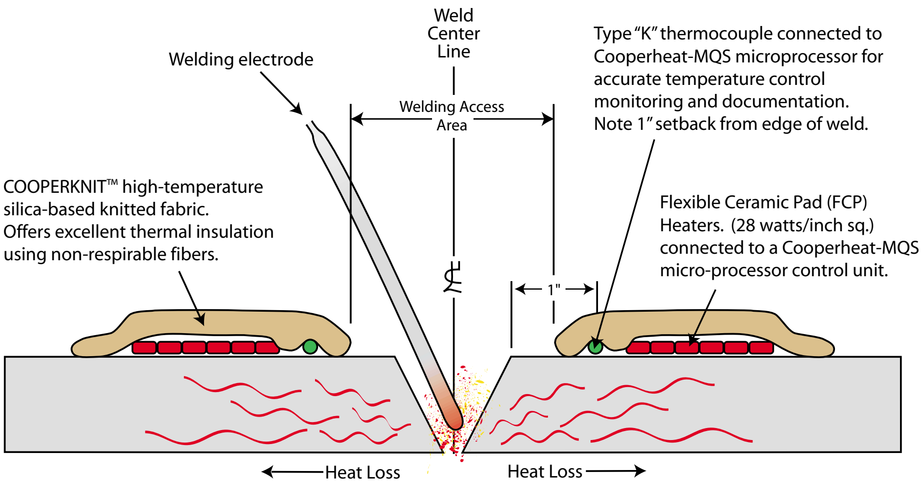
COOPERHEAT™ MQS℠ MQS Inspection

Why Preheat?

- **Improved weld quality and durability**
- **Helps minimize weld cracking**

Cross-Sectional View

Typical Preheat Setup



Benefits of Preheating

The goal of preheating is to reduce the cooling rate of the deposited weld metal, allowing time for it to fuse properly with the adjacent base metal. The benefits are numerous:

- Uniform heat penetration with minimal temperature variation.
- Continuous maintenance of specified minimum temperatures, without the interruptions that can occur during manual preheating.
- Assists proper fusion and compensates for high heat loss in thick carbon steel, copper, and aluminum alloys.
- Safe. Problems with open flame preheating, including worker safety and fire codes are avoided.
- Less downtime. Components are always ready to weld.
- Increases welder productivity when manual preheating tasks are eliminated.

Controlled Electric Preheating

Electric Resistance Preheating has been used and perfected by Cooperheat-MQS to help improve weld quality, produce stronger welds, enhance fabrication productivity, and improve worker safety.

The Cooperheat-MQS preheating system uses sophisticated, accurate micro-processor-based equipment that can significantly reduce weld cracks that result from the interaction of thermal stresses or the presence of hydrogen during fabrication.

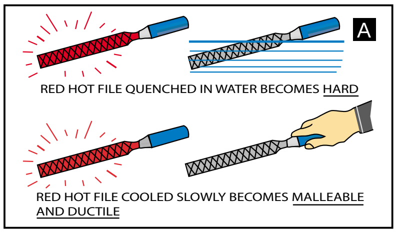
Weld metal/base metal cracking can occur in many ways. Cracking occurs both during and after welding when the colder base metal resists the inevitable contraction of the weld metal. Preheating reduces the temperature differentials between the weld metal and base metal, minimizing the tendency to crack.

Cooperheat-MQS: A Trusted Resource

Our experience and expertise in electrical resistance preheating technology can help you improve the integrity of your welds and minimize the need for rework. Our technical staff can help you meet the preheating requirements recommended by the American Society of Mechanical Engineers (ASME), American Welding Society (AWS), American Institute of Steel Construction (AISC), and other organizations that provide input or regulation to the welding industry.

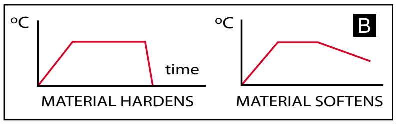
Hardening Process Slowed

High-carbon and low-alloy steels, such as chrome-molybdenum, harden if they are quenched from high temperatures (cherry red and higher), as shown in diagram "A". The same exact process can occur in a weld and heat-affected zone.



The result is cracking, unless the cooling rate is reduced by preheating the base metal.

However, by raising the temperature of the base metal through preheating, the hardening process can be controlled as the weld cools (see diagram "B").



(continued on page 4)

Preheat Requirements for
ASME B31.1 – 1998 Edition, Updated to 1999 Addenda
Power Piping
Paragraph 131

Important Note: For information only. Always refer to the actual code.

P-No.	Base Metal Group	Composition, Strength & Thickness	Min. Preheat Temperature ºF	Min. Preheat Temperature ºC
1	Carbon steel	C > .30% and thickness > 1-in. (25 mm)	175	80
		All other materials with this P-number	50	10
3	Alloy steels CR ≤ 1/2%	Specified Minimum Tensile Strength > 60 ksi (413.7 MPa) or thickness > 1/2-in. (13 mm)	175	80
		All other materials with this P-number	50	10
4	Alloy steels	Specified Minimum Tensile Strength > 60 ksi (413.7 MPa) or thickness > 1/2 -in. (13 mm)	250	120
		All other materials with this P-number	50	10
5A 5B	Alloy steels 2 1/4% ≤ CR ≤ 10%	Specified Minimum Tensile Strength > 60 ksi (413.7 MPa) or both Cr > 6% & thickness > 1/2 -in. (13mm)	400	200
		All other materials with this P-number	300	150
6	High alloy steels martensitic	All materials with this P-number	400	200
7	High alloy steels ferritic	All materials with this P-number	50	10
8	High alloy steels austenitic	All materials with this P-number	50	10
9	Nickel alloy steels	All P-number 9A materials	250	120
		All P-number 9B materials	300	150
10	Alloy steels 26 Cr & 1 Mo	All P-number 101 materials	300[1]	150[1]

Notes:
1. *Maximum interpass temperature 450ºF (230ºC).*
2. *Materials not listed in this table shall be preheated in accordance with the qualified WPS.*
3. *Lower preheat temperatures may be used for gas tungsten arc welding (GTAW) in accordance with the qualified WPS.*
4. *After welding commences, the minimum preheat temperatures shall be maintained until any required PWHT for P-Nos. 3,4,5A,5B and 6 except if certain conditions are satisfied.*

Preheat Requirements and Recommendations for ASME B31.3 – 1999 Edition, Updated to 2000 Addenda

Process Piping

Table 330.1.1

Important Note: For information only. Always refer to the actual code.

Base Metal P-No. or S-No. Note 1	Weld Metal Analysis A-No. Note 2	Base Metal Group	Nominal Wall Thickness		Specified Min. Tensile Strength, Base Metal		Min. Temperature			
							Required		Recommended	
			in.	mm	ksi	MPa	°F	°C	°F	°C
1	1	Carbon Steel	<1	<25	≤71	≤490			50	10
			≥1	≥25	All	All			175	79
			All	All	>71	>490			175	79
3	2, 11	Alloy steels,	<1/2	<13	≤71	≤490			50	10
		Cr ≤ 1/2%	≥1/2	≥13	All	All			175	79
			All	All	>71	>490			175	79
4	3	Alloy steels 1/2% < Cr ≤ 2%	All	All	All	All	300	149		
5A, 5B 5C	4, 5	Alloy steels 2 1/4% ≤ Cr ≤ 10%	All	All	All	All	350	177		
6	6	High alloy steels martensitic	All	All	All	All			300[3]	149[3]
7	7	High alloy steels ferritic	All	All	All	All			50	10
8	8, 9	High alloy steels austenitic	All	All	All	All			50	10
9A, 9B	10	Nickel alloy steels	All	All	All	All			200	93
10		Cr - Cu steel	All	All	All	All	300-400	149-204		
10I		27 Cr steel	All	All	All	All	300[4]	149[4]		
11A SG 1		8 Ni, 9 Ni steel	All	All	All	All			50	10
11A SG 2		5 Ni steel	All	All	All	All	50	10		
21-52			All	All	All	All			50	10

Notes:
1. *P-Number or S-Number from BPV Code, Section IX, QW/QB-422.*
2. *A-Number from Section IX, QW-442.*
3. *Maximum interpass temperature 316ºC (600ºF).*
4. *Maintain interpass temperature between 177º-232ºC (350ºF-450º)*

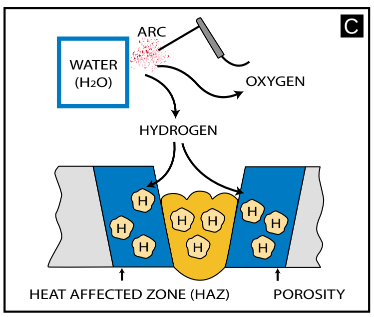
Reduces The Cooling Rate

Thick sections and materials with high thermal conductivity can cause rapid heat flow away from the weld, resulting in high cooling rates. When more time is allowed for redistribution of thermal stresses, cracking tendencies and distortion are reduced. For hardenable steels, preheating promotes the formation of ductile microstructures not susceptible to cracking. Toughness is increased by reducing the amount of residual stresses and brittle constituents.

Reduced Weld Porosity and Hydrogen Cracking

Electrode coatings and fluxes can often introduce moisture directly to the arc and weld pool. An electric arc breaks down water into its elements—hydrogen and oxygen. Both elements dissolve easily in the weld metal at high temperatures. The resulting hydrogen greatly increases the possibility of heat-affected zone cracking, and/or weld porosity.

Preheating can help prevent problems by eliminating moisture in the weld area.

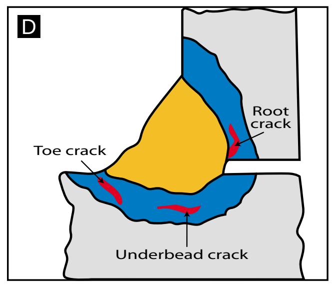


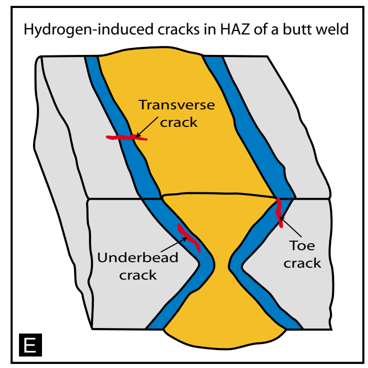
Lower Thermal Stress Levels

Conditions that produce thermal stress occur as a molten weld pool cools. Cracking can occur both during and after welding, when the colder parent metal resists the inevitable contraction of the weld metal. Preheating reduces the temperature differences between the weld metal and the parent metal, thus minimizing the tendency to crack.

Improved Microstructure in Low-Alloy Steels

Low-alloy steels containing elements such as chromium, molybdenum, and vanadium are susceptible to cracking in the heat-affected zone (HAZ), which becomes extremely hard unless the cooling rate is reduced by preheating (diagrams "D" and "E"). Preheating improves the welded microstructure of this zone by reducing the post-weld cooling rate, leading to formation of more desirable and more ductile microstructures. Cracking by hardening, particularly under the surface, is minimized.





Improved Puddle Control And Surface Finish

When the base metal is preheated, the weld puddle becomes more fluid and exhibits better control, weldability, and penetration. Also, the welding surface has a better appearance when solidified, and requires less interpass and postweld finishing, such as grinding.

Practical Options

With Cooperheat-MQS, you have various options for meeting your preheating requirements, including complete, on-site service. Our trained professionals will handle all aspects of your preheating needs—efficiently and cost-effectively.

Or if you prefer, you can purchase preheating equipment from Cooperheat-MQS with an assurance that the equipment you select will be the finest available.

Serving industries throughout North America with on-site and lab services

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