BDMT 170408ER-N5	50-70	0.2-0.3	25	3

Table 8 (continuation)

DIFENDER	Tools	V_c [m/min]	f_z [mm]	ap [mm]	ae [%]
550	Iscar: Solid Carbide EFS D16-5116234 IC900	140-160	0.08-0.12	15	0.2-0.5
	Kyocera: MECH 050-W40-11-7-AT Indexable Insert: BDMT 170408ER-N5	50-70	0.2-0.3	25	3
600	Iscar: Solid Carbide EFS D16-5116234 IC900	140-160	0.08-0.12	15	0.2-0.5
	Iscar: Solid carbide ECR-B6MF 20-42W20.104 IC900	140-160	0.08-0.12	30	0.2

Table 9: Guideline data for square-shoulder milling

DIFENDER	Tools	V_c [m/min]	f_z [mm]	ap [mm]	ae [%]
400	Iscar: HM390FTD D080-6-27-15 Indexable Insert: HM390 TDKT 1505PDR, IC 808	90	0.1	6	≤ 50
450	Iscar: HM390FTD D080-6-27-15 Indexable Insert: HM390 TDKT 1505PDR, IC 808	80	0.1	6	≤ 50
500	Iscar: HM390FTD D080-6-27-15 Indexable Insert: HM390 TDKT 1505PDR, IC 808	70	0.1	6	≤ 50
600	Iscar: P290 FPW D050-06-22-12 Indexable Insert: P290ACKT 1806PDR-FW, IC 830	50-70	0.12	14	5

Table 10: Guideline data for groove milling

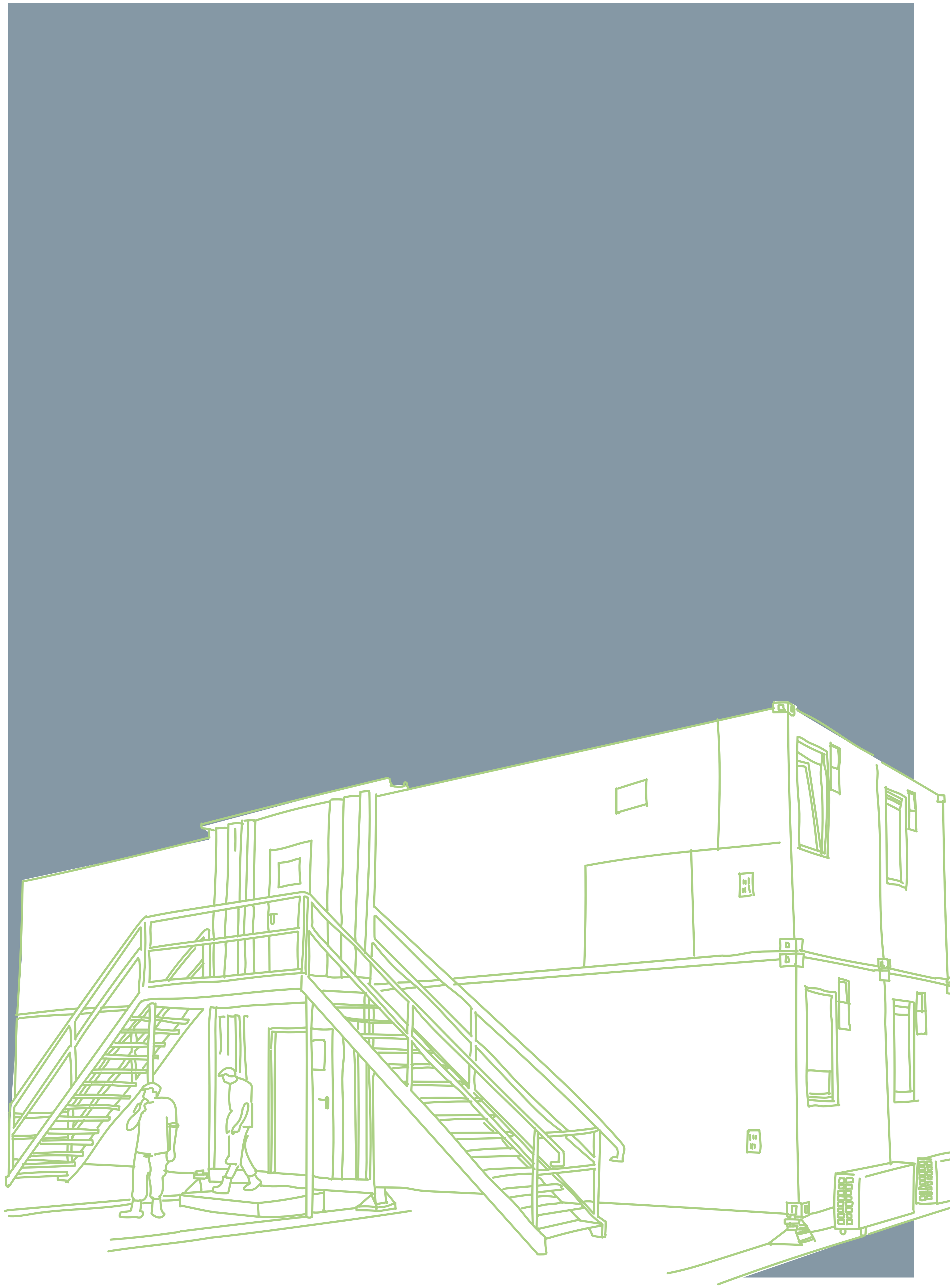
DIFENDER	Tools	V_c [m/min]	f_z [mm]	ap [mm]	ae [%]
400	Iscar: EFS-E44 16-34W16CF92, IC 900	80-100	0.08-0.12	16	≤ 75
450	Iscar: EFS-E44 16-34W16CF92, IC 900	70-90	0.08-0.12	16	≤ 75
500	Iscar: EFS-E44 16-34W16CF92, IC 900	60-70	0.08-0.12	16	≤ 75
600*	Iscar: ECR-B6MF 20-42W20.104, IC 900	50-70	0.04-0.06	20	≤ 75

* Roughing teeth advantageous

Table 11: Guideline data for thread milling

DIFENDER	Tools	V_c [m/min]	f_z [mm]	ap [mm]	ae [%]
600	Iscar: MTECB 2018D58 3.0 ISO 908	60	0.05	-/-	-/-

V_c: Cutting Speed
f_z: Advance per teeth
ap: Feed engagement
ae: Hob face width



Please contact one of our partners for individual advice, both technical or commercial.

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