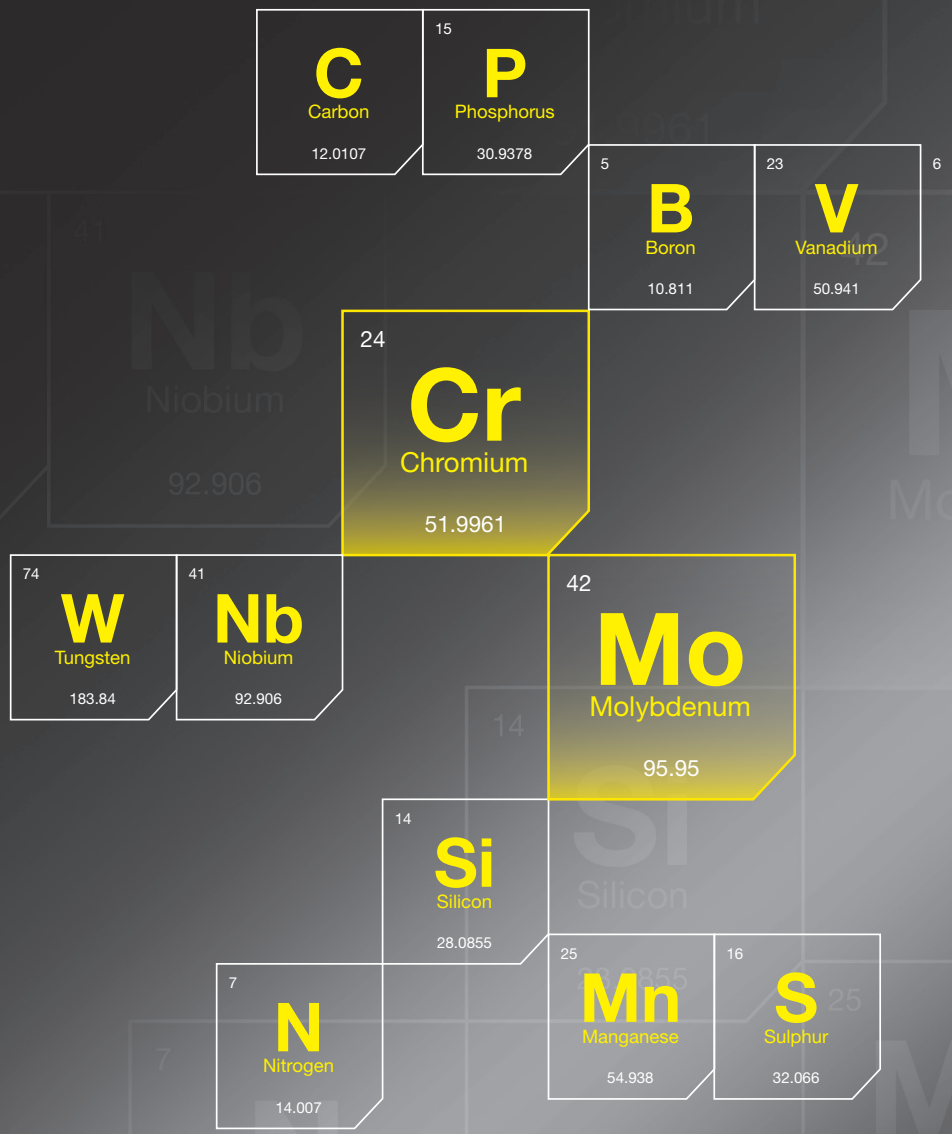
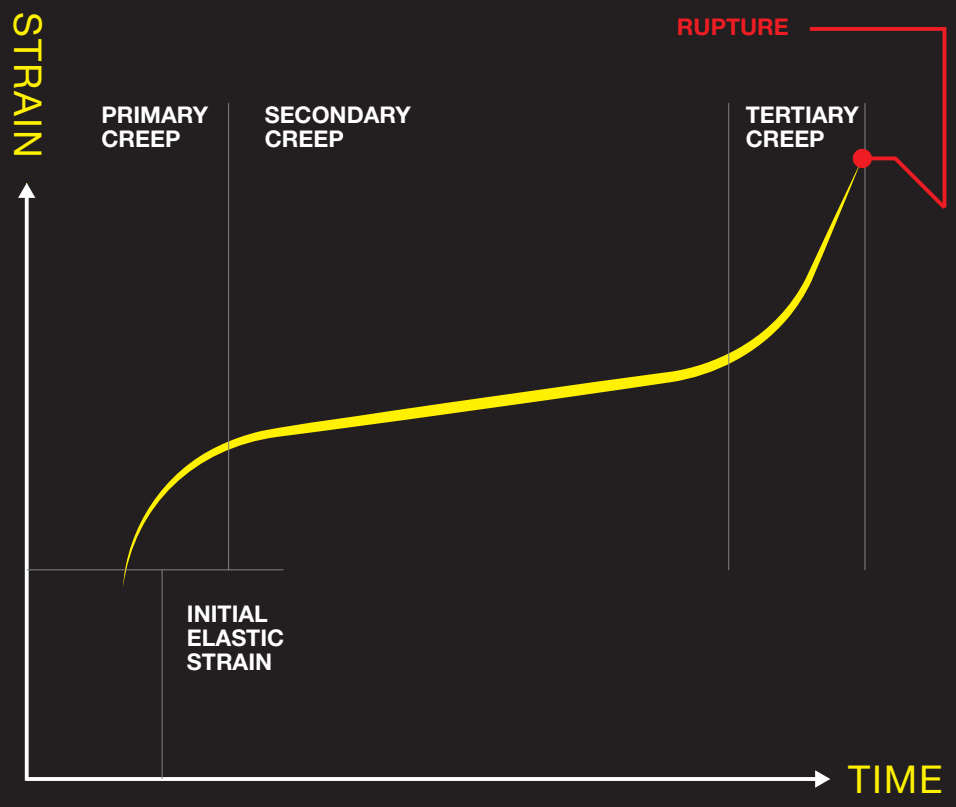


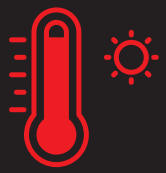
Welding Guide

Creep Resistance Steels

What is Creep?



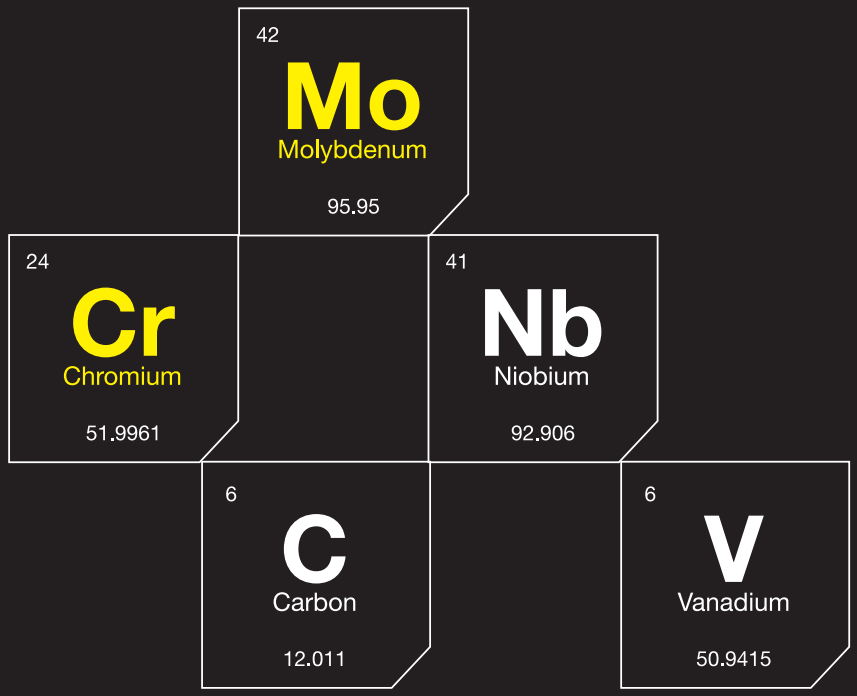
Creep is the tendency of a material to slowly deform over a long period exposed to stress (load or pressure), mostly below the yield strength, and elevated temperature.



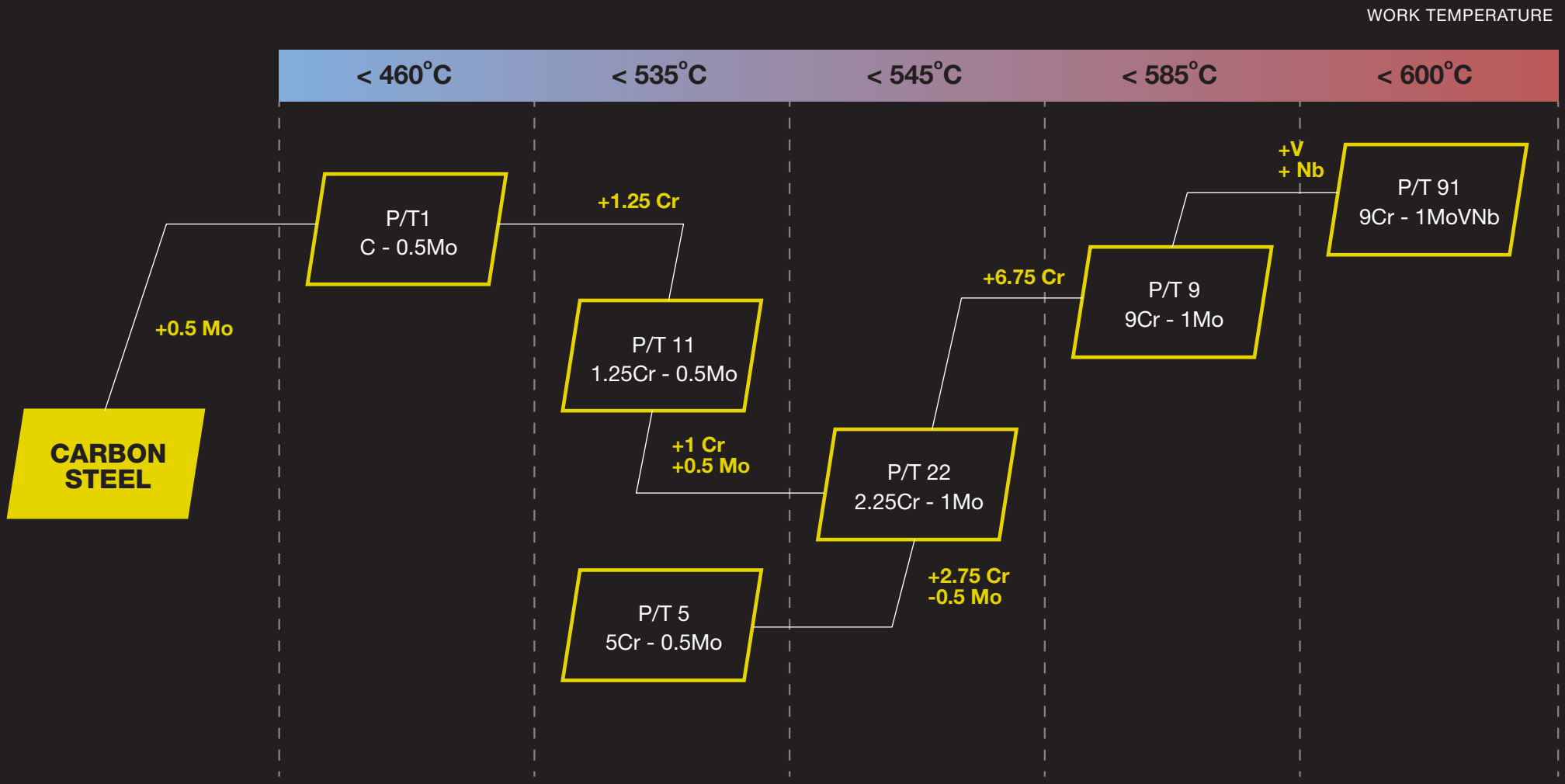
Creep Resistance

Creep resistance steels (well-known as CrMo Steels), ccontain strong carbide and/or nitride forming elements. These are intended to provide a fine dispersion of precipitates that both increase the tensile strength and prevents the formation of the voids. Also, this increase the **hardenability (the ability to form martensite).**

Creep strength, in ferritic steels, are achieved by alloying with elements like Chromium (Cr) and Molybdenum (Mo), as principal alloying elements, that enhance the strength and reduce the scaling or oxidation at high temperatures of the steel.



Typical Base Metals



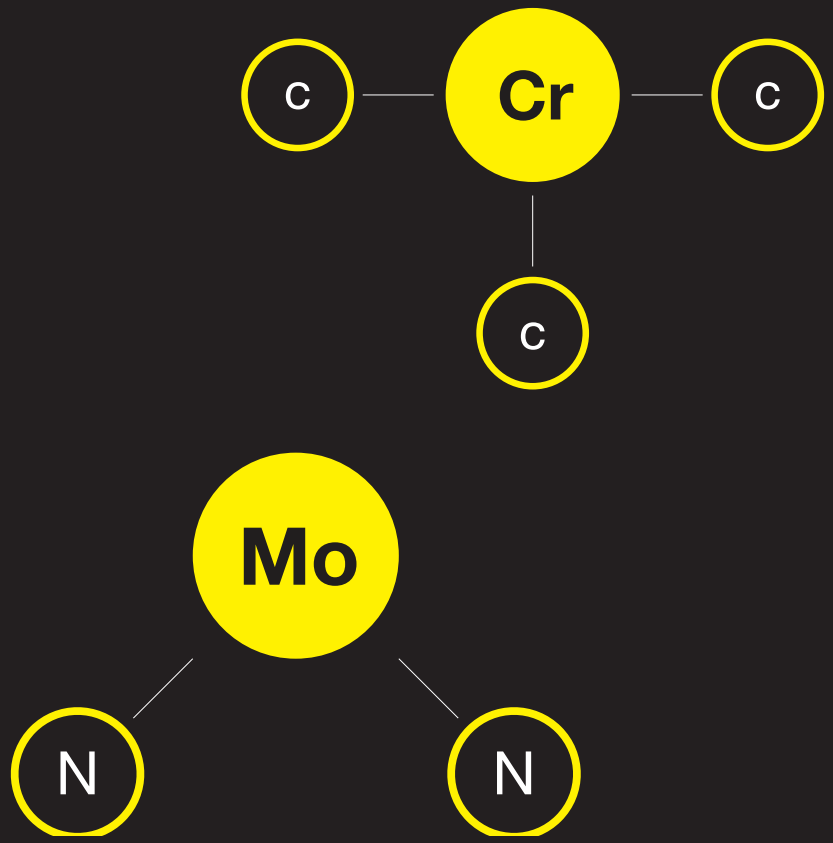
Main Problems

Creep resistant steels contain strong carbide and nitride forming elements. The hardenability (the ability to form martensite) of the steel increases as the alloy contents are added.

These facts obligate the CrMo steels to have restricted controls at the process and filler metals and, therefore, are susceptible to:

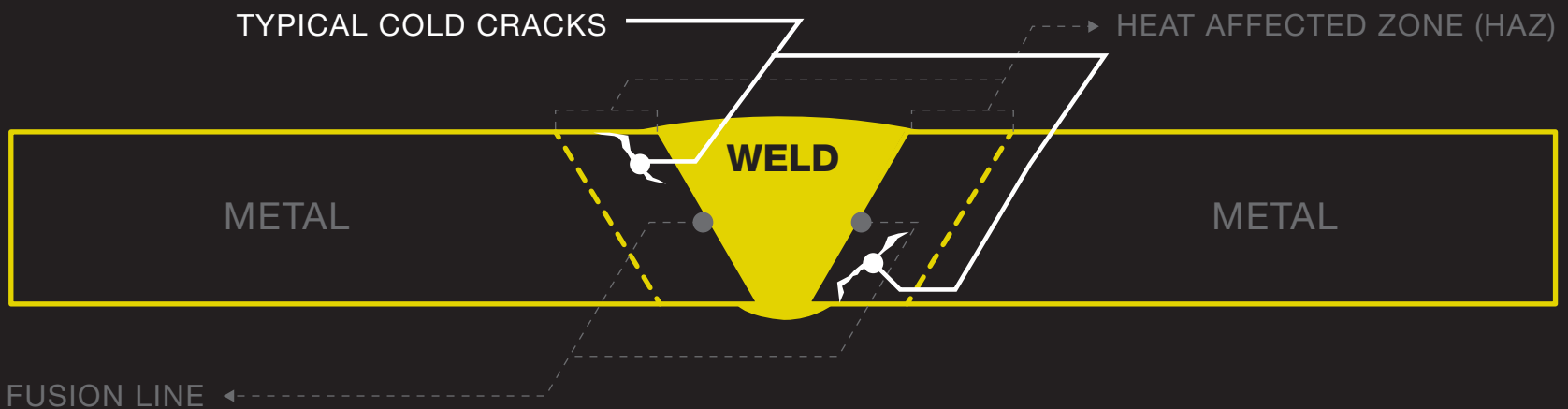
Cold Cracking

Reheat Cracking



Main Problems

Hydrogen induced cracking or Cold Cracking



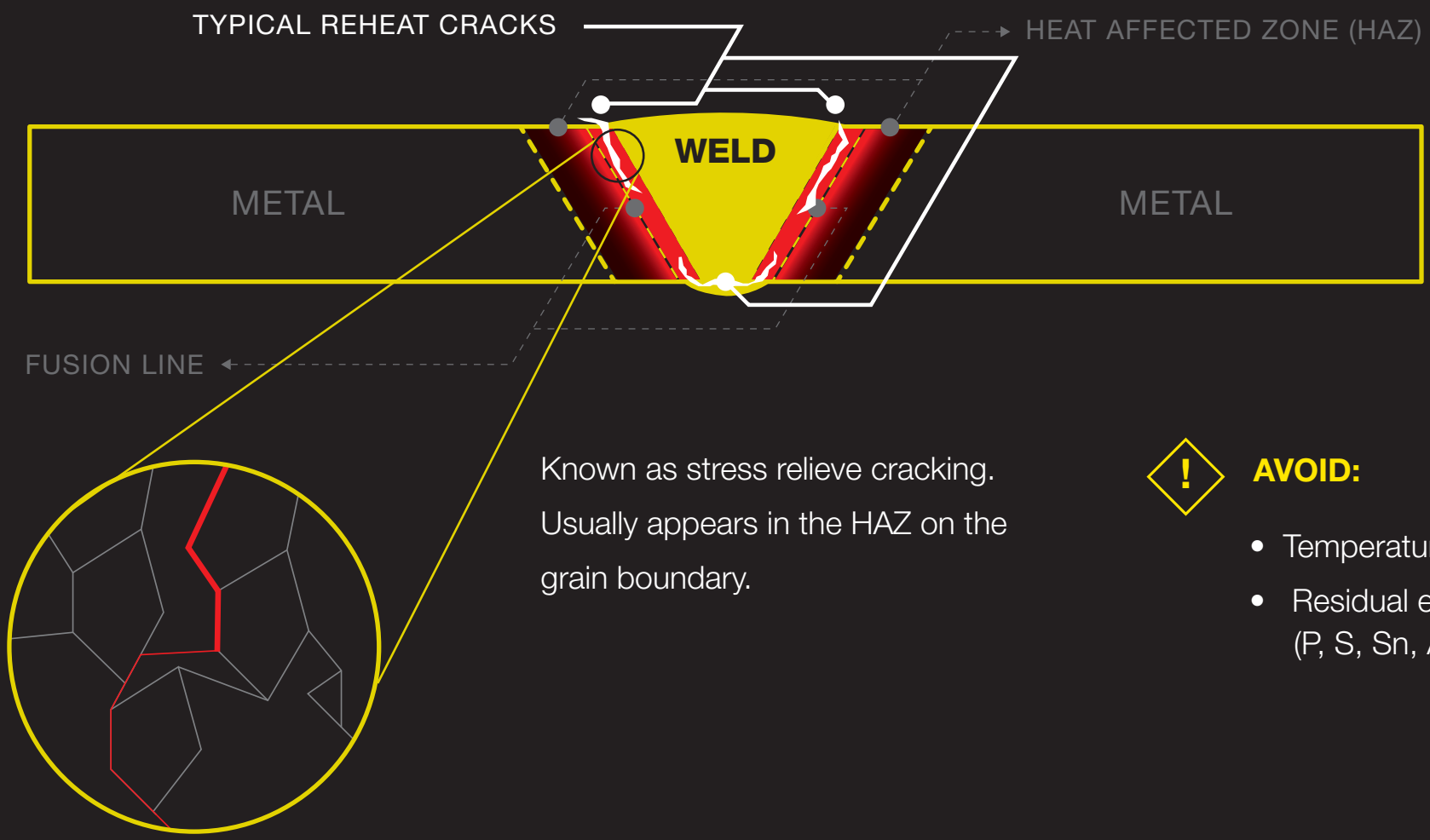
This is a type of cracking that appears after the welding (24-48hrs) and mainly at the HAZ (Heat Affected Zone).

AVOID:

- Martensite microstructre
- Residual stress
- Presence of hydrogen

Main Problems

Reheat Cracking



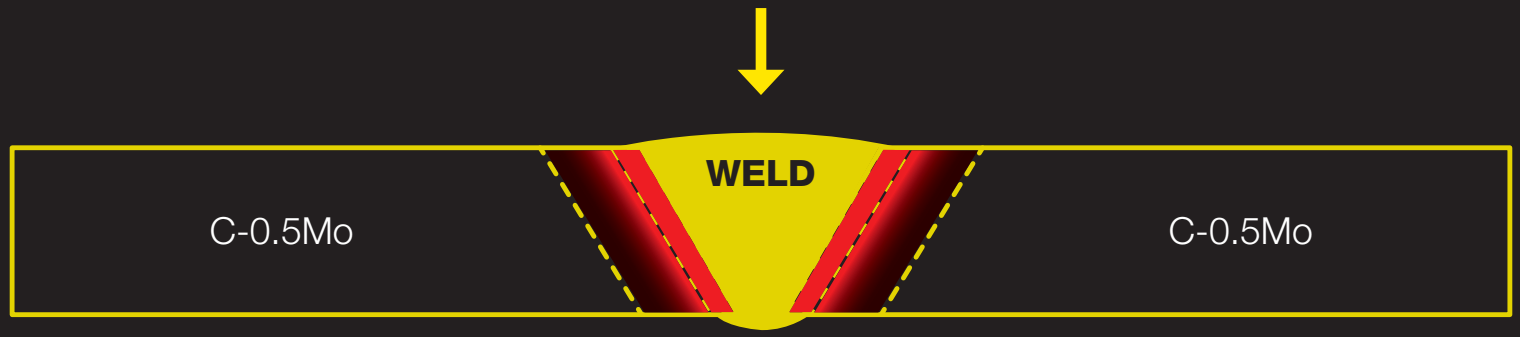
Known as stress relieve cracking.
Usually appears in the HAZ on the grain boundary.

AVOID:

- Temperature 450-700°C
- Residual elements (P, S, Sn, As e Sb)

Welding Recommendations

Base Metal	MMA	GTAW	GMAW	SAW	FCAW
P1	OK 74.46	OK Tigrod 13.09	OK Aristorod 13.09	OK Autrod 12.24 OK Flux 10.62	Dual Shield 7000-A1



Max. Inter Pass
< 250°C

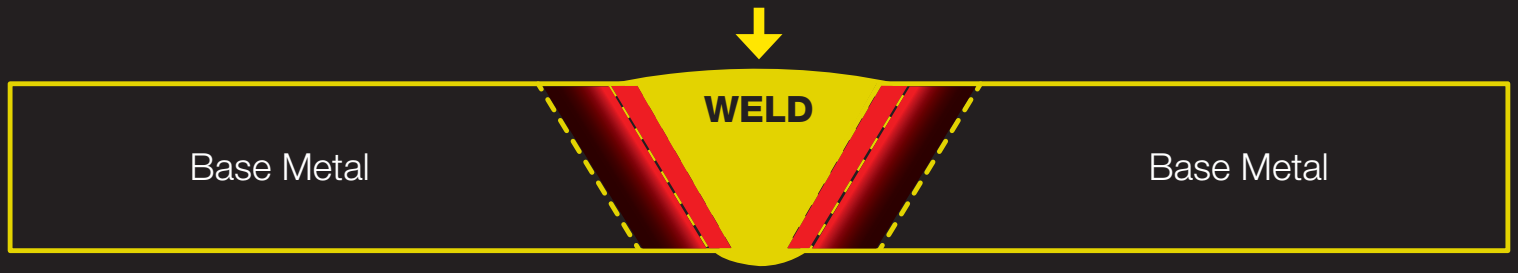
Thickness (mm)	Min. Pre-Heat (°C)
≤ 15 mm	20°C
15≤ T ≤30 mm	75°C
> 30 mm	100°C

PWHT

Temperature Range (°C)	Soak Time (hours)
630 - 670°C	1h per 25mm

Welding Recommendations

Base Metal	MMA	MIG/MAG	GTAW	SAW	FCAW
P11	OK 76.16, 76.18 OK B2 SC	Aristorod 13.16	OK Tigrod B2 SC OK Tigrod 13.16	OK Autrod B2 SC+ OK Flux 10.62/10.63	Dual shield 8000 B2
P22	OK 76.26, 76.28 OK B2 SC	Aristorod 13.17	OK Tigrod B3 SC OK Tigrod 13.17	OK Autrod B3 SC+ OK Flux 10.62/10.63	Dual Shield 9000 B3



Max. Inter Pass
< 300 - 350°C

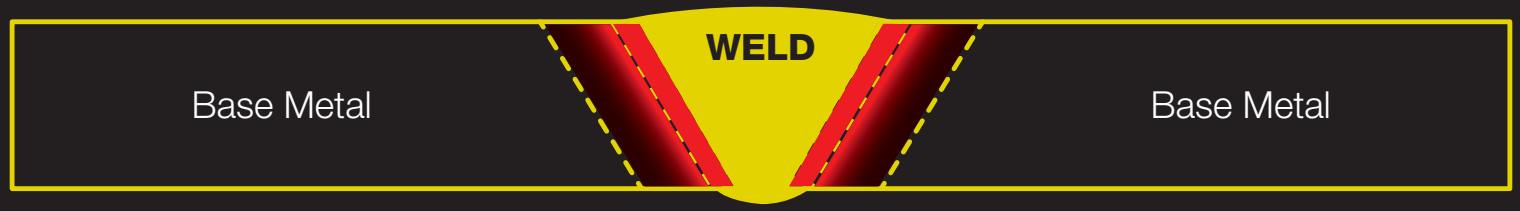
Steel Grade	Thickness (mm)	Min. Pre-Heat (°C)
1.25Cr-0.5Mo (P11)	≤15	100°C
	>15	150°C
2.25Cr-1Mo (P22)	≤15	100°C
	>15	200°C

PWHT

Temperature Range (°C)	Soak Time (hours)
650 - 700°C	1h per 25mm
680 - 720°C	Min. 2 hours

Welding Recommendations

Base Metal	MMA	GTAW	SAW
P5	**OK 76.35**	**OK Tigrod 13.32**	**OK Autrod 13.33** **OK Flux 10.63 (5%Cr)**



Max. Inter Pass
< 350°C

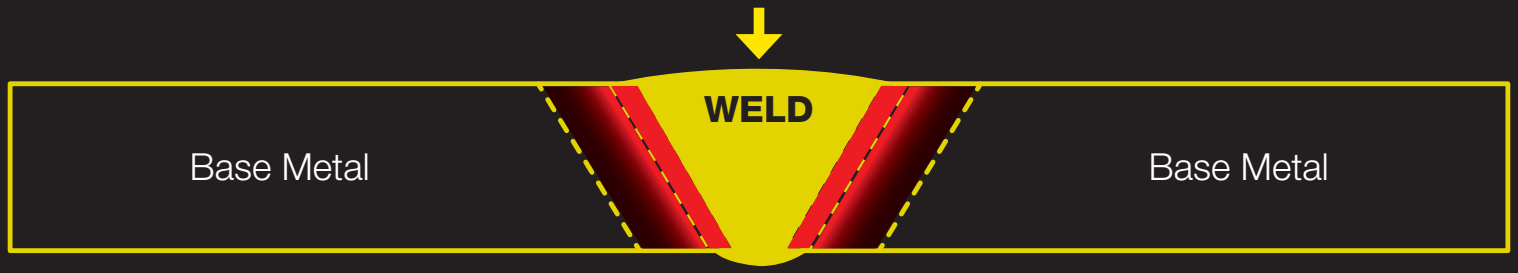
Steel Grade	Min. Pre-Heat (°C)
5Cr-0.5Mo (P5)	> 200°C

PWHT

Temperature Range (°C)	Soak Time (hours)
730 - 760°C	Min. 2 hours

Welding Recommendations

Base Metal	MMA	GTAW	SAW
P9	**OK 76.96**	**OK Tigrod 13.37**	-
P91	**OK 76.98**	**OK Tigrod 13.38**	**OK Autrod 13.35** **OK Flux 10.64**



Max. Inter Pass
< 300 - 350°C

Steel Grade	Min. Pre-Heat (°C)
9Cr1Mo (P9)	> 200°C
9Cr-1MoVNb (P91)	

PWHT

Temperature Range (°C)	Soak Time (hours)
730 - 760°C	Min. 2 hours

Welding Recommendations

Preheat and Interpass Temperature

Preheat is essential for most of the alloys (the IIW carbon equivalent method is not valid for these grades of steel) and few welding specifications give much guidance regarding recommended preheat temperatures.

Table 2: Preheating & Interpass Temperature

Steel Grade	Thickness (mm)	Min. Preheat (°C)	Max. Interpass (°C)
C-0.5Mo (P1)	≤15 >15≤30 >30	20 75 100	250
1.25Cr-0.5Mo (P11)	≤15 >15	100 150	300
2.25Cr-1Mo (P22)	≤15 >15	150 200	350
5Cr-0.5Mo (P5)	All	200	350
9Cr-1MoVNb (P91)	All	200	350

Welding Recommendations

Chemistry - The CrMo steels are in general sensitive to hot and re-heating cracking, originated by the chemistry and residual stress. To minimize the possibility to have the issue , the content of impurities must be controlled, as well as the residual stress.

BASE METAL (Watanabe), J-Factor

J = (% Si + % Mn) (% P + Sn) x 104 (wt.%)

J < 150

Cu %0.20 max; Ni %0.30 max (API 934)

Mn + Si typically < 1.1

Filler Metal (Bruscato), X-Factor

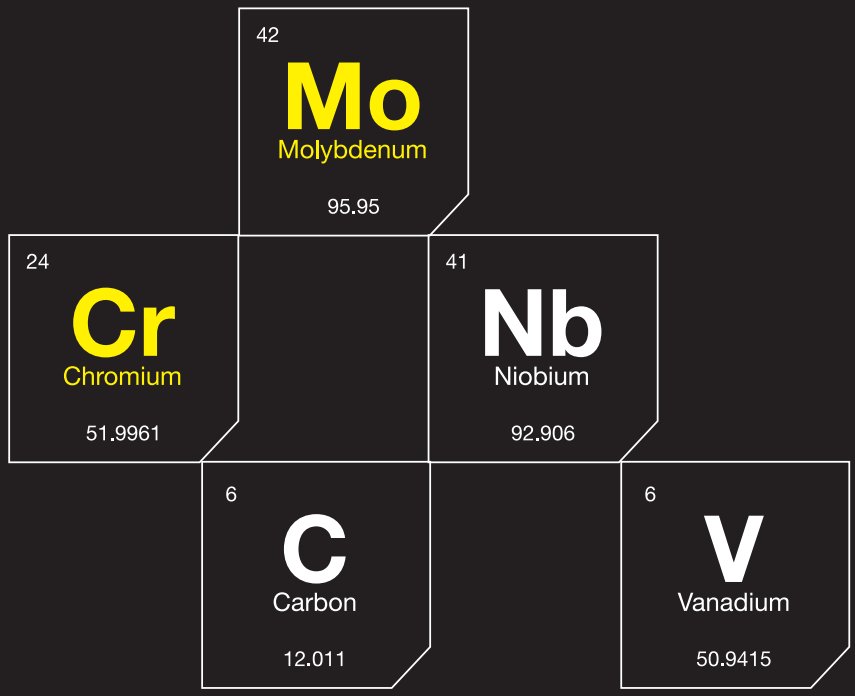
$$\mathbf{X} = \frac{(10\,P + 5\,Sb + 4\,Sn + As)}{100}\ (ppm)$$

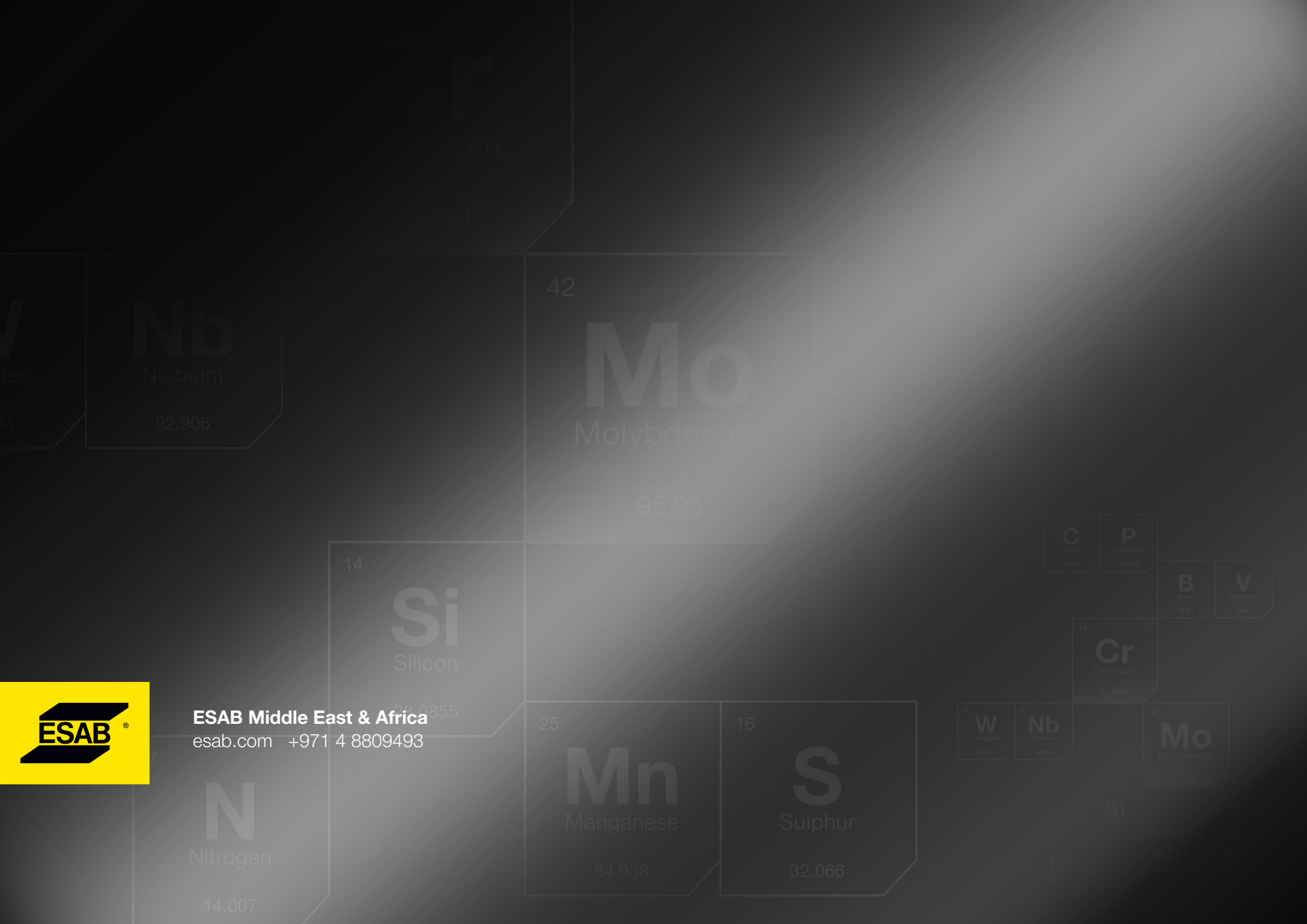
J < 20 ppm

For more information..

Need more information on **Creep Resistance Steels** or our industry-leading products and solutions?

Please visit esab.com or send us an email at info@esab.ae





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