TOOL STEEL CHART

Colour Code	Type	Sanderson	Related Spec's			Recommended Hardness	Werkstoff Number
	High Speed	Saben 652	Thyrapid 3343	S600	Gigan M5	63-64 HRC	1.3343
		Saben Wunda	Thyrapid 3243	S705	Gigan M5co	65-66 HRC	1.3243
	Cold Work	476	Thyrodur 2379	K110	Rcc Supra	58-60 HRC	1.2379
		Newhall	Thyrodur 2510	K460	Rus 3	60-62 HRC	1.2510
		Pax No 2	Thyrodur 2542	K450	RTW2H	52-54 HRC	1.2547
		476 Special	Thyrodur 2436	K107	RCC Extra	60-64 HRC	1.2436
		LTB	Thyrodur 2767	K600	RABW	54-56 HRC	1.2767
	Hot Work	CMV	Thyrotherm 2344	W302	RDC2V	54-56 HRC	1.2344
		DBS	Thyrotherm 2714	W500	RGS 4	48-52 HRC	1.2714
	Plastic Mould	PMS	Throplast 2312	M210	-	As Supplied 28-23 HRC	1.2312
		IMPAX	Throdur 2767	K605	-	50-52 HRC	1.2767
		PVC	Throdur 2316	M300	Bp42	48-50HRC	1.2316
	Silver Steel	Silver Steel	Thyrodur 2210	K510	-	60-64 HRC	1.2210
	Flat Ground Stock	GFS	-	K460	-	58-62 HRC	1.2510
	High Tensile Steel	MCV	-	V155	-	As Supplied 28-32 HRC	1.6582
		AISI 4140	-	-	-	31-32 HRC	1.2313
	Stainless Steel	AISI 440C	-	-	-	50-54 HRC	1.4568
		SAE 8620	-	-	-	58-60 HRC	1.6523

476/K110® Colour Code: White & Black D2 1.2379

HIGH DUTY TOOL STEEL AISI WERKSTOFF No

C	Si	Mn	Cr	Mo	W	V	Co
1.55			12.0	0.85		0.28	

Features and Uses
Being of the high carbon, high chromium type this steel offers very high wear resistance, yet it is tough and machinable. It hardens in air up to large sections with a low order of movement and offers a measure of corrosion resistance when polished.

"**476**" is used for tools operating under conditions of severe wear and abrasion or as an alternative to oil hardening tool steels when longer runs are required.

Applications include blanking dies and punches for steel sheet and plate, high silicon transformer materials, stainless steel and iron, brass, copper, zinc and hard abrasive metals generally. Deep drawing dies, cupping dies, forming dies. Sheet metal forming rolls, shear blades for strip and sheet including flying shears. Circular cutters for cold rolled strip. Trimmer dies, thread rolling dies, cold extrusion dies. Broaches, plug gauges, ring gauges, special taps, staybolt taps. Brick and tile mould liners. Master hobs for cold hobbing, plastic moulds. Cut moulds for plastics.

Working and Heat Treatment
Forging
Pre-heat at 900ºC / 950ºC. then raise temperature to 1050º / 1100ºC. Soak until uniformly heated. This steel is relatively hard at elevated temperatures, therefore, initial hammer blows must be light and the temperature must not be allowed to fall below 1020ºC. until the metal begins to flow. Final forging should not be done below 900ºC.
Annealing
"476" is supplied in the annealed and machinable condition. Re-annealing will only be necessary if the steel has been forged by the toolmaker or if it is desired to machine a hardened tool. To anneal, heat slowly and uniformly to 900ºC. in a protective gas atmosphere. Soak for three to four hours and allow to cool in the furnace to shop temperature. Then, without removing the steel from the furnace, re-heat to 800°C and again soak for three to four hours. Allow to cool in the furnace to shop temperature.

Stress relieving
When tools are heavily machined, ground or otherwise subjected to cold work, the relief of internal strains is advisable before hardening to minimize the possibility of distortion. Stress relieving should be done after rough machining. To stress relieve, heat carefully at 600° / 650°C. Soak well and cool in the furnace or in air. The tools may then be finish-machined before hardening.

Hardening
It is preferable to heat the tools in a controlled atmosphere. This material is ideal for vacuum hardening and also suited to salt bath hardening. If this is not possible, pack hardening is recommended. A reducing atmosphere is desirable. Pre-heat slowly to 750° / 800°C. and allow to soak at this temperature. The tools may then be brought up to 1000° /1020°C. for air-cooling, or 980°C. for oil quenching. Soak thoroughly at the temperature for twenty to thirty minutes per inch of ruling section, then cool or quench accordingly. It is important not to exceed 1020°C. when heating for hardening. Exceeding this temperature will cause indifferent hardening. A deterioration in magnetic properties indicates that the steel has been overheated in hardening. Tempering will always be necessary.

Martempering
Martempering is an alternative hardening procedure, which may be used when suitable salt bath equipment is available. By this method internal strain, distortion and risk of quench cracking are reduced to the minimum. Pre-heat dry at 300°/400°C. Pre-heat in salt at 800º / 850°C. holding in the salt for ten minutes per 25 mm of ruling section. Raise to the hardening temperature of 1000° /1020°C. holding in the salt for ten minutes per 25 mm of ruling section.

Marquench in salt at 230° / 250°C. , holding in the bath for twenty minutes per 25 mm of ruling section. Cool in still air. Tempering will be necessary.

Tempering
Double tempering is recommended. Tempering should be done with the least possible delay after hardening, preferably when the tools are still hand warm. Refer to the tempering curve and select a suitable temperature bearing in mind the service requirements. Heat slowly and uniformly. When the tool has reached the desired temperature, soak for at least sixty minutes, withdraw from the furnace and allow to cool in air. The second tempering should be a repetition of the first.

Guide to Tempering Temperatures
TOOLS FOR LIGHT SHOCK APPLICATIONS when maximum wear resistance is required, e.g. moulding dies, thin sheet-punching dies. Temper 190° - 250°C. Hardness Rockwell C60-63.

MEDIUM DUTY APPLICATIONS slitting cutters, plate punching dies, master hobbing tools, trimming dies, cold extrusion dies. Temper 500°-520°C. Hardness Rockwell C57-60.

MEDIUM TO HEAVY DUTY APPLICATIONS slitting cutters, shear blades, punching tools, forming tools, trimming dies, cold extrusion dies, and bolt cutters. Temper 520°-540°C. Hardness Rockwell C55-58.

HEAVY DUTY APPLICATIONS heavy sheer blades, flying shears, heavy plate punching tools, punching and forming tools. Temper 540°-560°C. Hardness Rockwell C52-56.

Final Grinding
Select the correct grade of wheel in consultation with the grinding wheel manufacturer. Keep the wheel in good condition by means of a suitable dressing tool. Wet grinding is preferable using a copious supply of coolant. If dry grinding is resorted to, use a very soft wheel.

“476 SPECIAL” 2% Carbon 12% Chromium

Colour Code: White/Black/Green **D6** **1.2436**

HIGH DUTY TOOL STEEL AISI WERKSTOFF No

C	Si	Mn	Ni	Cr	Mo	W	V	Co
2.1				12.0		0.7		

Features and Uses
476 SPEC a high carbon high chromium steel noted for its resistance to abrasion. It offers excellent dimensional stability in hardening.

After heat treatment 476 SPEC is hard, durable and dense and is immune from sinking in use. It offers a measure of corrosion resistance when polished.

Applications: complex blanking and forming tools for long runs and for hard and abrasive materials. Brick and tile mould liners, master hobs for cold hobbing plastic moulds, tabletting punches and sleeves for corrosive powders.

In general the applications of 476 SPEC resemble those of 476 but it should be remembered that 476 is the tougher of the two steels and is preferred for such items as shear blades. Owing to its higher wear resistance. 476 SPEC is somewhat more difficult to grind than 476

Working and Heat Treatment Forging
Pre-heat at 900°/950°C, then raise temperature to 1050°/1100°C. Soak until uniformly heated. This steel is relatively hard at elevated temperatures; therefore, initial hammer blows must be light and the temperature must not be allowed to fall below 1020°C until the metal begins to flow. Final forging should not be done below 900°C.

Annealing
476 Special supplied in the annealed and machineable condition. Re-annealing will only be necessary if the steel has been forged by the tool maker or if it is desired to machine a hardened tool. To anneal, heat slowly and uniformly to 900°C in a closed container. Soak for three to four hours and allow to cool in the furnace to shop temperature. Then, without removing the steel from the tube or container, re-heat to 800°C and again soak for three to four hours. Allow to cool in the furnace to shop temperature.

Stress Relieving
When tools are heavily machined, ground or otherwise subjected to cold work, the relief of internal strains is advisable before hardening to minimise any possibility of distortion. Stress relieving should be done after rough machining. To stress relieve, heat carefully at 600°/650°C. Soak well and cool in the furnace or in air. The tools may then be finish-machined before hardening.

Hardening
The tools must be protected against decarburisation by heating in a neutral salt bath or by pack hardening. For pack hardening the tools must be wrapped in oiled brown paper then packed into a lidded iron box with cast iron ships or turnings then heated to the hardening temperature. Pre-heat slowly to 750°/800°C and allow to soak before raising to the hardening temperature of 950°/980°C. Sufficient time must be allowed for the heat to penetrate the box and packing so that the tools attain full temperature. Soak for thirty minutes per inch of section of the container. Withdraw the container from the furnace and quench the tools in oil.

Tempering will then be necessary.

Martempering
Martempering is an alternative hardening procedure which may be used when suitable salt bath equipped is available. By this method internal strain, distortion and risk of quench cracking are reduced to the minimum. Pre-heat dry at 300°/400°C. Pre-heat in salt at 800°/850°C holding in the salt for ten minutes per inch of ruling section.

Marquench in salt at 230°/250°C, holding in the bath for five minutes per inch of ruling section. Cool in still air. Tempering will be necessary.

Tempering
Tempering between 180°/260°C, will give a hardness of C60/64 Rockwell, but tempering below 400°C is recommended for shock-free applications only. For maximum toughness, temper between 400°/540°C.
Brick liners, temper at 180°C to Rockwell C62/64.

Blanking thin hardened and tempered strip, temper at 200°C to Rockwell C61/63.

Lamination dies, gauges, temper at 240°C to Rockwell C60/62.

General blanking and press tools, temper at 420°C to C59/58 Rockwell.

Heat slowly and uniformly. When the tool has reached the desired temperature, soak for at least sixty minutes, then withdraw from the furnace and allow to cool in still air away from draughts. Double tempering is beneficial. The second tempering should be a repetition of th first.

CMV Colour code: Yellow & Black — H13 — 1.2344

HOT WORK DIE STEEL — AISI — WERKSTOFF No

C	Si	Mn	Cr	Mo	W	V	Co
0.38	1.05	0.35	5.25	1.35		1.00	

Features and Uses
C.M.V. is reliable hot work steel with a wide variety of applications. It combines very good red-hardness with toughness and tools made from it may be water-cooled in service.
C.M.V. may be cold hobbed in the annealed condition.
Applications include:
Die casting dies for aluminium, magnesium and zinc.
Extrusion dies for aluminium and glass.
Liners, mandrels, pressure pads, followers, bolsters, die cases, die holders and adaptor rings of copper and brass extrusion.
Hot stamping and press forge dies.
Split hot heading dies, gripper dies.
Hot punching, piercing and trimming tools. High speed wood turning, cutting and shaping.
Plastic moulds.
Shear blades for hot work.
Hot swaging dies.

Work and Heat Treatment Forging
Preheat slowly to 750°C. then increase temperature more rapidly to 1050° / 1100°C. Do not forge below 850°C. It is essential to cool slowly after forging either in a furnace or in vermiculite.

Annealing
Soak thoroughly at 840° / 860°C. before furnace cooling at a maximum rate of 20°C. per hour down to 600°C. followed by cooling in air. To avoid scaling, box annealing in cast iron chips is preferred.

Stress Relieving
Heat carefully to 700°C, allow a good soaking period (2 hours per inch of ruling section) cool in furnace or in air.

Hardening
Preheat to 780° / 820°C, soak thoroughly then increase rapidly to the hardening temperature of 1000° / 1030°C. When the part has attained this temperature, soak for 20 to 30 minutes, cool in air. Large sections may be quenched in oil.

To reduce scaling or decarburisation we recommend isothermal molten salt bath treatment. Preheat in salt at 780° / 820°C then transfer to salt bath standing at 1000° / 1030°C, soak and quench into salt standing at 500° / 550°C, allow to equalize, withdraw and cool in air. Alternatively the steel may be vacuum hardened or pack hardened.

Tools should be tempered as soon as they become hand warm.

Tempering
Heat uniformly to the required temperature allowing a soaking time of 2 hours per inch of ruling section, withdraw from the furnace and allow to cool in air. A second tempering is strongly recommended, the tool being allowed to cool to room temperature between tempers. The usual tempering range is 530° / 650°C. , depending on the hardness requirements and the operating temperature of the tool.

Nitriding
C.M.V. will respond to Nitriding whether gas Nitriding (cracked ammonia) or liquid Nitriding (Tuftriding and Sulfinuz). The object of Nitriding is to increase the surface hardness of hardened and tempered parts, for example die casting dies, and to improve resistance to scaling or erosion.

It is important to note that with increase in penetration of the Nitriding there is a reduction in resistance to thermal shock and an increase in embrittlement.

Welding
In general we do not advise the welding of parts or tools but users sometimes prefer to weld in order to avoid the cost of retooling.

It should be remembered that C.M.V. is an air hardening steel and that in welding, the area of the weld attains a temperature of about 1000°C. Cracking is likely to occur during cooling unless proper precautions are taken.

The most popular methods of welding are:
a) Atomic Hydrogen
b) Argon Arc

Welding Procedure
1) It is desirable to anneal the tool prior to welding but with care welding may be done on hardened and tempered tools.

2) It is important to preheat the die to 300° / 500°C and to maintain this temperature during welding.

3) After the weld has been completed, maintain at 300° / 500°C for one hour, then cool the die slowly in a furnace or in insulating material.
4) If the tool has been annealed prior to welding, stress relieve at 700°C. before re-hardening.

5) If the tool has not been annealed prior to welding re-temper at 550° / 600°C for a minimum of 2 hours.

Hot Hobbing
A number of die casting blocks in C.M.V. have been successfully hot hobbed.

PITHO / GROUND FLAT STOCK SIZES

WIDE	1	1.5	2	2	4	5	6	8	10	12	15	20	25	30	50
10	●	●	●	●	●	●	●	●	●						
15	●	●	●	●	●	●	●	●	●	●	●				
20	●	●	●	●	●	●	●	●	●	●	●	●			
25	●	●	●	●	●	●	●	●	●	●	●	●	●		
30	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
40	●	●	●	●	●	●	●	●	●	●	●	●	●		
50	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
60	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
80	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
100	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
125	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
150	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
200	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
250			●	●	●	●	●	●	●	●	●	●	●	●	
300			●	●	●	●	●	●	●	●	●	●	●	●	
SQUARE	6	8	10	12	15	20	25	30	40	50	60	80			

METRIC TOLERANCES: Thickness + 0.05 –0.00mm
Width up to 30mm +0.20 - 0.00mm
over 30mm to 120mm +0.30 –0.00mm
over 120mm to 300 mm +0.40 – 0.00mm

LENGTHS: 500mm & 1000mm

IMPERIAL SIZES: +/-10 working days delivery

NON-STANDARD SIZES & TOLERANCES: available upon request

SABEN 652 Colour Code: Pink M2 1.3343

HIGH SPEED STEEL AISI WERKSTOFF No

C	Si	Mn	Cr	Mo	W	V	Co
0.83			4.1	5.0	6.4	1.9	

Features and Uses

This is general-purpose high-speed steel and is a standard material with leading toolmakers for the manufacture of high-class cutting tools.

It has excellent wear resistance combined with toughness and is readily machinable in the annealed condition.

Applications include turning planning and slotting tools, reamers, drills, cutters, hobs, taps, punches and dies, blanking dies and punches for steel sheet and plate, high silicon transformer materials, stainless steel and iron, brass, copper, zinc and hard abrasive metals generally. Deep drawing dies, cupping dies, forming dies. Sheet metal forming rolls, shear blades for strip and sheet including flying shears. Circular cutters for cold rolled strip. Trimmer dies, thread rolling dies, cold extrusion dies. Broaches, plug gauges, ring gauges, special taps, staybolt taps. Brick and tile mould liners. Master hobs for cold hobbing, plastic moulds. Cut moulds for plastics.

Working and Heat Treatment

Forging

Pre-heat at 900ºC / 950ºC. then raise temperature to 1050º / 1150ºC. Soak until uniformly heated. The temperature must not be allowed to fall below 880º / 900ºC. Cool very slowly after forging and protect from draughts.

Annealing

Saben 652 is supplied in the annealed and machinable condition. Re-annealing will only be necessary if the steel has been forged by the toolmaker or if it is desired to machine a hardened tool.
To anneal, heat slowly and uniformly to 850ºC. in a closed container. Soak for three to four hours and allow to cool in the furnace to shop temperature.

Stress relieving

When tools are heavily machined, ground or otherwise subjected to cold work, the relief of internal strains is advisable before hardening to minimize the possibility of distortion. Stress relieving should be done after rough machining. To stress relieve, heat carefully at 650° / 700°C. Soak well and cool in the furnace or in air. The tools may then be finish-machined before hardening.

Hardening

Very slow initial heating is essential when hardening high speed steels and the steel should be warmed through on the furnace top then pre-heated slowly to 840º / 860ºC. and allow to soak at this temperature. It is preferable to heat the tools in a controlled atmosphere. If this is not possible, pack hardening is recommended. A reducing atmosphere is desirable. The tools may then be brought up to 1200º / 1240°C. Avoid undue soaking at the hardening temperature but remove when the tools are soaked through.

Hardening in a neutral salt bath is advantageous when treating cutters or other tools with delicate teeth or edges as it will minimize decarburisation. The tools should be air quenched from the hardening temperature in a dry air blast or oil, removed, and left to cool until hand warm before tempering.

Martempering

Martempering is an alternative hardening procedure, which may be used when suitable salt bath equipment is available. By this method internal strain, distortion and risk of quench cracking are reduced to the minimum. Pre-heat dry at 300° / 400°C. Pre-heat in salt at 850 / 900°C holding in the salt for ten minutes per inch of ruling section. Raise to the hardening temperature of 1200° / 1240°C. holding in the salt until heated through.

Marquench in salt at 550° / 580°C, allow to equalize, remove and cool in still air until hand warm. Tempering will be necessary.

Tempering

Double tempering is recommended. Tempering should be done with the least possible delay after hardening, preferably when the tools are still hand warm. Refer to the tempering curve and select a suitable temperature bearing in mind the service requirements usually 540 º / 560ºC. Heat slowly and uniformly. When the tool has reached the desired temperature, soak for at least sixty minutes, withdraw from the furnace and allow to cool in air. Double tempering is essential for maximum tool performance,
The second tempering should be a repetition of the first.

Final Grinding
Select the correct grade of wheel in consultation with the grinding wheel manufacturer. Keep the wheel in good condition by means of a suitable dressing tool. Wet grinding is preferable using a copious supply of coolant. If dry grinding is resorted to, use a very soft wheel.

LTB Colour Code: Orange & Grey — A6 — 1.2767

AIR HARDENING TOOL STEEL — AISI — WERKSTOFF No

C	Si	Mn	Ni	Cr	Mo	P	S
0.47	0.20	0.36	4.0	1.30	0.18	0.013	0.003

Features and Uses

"LTB" die steel hardens in air at a low temperature and as a result distortion is kept to a minimum. It can be vacuum hardened, salt bath hardened and even pack hardened. This material superceded the well-known Sanbold 30 and"L.T.A.H." grades, the production of which has been discontinued. The hardening properties are almost identical to "L.T.A.H.", however, with the addition of Nickel and lower carbon content, "L.T.B." is tougher with a slightly lower maximum hardness of about
57/58 HRC.

"L.T.B." can also be hardened with a cutting torch flame for use as an emergency tool during a break down where maintaining production is critical. In this case, the whole of the tool is heated to a light red colour and allowed to cool in still air. In the case of large tools, the cutting edge only can be flame hardened. At a later stage the tool may be removed from service, thoroughly annealed and re-hardened by conventional methods such as salt bath or vacuum processes.

Applications include heavy forming dies, blanking dies, trimming dies, coining dies, notching dies, mandrels, retaining rings, rim rolls, bending tools, cold shears, plastic moulds, drive shafts and almost any application where extreme toughness coupled with wear resistance is desired.

This material is becoming increasingly popular in the plastic moulding industry due to its mirror polishability, stability during hardening and toughness.

LTB offers:

- Outstanding freedom from size change and distortion.
- Capacity to through harden up to 90 mm thick
- Toughness with good hardness and wear resistance
- Good machinability
- Good polishability

Working and Heat Treatment

Forging

Forge at 1050º / 1100ºC. Reheat slowly when temperature fall below 850° / 900°C Slow cooling is necessary after forging. Allow to cool down with furnace if possible, otherwise cover with dry lime or ashes.

Normalising

Normalising is not recommended for this steel.

Annealing

Pack anneal in a tube or other closed container with clean cast iron borings at 640°/ 650°C for at least 2 to 3 hours. Cool very slowly in the furnace. Brinell hardness after annealing will be approximately 255

Stress relieving

For applications where distortion must be at a minimum, we recommend stabilizing just before tools are finish machined in order to relieve machining strains. Heat to 620° / 650°C and allow to slow cool.

Hardening

Heat the steel to 840° / 870°C (upper limit for larger sizes). Soak for at least twenty minutes at the temperature.

Quenching

Air, air blast, oil or Marquench at 300° / 350°C. Hardness obtainable in salt or oil is higher than that of air or vacuum

Tempering

Immediately after hardening, re-heat, preferable in an air circulating tempering furnace, to the required tempering temperature and soak for one hour. Cool in air.

A suitable tempering temperature may be selected by reference to the Tempering Graph usually between 150° / 300 °C

Guide to Tempering Temperatures

TOOLS FOR LIGHT SHOCK APPLICATIONS when maximum wear resistance is required, e.g. moulding dies, thin sheet-punching dies. Temper 150° / 200°C. Hardness Rockwell C54-57.

MEDIUM DUTY APPLICATIONS slitting cutters, plate punching dies, master hobbing tools, trimming dies, cold extrusion dies. Temper 250° / 300°C. Hardness Rockwell C52-54.

MEDIUM TO HEAVY DUTY APPLICATIONS slitting cutters, shear blades, punching tools, forming tools, trimming dies, cold extrusion dies, and bolt cutters. Temper 300°-320°C. Hardness Rockwell C50-52.

HEAVY DUTY APPLICATIONS heavy sheer blades, flying shears, heavy plate punching tools, punching and forming tools. Temper 450°-500°C. Hardness Rockwell C42-45.

NEWHALL Colour Code: White O1 1.2510

OIL HARDENING TOOL STEEL AISI WERKSTOFF No

C	Si	Mn	Cr	Mo	W	V
0.95		1.20	0.55		0.55	0.20

Features and Uses

This moderately priced oil hardening tool steel hardens in oil from a low temperature, offers pronounced non-deforming characteristics and retains its original dimensions after oil hardening and tempering. It gives excellent wear resistance, holds a good cutting edge and is relatively easy to machine. Due to these properties, Newhall is excellent general-purpose tool steel often used where the expenses of high carbon high chromium steels would not be justified.
Typical applications of Newhall include medium run dies, intricate press tools, drawing punches, broaches, bushings, lathe centers, chuck jaws, master cavity sinking hobs, paper cutting machine knives, plug gauges, thread gauges and precision measuring tools generally, cams, cloth cutting knives, cold taps, reamers, collets, cutting hobs, strip slitting cutters, trimmer dies, tube expander rolls, plastic moulds and wood working knives.

Working and Heat Treatment

Forging

Heat slowly and begin forging at 980º / 1000ºC. Do not allow temperature to fall below 800°C reheating if necessary. Slow cool.

Normalising

Normalising is not recommended for this steel.

Annealing

Pack anneal in a tube or other closed container with clean cast iron borings at 740°/760°C for at least 2 to 3 hours. Cool very slowly with the furnace until the temperature falls below 500°C. With draw from box or tube and allow to cool to shop temperature. Brinell hardness after annealing will be approximately 229.

Stress relieving

Where tools are heavily machined, ground or subjected to cold work, the relief of internal strains is essential before hardening. Stress relieving should be done after rough machining. To stress relieve, heat carefully to 670°/700°C soak well and allow to cool in air.

Hardening

Heat slowly and if possible pre-heat to 300° / 500 °C before raising to the hardening temperature of 780° / 820°C. Pre heating is especially desirable for complex sections. Soak thoroughly, allowing 30 minutes per inch of ruling section before quenching. Light sections should be quenched in oil from the lower end of the temperature range.

Long slender sections should always be suspended in the furnace for heating and quenched by plunging vertically into the oil bath.
Tempering is always necessary after hardening.

Martempering

Martempering is an alternative hardening procedure, which may be used when suitable salt bath equipment is available. By this method, internal strain, distortion and risk of quench cracking is reduced to the minimum.
Pre heat at 360°C then reheat to 800°C for sections 3.5 mm or less, or 820°C for sections over 3.5 mm. Soak according to section, then quench into molten salt held at 210°C. Allow sufficient time for the center of the piece to reach bath temperature, withdraw and cool in the air. Tempering will them be necessary. Hardness obtainable in salt or oil is similar but salt bath quenching reduces distortion. Only sections of less than 10 mm thick can be vacuum hardened.

Tempering

Temper between 150°C and 350°C according to the requirements of the job and by reference to the tempering curve. Soak for one hour at the tempering temperature. Where possible, use an air-circulating Furnace.

Tempering Curves and stock range are printed on the reverse of this data sheet.

PAX No 2 Colour Code: Red & black S1 1.2547

SHOCK RESISTING TOOL STEEL AISI WERKSTOFF No

C	Si	Mn	Cr	Mo	W	V
0.50	0.65	0.30	1.50		2.25	0.20

Features and Uses

PAX 2 is an alloy shock-resisting tool steel for both hot and cold work applications. The tungsten content of this steel confers fatigue resistance, the chromium content gives depth of hardness and resistance to abrasion.
PAX 2 is suitable for cold work tools subject to heavy shock and uneven loading, for example, press tools used for punching heavy gauge material, shear blades, nut blanking tools, perforating and piercing punches.
This steel is also used with great success for chisels, punches and sates required for heavy work on hard tough materials.
PAX 2 is resistant to heat checking. It is suitable for hot-work applications where high fatigue strength in combination with medium hot hardens is desirable. Tools made from this material may be water cooled in service with little risk of cracking. Typical hot work applications include mandrel bars for drawing steel tubes, hot heading, swaging, forming and gripper dies used in medium temperature work, punching, piercing, and trimming dies and shear blades working at medium temperature including flying shear blades.

Working and Heat Treatment

Forging

Heat slowly to 1000º / 1050ºC and forge with light rapid blows. Reheat when temperature falls below 900°C. Slow cool, preferably in the furnace, to shop temperature.

Normalising

Normalising is not recommended for this steel.

Annealing

Pack anneal in a tube or other closed container with clean cast iron borings at 800°/810°C for at least 2 to 3 hours. Cool slowly with the furnace

Stress relieving

For applications where distortion must be kept to a minimum or where the machining operations have been severe, we recommend stabilizing just before the tools are finish machined in order to relieve machining strains. Heat slowly to 700°C and allow to cool in air.

Hardening

Preheat at 650°C followed by rapid increase of temperature to 900 / 950°C quench in oil. When it is not intended to grind after hardening, tools should be packed into a container with clean cast iron borings for heating for hardening, or heated to the hardening temperature in a neutral salt bath or gas atmosphere furnace followed by quenching in oil.

Tempering

The hardened steel must always be tempered. Heat slowly to the required tempering temperature, soak thoroughly for 2 hours per 25 mm of ruling section and allow to cool in still air. For hot work applications a minimum tempering temperature of 550°C should be used.

PITHO/NEWHALL O1 1.2510

GROUND FLAT STOCK / GAUGE PLATE AISI WERKSTOFF No

C	Si	Mn	Cr	Mo	W	V
0.95		1.20	0.55		0.55	0.20

Features and Uses

This material is supplied precision ground, coated in a rust preventative and wrapped in paper to protect the material from damage. It is normally supplied in standard lengths of 500 mm and 1000 mm but non-standard sizes will be specially manufactured upon request with a delivery time of about 10 working days.
This moderately priced oil hardening too steel gives excellent wear resistance, holds a good cutting edge and is relatively easy to machine. It is excellent general-purpose tool steel often used where the expenses of high carbon high chromium steels would not be justified.
There are thousands of applications for this product and it has the advantage of already being ground to size thereby saving the toolmaker many hours in preparing the material.
It is well known as a paper knife material and also for ejectors and slides in tool making. Cams. Punches, dies and other profiles are wire cut or water jet cut either prior to hardening or afterwards. It is advisable to stress temper items that have been wire cut after heat treatment as the wire cutting process causes secondary hardening which can lead to cracking.

Working and Heat Treatment

Normalising

Normalising is not recommended for this steel.

Annealing

Pack anneal in a tube or other closed container with clean cast iron borings at 740° / 760°C for at least 2 to 3 hours. Cool very slowly with the furnace until the temperature falls below 500°C. With draw from box or tube and allow to cool to shop temperature. Brinell hardness after annealing will be approximately 229.

Stress relieving

Where tools are heavily machined, ground or subjected to cold work, the relief of internal strains is essential before hardening. Stress relieving should be done after rough machining. To stress relieve, heat carefully to 670° / 700°C soak well and allow to cool in air.

Hardening

This material hardens in oil at a low temperature with minimum movement. Quench in oil from 780 / 820ºC. Long slender sections should always be suspended in the furnace for heating and quenched by plunging vertically into the oil bath. Resultant hardness will be Rockwell C63/64.
Tempering is always necessary after hardening.

Martempering

Martempering is an alternative hardening procedure that may be used when suitable salt bath equipment is available.

By this method, internal strain, distortion and risk of quench cracking is reduced to the minimum.
Pre heat at 360°C then reheat to 800°C for sections 3.5 mm or less, or 820°C for sections over 3.5 mm. Soak according to section, then quench into molten salt held at 210°C. Allow sufficient time for the center of the piece to reach bath temperature, withdraw and cool in the air. Tempering will them be necessary. Hardness obtainable in salt or oil is similar but salt bath quenching reduces distortion. Only sections of less than 10 mm can be vacuum hardened.

Tempering

Temper between 150°C and 350°C according to the requirements of the job. Soak for one hour at the tempering temperature. Where possible, use an air- circulating Furnace.

150ºC to obtain Rockwell C62.
200ºC to obtain Rockwell C60.
250ºC to obtain Rockwell C58
350ºC to obtain Rockwell C56.

Tempering curves and size range are printed on the reverse of this data sheet.

PMS Colour Code: Orange — P20 — 1.2312

PLASTIC MOULD STEEL — AISI — WERKSTOFF No

C	Si	Mn	Cr	Mo	S	P
0.37	0.30	0.80	1.50	0.20	0.05	0.06

Features and Uses

PMS is premium quality Cr-Mo alloyed steel, which is supplied, in the hardened and tempered condition offering the following benefits:

- No hardening risks
- No hardening costs
- Time saving (no waiting for heat treatment)
- Lower tool cost (e.g. no distortion to rectify)
- Modifications easily carried out
- Can be subsequently Nitrided or Tuftrided to reduce surface damage.
- Good polishing & photo etching properties.
- Good machinability
- Uniform Hardness

PMS may be used in the following applications:
Injection mould for thermoplastics
Extrusion dies for plastics
Blow moulds
Forming Tools, press brake dies (possibly flame hardened or Nitrided)
Structural components and shafts

Heat Treatment

Annealing

Anneal in a protective gas atmosphere at 700°C for at least 2 to 3 hours. Cool at 10°C per hour with the furnace until the temperature falls below 600°C. Withdraw from the furnace and allow cooling to shop temperature.

Stress relieving

Where tool are heavily machined, ground or subjected to cold work, the relief of internal strains is essential before hardening. Stress relieving should be done after rough machining. To stress relieve, heat carefully to 550°C soak well and allow to cool slowly to room temperature.

Hardening

The steel should be fully soft annealed before hardening. Pre-heat to 500° / 600 °C before raising to the hardening temperature of 850°C. Pre heating is especially desirable for complex sections. Soak thoroughly, allowing 30 minutes per inch of ruling section before quenching.

Quenching Media

Gas or vacuum quenching is only suitable for small sections up to approximately 35 mm thick.

Oil produces the desired hardness but distortion should be allowed for in the design.

Martempering is advised by means of a salt bath at 450° / 550 °C for a maximum of 4 minutes, then air cool.

Tempering

Temper the tool for a minimum of 2 hours as soon as it reaches 50° / 70 °C between 180°C and 300°C according to the requirements of the job and by reference to the tempering curve. Where possible, use an air-circulating Furnace.

Flame and Induction Hardening

PMS can be hardened in this way to a maximum of approximately 50 HRC. Cooling in air is preferable.

Case Hardening

In order to increase the surface hardness PMS can be case-hardened however allowances must be made for the brittle nature of the case near sharp corners and also for dimensional changes. Our Heat Treatment Department will be glad to advise you.

Nitriding and Tuftriding

Nitriding gives a very hard surface, which is resistant to wear and erosion. A Nitrided surface also increases corrosion resistance. For best results the following steps should be followed:

1. Rough Machining
2. Stress tempering
3. Grinding
4. Nitriding

The following surface hardness and depths should be achieved after Gas Nitriding.

Temp-in °C	Time in Hours	Surface Hardness Vickers	Depth of case mm
525	20	650	0.30
525	30	650	0.35
525	60	650	0.50

A comprehensive range of round bar is held in stock. Flat sizes are cut to suit customer's requirements from mother blocks.

PVC Colour Code: Orange & green

P42

1.2316

PLASTIC MOULD STEEL | AISI | WERKSTOFF No

C	Si	Mn	Cr	Mo	Ni
0.38	0.40	0.65	16.0	1.00	0.80

Features and Uses

PVC is classified as a heat treatable stainless steel as it contains in excess of 12% Chromium and sufficient carbon to harden upon quenching.

It is supplied in the heat-treated condition and can be used in any application where strength coupled with corrosion resistance is required. It is particularly suited for use in the manufacture of moulds where chemically aggressive materials such as PVC and amino plastics are used.

Benefits:

- No Hardening costs
- Time saving (no waiting for heat treatment)
- Lower tool cost (e.g. no distortion to rectify)
- Modifications easily carried out
- Can be subsequently Nitrided or Tuftrided to reduce surface damage.
- Good polishing & photo etching properties.
- Fair machinability
- Uniform Hardness

PVC may be used in the following applications:
Extrusion tools for window frames
Blow moulds
Sheet moulds
Sizing tools
Hunting knives
Structural components and shafts

Heat Treatment

Annealing

Anneal preferable in a gas atmosphere at 760º / 800°C for at least 2 to 3 hours. Cool at 10°C per hour with the furnace until the temperature falls below 400°C. Withdraw from box or tube and allow cooling to shop temperature.

Stress Relieving

Where tools are heavily machined, ground or subjected to cold work, the relief of internal strains is essential before hardening. Stress relieving should be done after rough machining. To stress relieve, heat carefully to 550°C soak well and allow to cool slowly to room temperature.

Hardening

The steel should be fully soft annealed before hardening. Pre-heat to 500° / 600 °C before raising to the hardening temperature of 1020° / 1050ºC. Pre heating is especially desirable for complex sections. Soak thoroughly, allowing 30 minutes per inch of ruling section before quenching.

Quenching Media

Gas or vacuum quenching is only suitable for small sections up to approximately 50 mm thick.
Oil produces the desired hardness but distortion should be allowed for in the design.

Martempering

This is advised where distortion levels must be minimized. The job is quenched into a salt bath at 500° / 550 °C and held for a maximum of 10 minutes, then air-cooled.

Tempering

Temper the tool for a minimum of 2 hours as soon as it reaches 50° / 70 °C usually between 600°C and 700°C according to the requirements of the job and by reference to the tempering chart. Where possible, use a protective atmosphere or salt bath.

Nitriding and Tufftriding

Nitriding gives a very hard surface, which is resistant to wear and erosion. A Nitrided surface also increases corrosion resistance.
For best results the following steps should be followed:

1. Rough Machining
2. Stress tempering
3. Grinding
4. Nitriding or Tufftriding

The following hardness should be achieved after tempering.

Temperature in °C	Surface Hardness Rockwell C
100	49-50
200	47-48
300	46-48
400	45-46
500	46-47
600	32-35
700	30-32

SABEN SILVER STEEL 1.2210

PRECISION GROUND DOWELL ROD B.S.1407 WERKSTOFF No

C	Si	Mn	Cr	Mo	W	V	Co
1.20		0.40	0.40				

Features and Uses

Saben Silver Steel is bright finished rod produced from hot rolled bar by means of centreless grinding.
The high carbon content of this steel means that it can be hardened to give considerable wear resistance and the chromium content adds to the strength and hardenability
As supplied however, the steel is machinable owing to the annealing treatment given to it prior to grinding.
Saben silver steel is spherodise annealed for best machinability, the annealed hardness being in the region of 270 Brinell (Rockwell C27). On hardening and tempering a hardness of up to Rockwell C64 can be obtained. Being in the spherodised condition, the material offers maximum response to hardening and the chromium content ensures deep hardening.

Applications

Saben silver steel finds innumerable uses in the tool room and in general engineering. The user can select a size suitable for his purpose, thereby reducing or eliminating the need for grinding or machining the finished part.

Applications include screwdrivers, punches, shafts, axles, pinions, pins, die posts, instrument parts, model parts, taps and drills for mild steel, engravers tools, and fine cutters.

Hardening

It is preferable to heat the tools in a controlled atmosphere. If this is not possible, pack hardening is recommended. A reducing atmosphere is desirable.

Heat to 770 / 780ºC and when thoroughly soaked through, quench in water. (sizes up to 8 mm diameter may be oil hardened from 800 / 810ºC) Tempering will be necessary.

Tolerances

B.S. 1407/1959 conforms with I.S.O. H8
Up to and including 3mm
+0.00 – 0.014 mm
Over 3mm and including 6mm
+0.00 – 0.018 mm
6mm and including 10 mm
+0.00 – 0.022 mm
10mm and including 18 mm
+0.00 – 0.027 mm
18mm and including 30 mm
+0.00 – 0.033 mm
30mm and including 50 mm
+0.00 – 0.039 mm

Tempering
Temper according to the purpose for which the parts are required generally between 150 / 300ºC

Rockwell C	Temperature
63/65	as quenched
63/65	120ºC
64/62	150ºC
62/61	200ºC
59/58	250ºC
56/55	300ºC
54/53	350ºC
50/48	400ºC

STOCK	SIZES	DIA
2 mm	15	1/16”
2.5	16	3/32”
3	17	1/8”
3.5	18	5/32”
4	19	3/16”
4.5	20	7/32”
5	21	1/4"
5.5	22	5/16”
6	23	3/8”
6.5	24	7/16”
7	25	1/2"
7.5	26	9/16”
8	27	5/8”
8.5	28	3/4"
9	29	13/16”
9.5	30	7/8”
10	35	15/16”
11	40	1”
12	45	1/4"
13	50	1.1/2
14		
Non standard sizes available in +/- 10 working days		