Special Steel WP7V

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Established for Hot Stamping

Dr.-Ing. Jens Jonas Wilzer

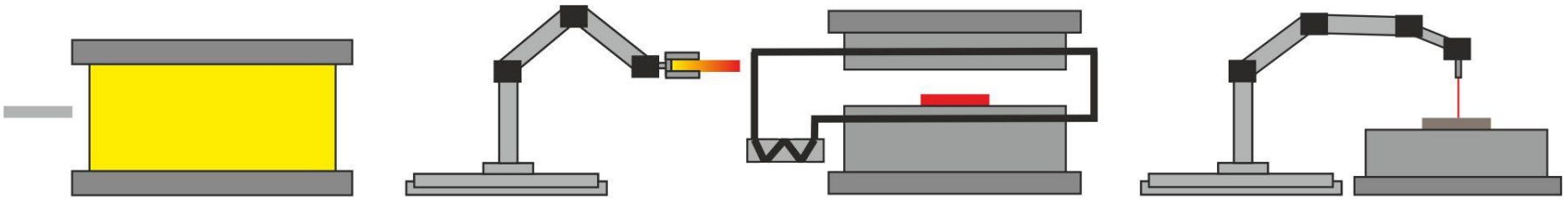
TECHNICAL CUSTOMER SUPPORT
SPECIAL STEELS

Dörrenberg Edelstahl

Overview

1. **Hot Stamping Tools**
2. Features of WP7V
3. Benefits of WP7V
4. Technical Information

Hot Stamping Process



Austenitization
- 900-950°C (~1650-1750°F)
- 5-10 min

Transfer
- t ~ 5 s
- Loss of temperature

Hot Stamping
- T_{In} ~ 850-900°C (~1550-1650°F)
- t ~ 8-20 s
- T_{Out} ~ 150-200°C (300-400°F)

Trimming
- Hard cutting
- Laser cutting

Important Aspects:
- Cooling rate inside the tool
- Wear impact on the tool
- Mechanical properties of the tool

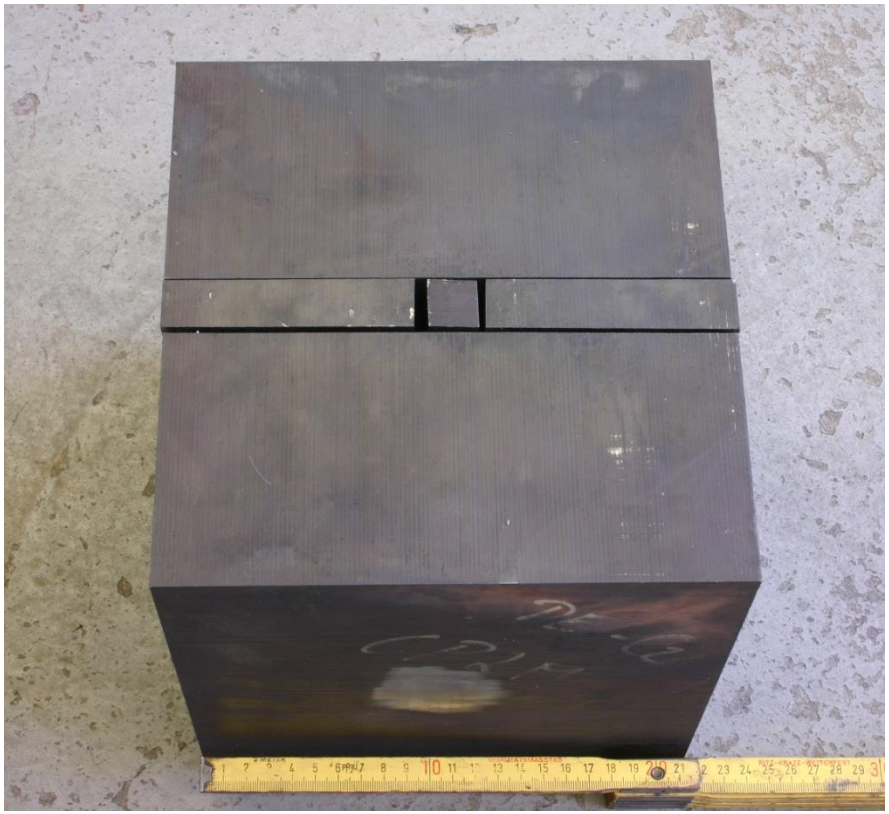
→
- **Productivity**
- **Product Quality**

Challenges with Hot Stamping Tools

Source: J. J. Wilzer, Ch. Escher, M. Kotzian, S. Weber, W. Theisen: *Tool Steel with Improved Properties for Hot Stamping Tools*. HTM J. Heat Treatm. Mat. 71 (2016)

- High wear on the drawing rad
- Long cycle times due to cooling
- Extensive maintenance
- Cracking of the tool
- Extensive tooling
- Extensive time pressure

Requirements on Tool Steels



Source: J. J. Wilzer, Ch. Escher, M. Kotzian, S. Weber, W. Theisen: *Tool Steel with Improved Properties for Hot Stamping Tools*. HTM J. Heat Treatm. Mat. 71 (2016)

- High wear resistance
- High thermal conductivity
- High tempering resistance
- Sufficient toughness
- Good hardenability
- Good machinability
- Weldability

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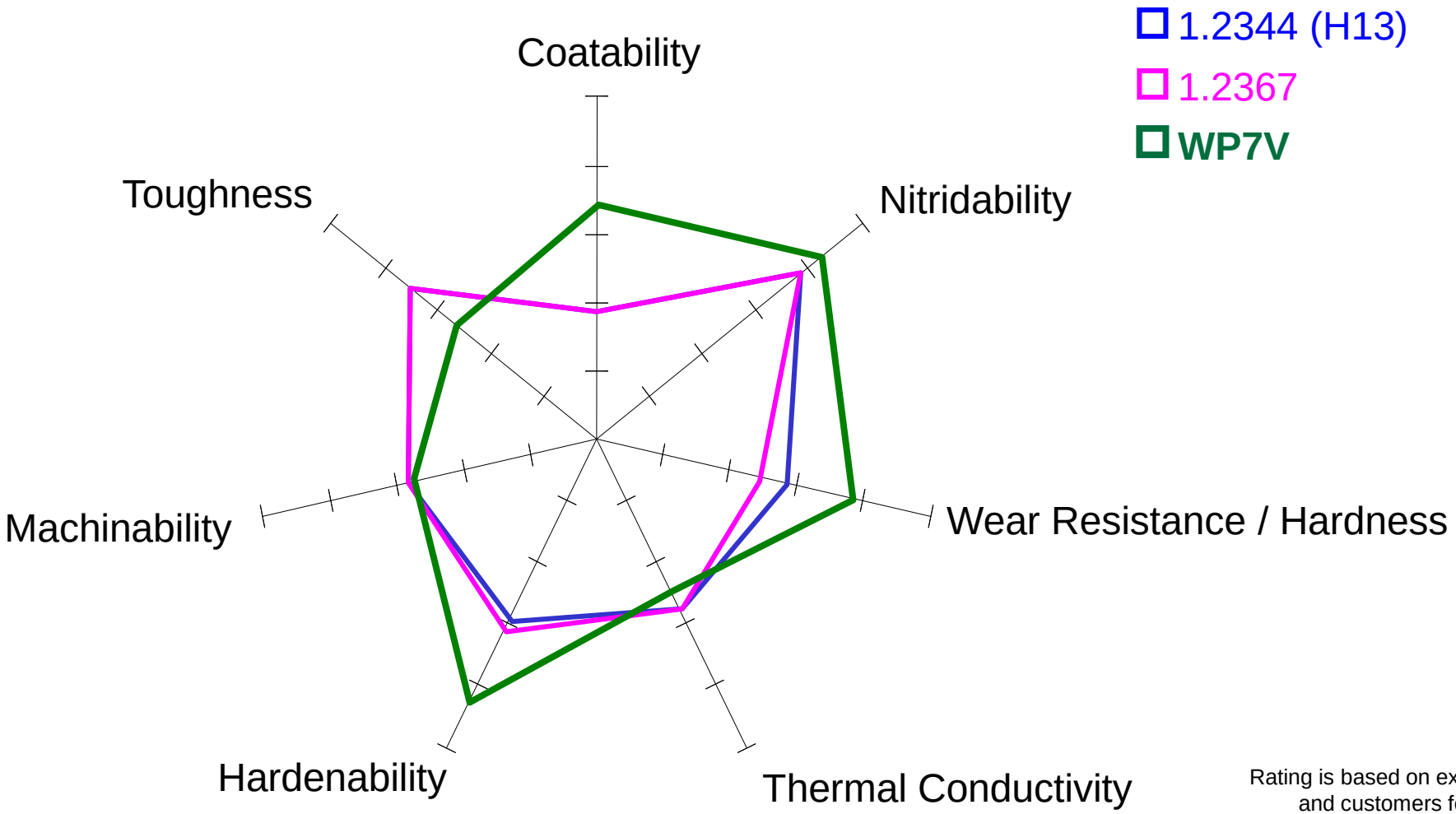
Reference Analysis

Material	C	Cr	Mo	V	Delivery Condition
1.2344 (H13)	0.40	5.30	1.40	1.00	Soft Annealed
1.2367	0.38	5.00	3.00	0.50	Soft Annealed
WP7V	0.50	7.80	1.50	1.50	Soft Annealed

Special Properties of WP7V



Rating is based on experience and customers feedback.

Overview

1. Hot Stamping Tools
2. Features of WP7V
3. **Benefits of WP7V**
4. Technical Information

Benefits of WP7V in Hot Stamping

Features of WP7V	Benefit in Practice
• High hardness • High wear resistance	• Longer lifetime • Less maintenance effort • Higher productivity
• High toughness	• High process reliability • Low risk of fracture
• Good hardenability	• Easy heat treatment • Low risk of fracture

Overview

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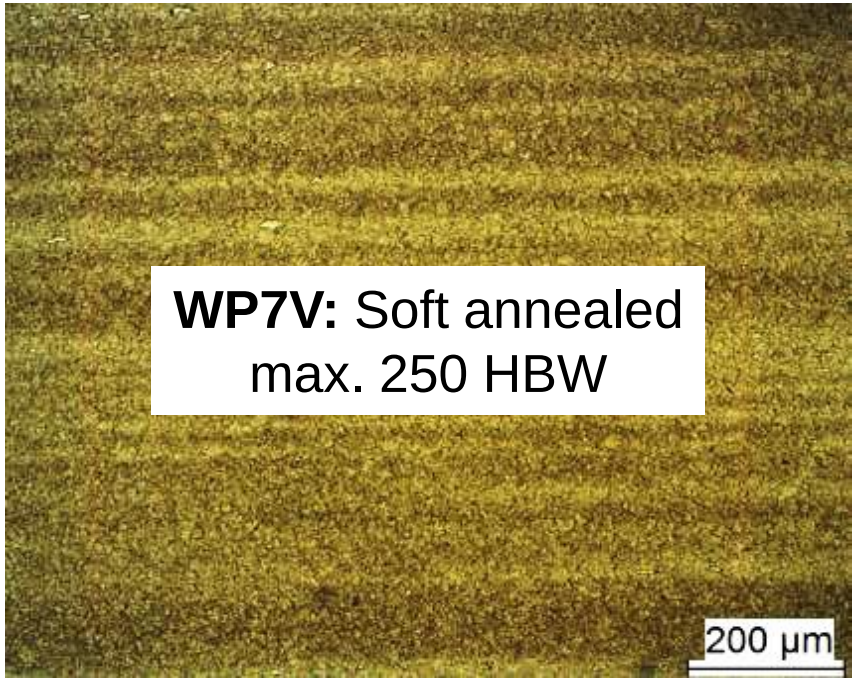
3. Benefits of WP7V
4. **Technical Information**

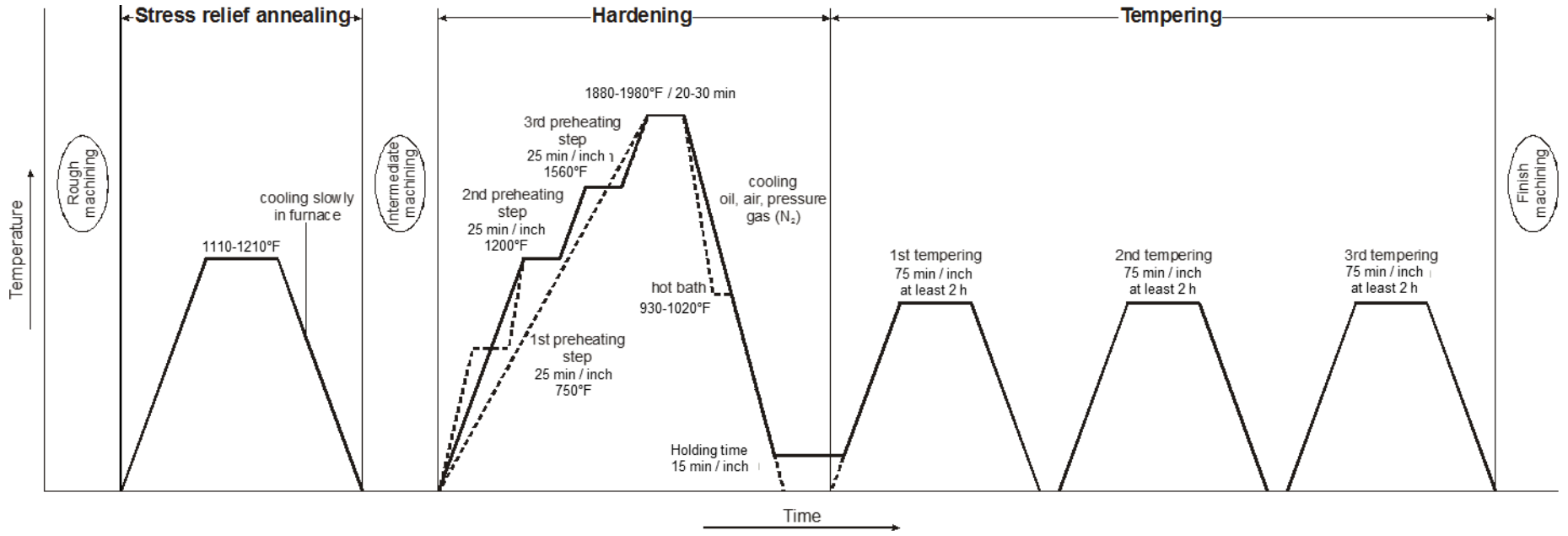
Delivery Condition



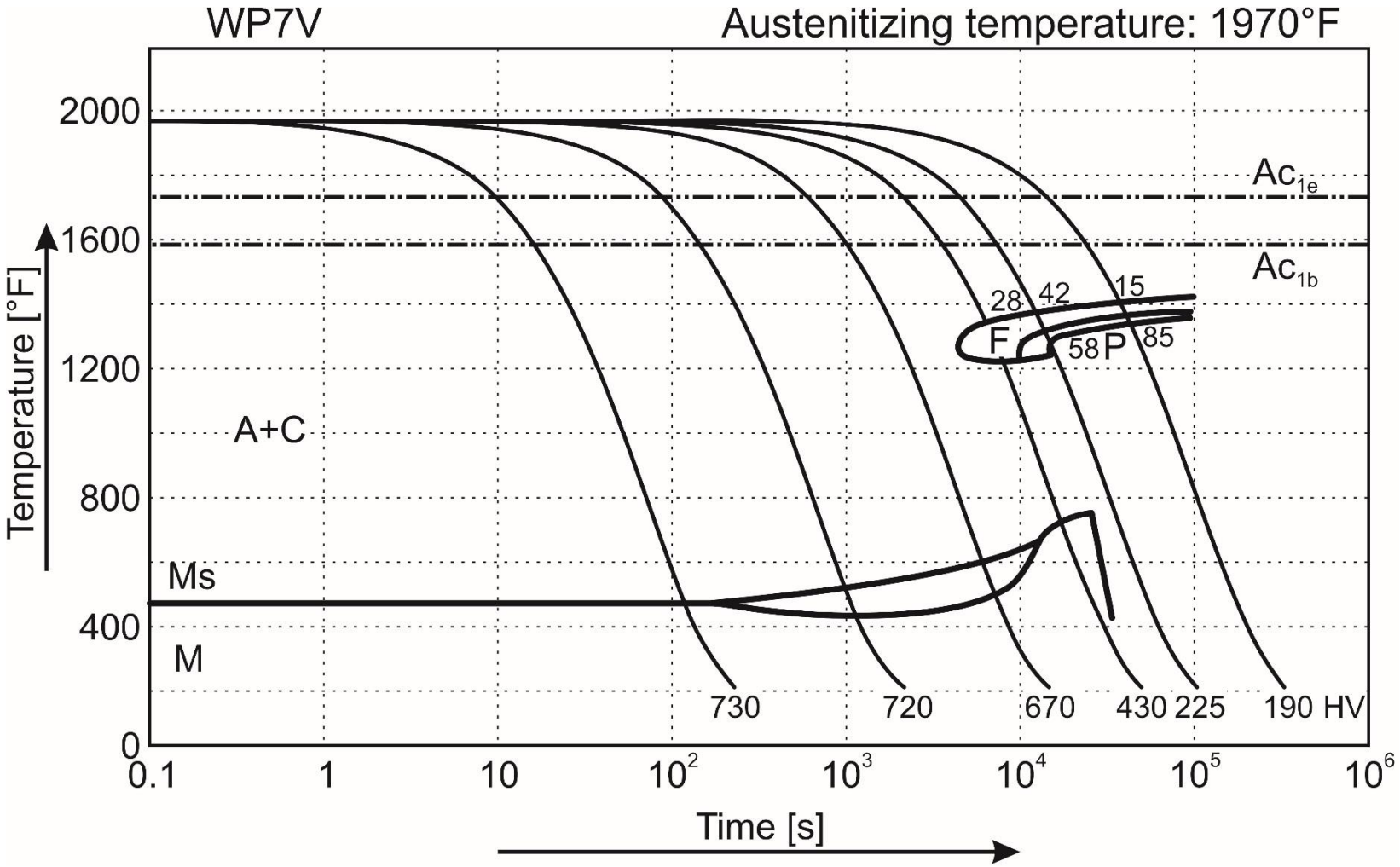
Standard sizes:

- Flat
  - Width: 155-900 mm (6.1-35.4 inch)
  - Thickness: 40-400 mm (1.6-15.7 inch)
- Squared
  - 100-230 mm (4.0-9.0 inch)
- Round
  - 22-285 mm (0.9-11.2 inch)

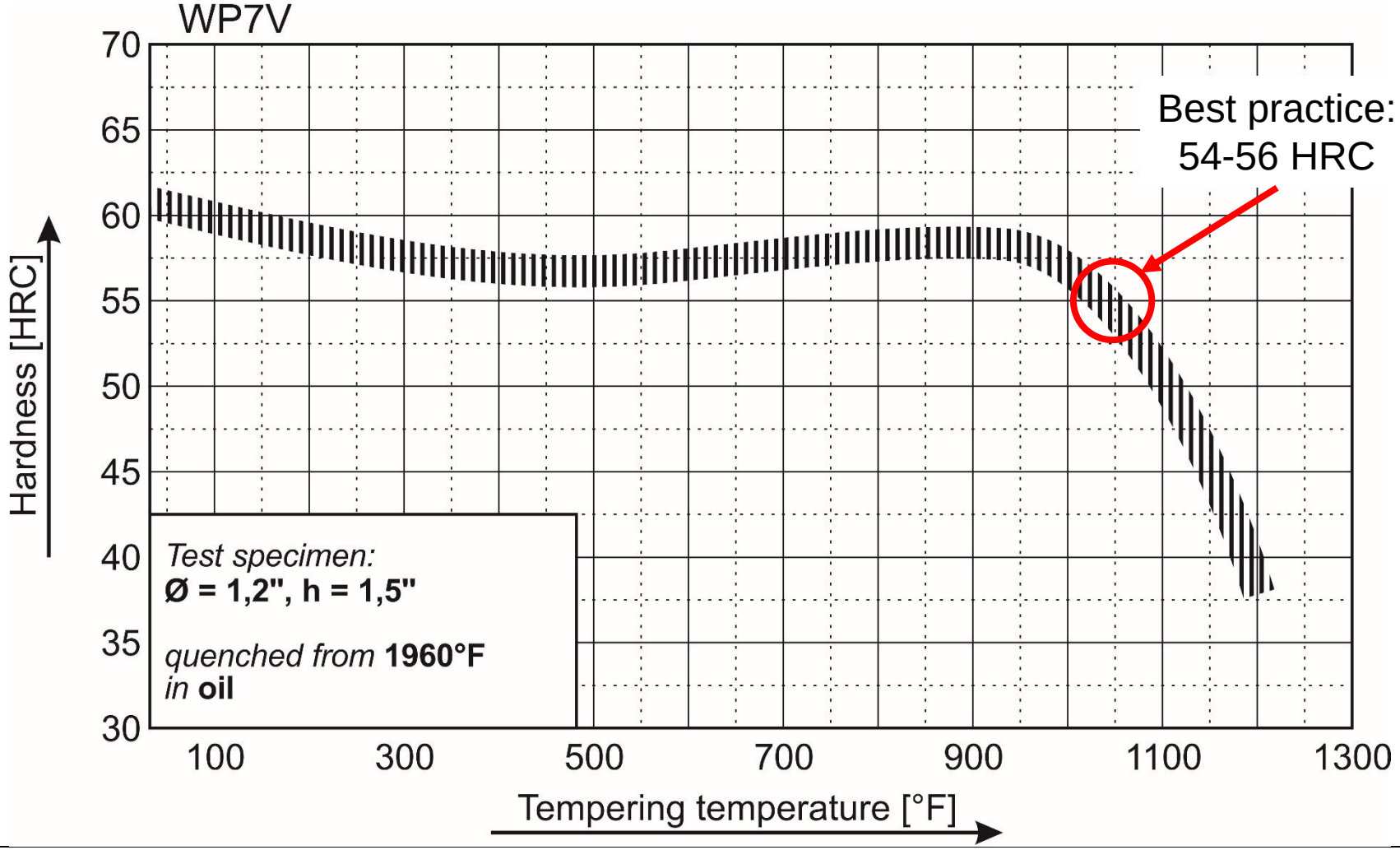
Heat Treatment Recommendations



Time Temperature Transformation Diagram



Tempering Diagram



Tensile and Yield Strength

Hardness in HRC	Yield Strength in ksi	Tensile Strength in ksi	Elongation at Rupture in %	Impact Toughness in J	
				unnotched	notched
50-52	-	-	-	200-220	-
54-56	230-250	290-310	≤ 5	-	6-8
55-57	-	-	-	180-200	-
58-60	-	-	-	110-130	-

Data was determined by means of measurements on heat treated tensile specimens.
Scattering bands are broader for big heat treated dimensions.

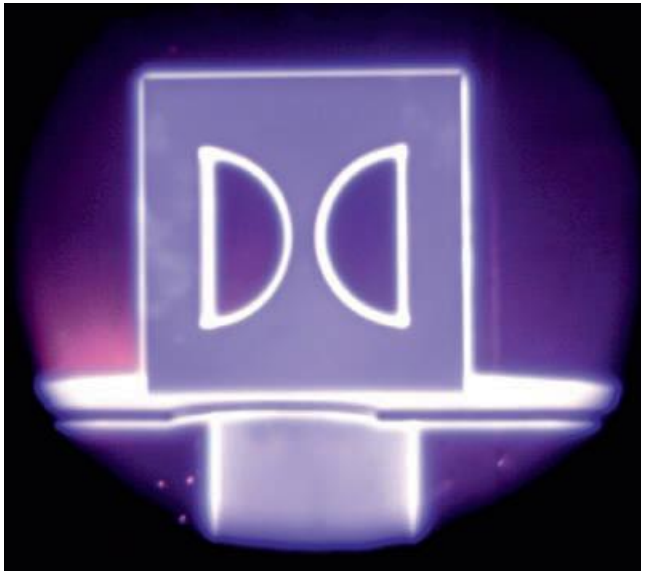
Physical Properties

Hardness in HRC	Temperature in °F	Thermal conductivity in W/mK	Thermal expansion coefficient in 10^{-6}·1/K*
42-44	68	25	-
	212	26	11.7
	392	28	12.3
	572	29	13.8
	752	28	13.9
	932	28	13.8
50-52	68	24	-

Thermal expansion coefficient was determined with a reference temperature of 20°C (68°F):

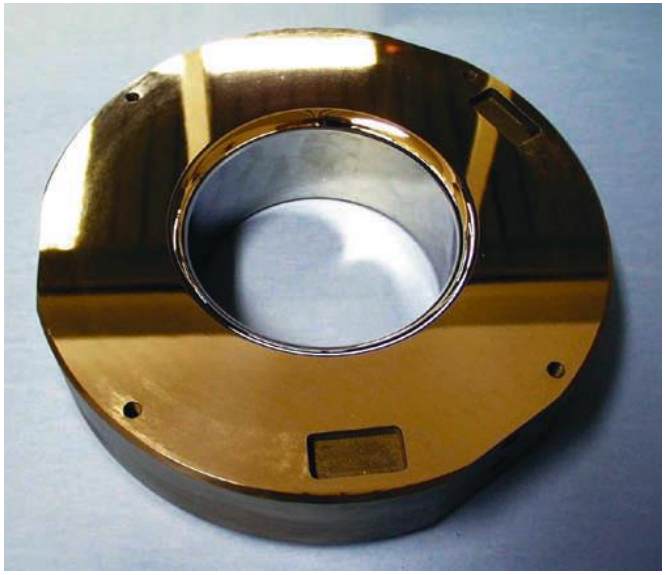
$$\alpha_{th} = \frac{1}{l_{RT}} \cdot \frac{l_T - l_{RT}}{T - RT}$$

Surface Treatment



Plasma nitriding:

- Surface hardness: 900 – 1250 HV_1
- Nitrided case depth: ≤ 0.2 mm
- Tempering first (above **S**econdary **H**ardness)

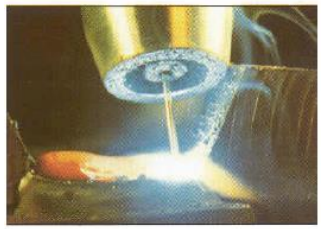


Coating:

- PVD
- No benefit for hot stamping

Welding

	Annealed	Q+T
1.	Grinding and cleaning of the weld zone	
2.	Heating up to 752-842°F, do not drop below 572°F during processing	
3.	Short welding seams (EnDotec DO*15, FONTARFILL 760), for bigger welds use buffer layer (Castolin Xuper 680 S)	
4.	Hammering of the hot welding zone after each seam	
5.	Slow air cooling, soft annealing at 1500-1580°F with furnace cooling (hardness of weld zone: 200-300 HB)	Slow air cooling down to 180-210°F, tempering at 930°F immediately
6.	Machining of the weld zone	



Welding in cold condition is not recommended for any hardenable tool steel!

Machining

Drilling

Cutting Material	Rot. Speed in ft/min	Feed in thou/rev	Drill Ø in inch
HSS[a]	26-46	1.5-5.5	0.315-0.630
HSS[a]+Coating	59-75	4.7-7.8	0.315-0.630
CC[b]	131-197	2.3-11.8	0.787-1.850

[a] **H**igh **S**peed **S**teel
[b] **C**emented **C**arbide

Turning

Cutting Material	Rot. Speed in ft/min	Feed in thou/rev	Depth of cut in inch
Rough machining			
HSS[a]	49-82	7.8-15.7	0.079-0.157
CC[b]	197-459	11.8-23.6	0.079-0.197
CC[b] + Coating	410-640	15.7-39.3	0.118-0.315
Finishing			
HSS[a]	82-164	3.9-7.8	0.020-0.039
CC[b]	262-525	3.9-11.8	0.020-0.039
CC[b] + Coating	656-1050	3.9-15.7	0.030-0.118

[a] **H**igh **S**peed **S**teel
[b] **C**emented **C**arbide

Milling

Cutting Material	Rot. Speed in ft/min	Feed[c]	Depth of cut in inch
Rough machining			
HSS[a]	33-59	0.787-1.575	0.236-0.394
HSS[a]+Coating	98-148	0.787-3.150	0.236-0.394
CC[b]	197-328	0.008-0.016	0.236-0.315
CC[b] + Coating	295-492	0.008-0.016	0.079-0.236
Finishing			
HSS[a]	49-82	1.181-2.362	0.020-0.079
HSS[a]+Coating	148-230	2.363-5.511	0.020-0.079
CC[b]	230-427	0.039-0.118	0.020-0.079
CC[b] + Coating	328-558	0.394-0.787	0.039-0.079

[a] **H**igh **S**peed **S**teel
[b] **C**emented **C**arbide
[c] HSS: inch/rev, CC: inch/tooth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