

**F22 MODIFIED, 75 KSI (517 MPA), FORGINGS, H2S COMPATIBLE,  
SIMULATED POST WELD HEAT TREATMENT REQUIRED**

Rev	Reason of Change	Date	Made By	Reviewed By	Approved By	Status
0	Initial release	12-12-2016	MN	AS	KKD	Released
1	Quenching media temperature requirements amended & retention period added in clause 6.0 added as per API 6A 21st edition	03-10-2019	MN	USR	AS	Released

## 1.0 Scope

This specification covers F22 (2.25-Cr 1-Mo) forgings with minimum yield strength of 75 ksi (517MPa). This material is compatible with H<sub>2</sub>S service.

This specification may be used where welding will be performed on the base metal.

A simulated post weld heat treatment (SPWHT) is required per heat per heat treatment batch of forgings. The mechanical properties required in this specification shall be met following SPWHT.

## 2.0 Reference Specifications

Documents	Descriptions
API 6A	Specification for Wellhead and Christmas Tree Equipment
ASTM E112	Standard Test Methods for Determining Average Grain Size
ASTM A182	Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
NACE MR-01-75/ISO 15156	Petroleum and natural gas industries - Materials for use in H <sub>2</sub> S-containing environments in oil and gas production

## 3.0 Chemistry Requirements

The material shall be fully killed and melted in accordance with a fine grain practice, capable of producing ASTM E112 grain size of 5 or finer.

The chemistry shall meet the requirements of Table 1.

Table 1: Chemical Requirements (All are maximums unless otherwise noted)

Elements	Wt. Percentage (%)
Carbon	0.10 - 0.15
Manganese	0.30 - 0.60
Chromium	2.00 - 2.50
Molybdenum	0.87 - 1.13
Phosphorus	0.015
Sulfur	0.010
Silicon	0.15 - 0.50
Nickel	0.50
Vanadium	0.03
Niobium (Cb)	0.01
Titanium	0.03
Aluminum	0.05
Total Residual Elements	0.5

Nb(Cb) and Ti as well as other elements not listed above shall not be intentionally added.

## 4.0 Mechanical Properties

The material shall meet the mechanical requirements of Table 2 on the 'as heat treated' test material and test material that has been subjected to a SPWHT of 1200 °F (650 °C) for 20 hours.

Table 2: Mechanical Properties. (All values are minimums unless otherwise noted.)

Tensile Strength	95,000 psi (654 MPa)
Yield Strength	75,000 psi (517 MPa)
YS/UTS Ratio, max	0.90
Elongation in 2" or 4D	18%
Reduction of Area	35%
Brinell Hardness (raw)	207-237 HBW
Brinell Hardness (finished part)	197-237 HBW
Rockwell Hardness, max	22 HRC

For material that is permitted to be qualified by a separate QTC, a separate QTC shall be made for 'as heat treated' properties and a second separate QTC shall be made for 'SPWHT' properties.

When prolongations are required, the simulated post weld heat treat material shall be the equivalent to at least  $\frac{1}{2}$  of the prolongation which remains following removal of test material for 'as heat treated' properties (Figure 1). Following SPWHT, mechanical testing shall be done at the same test locations (depths) as the 'as heat treated' testing.

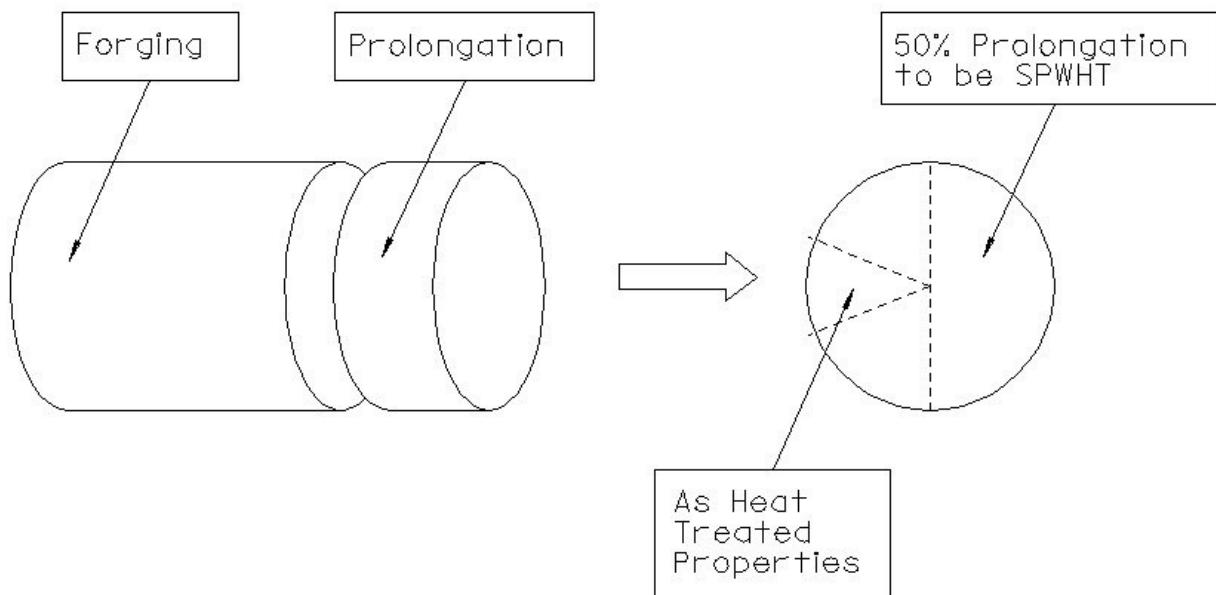


Figure 1: Example of How to use Prolongation for SPWHT

## 5.0 Heat Treatment

Heat treatment temperatures shall be in accordance with the temperatures in Table 3.

Table 3: Required Temperature Ranges for Heat Treat

PROCESS	ATMOSPHERE/MEDIA	TEMPERATURE	TIME AT TEMPERATURE
Normalized	Air	1700 °F – 1775 °F (927 °C – 968 °C)	30 Minutes / Inch of T, Minimum Time is 30 Minutes.

Still air cool to below 400 degrees F (204 degrees C) before further processing

Austenitize	Air	1650 °F - 1725 °F (899 °C – 941 °C)	30 Minutes / Inch of T, Minimum Time is 30 Minutes.
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Quench (Below 400°F (204 °C))	Water	The temperature of quenching medium shall not exceed 100 °F (38 °C) at the start of the quench nor exceed 49°C (120°F) at any time during the quench cycle.
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Temper	Air	1220°F (660°C) minimum	1 hour per inch of maximum through thickness. One hour Minimum.
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## 5.1 Simulated Post Weld Heat Treatment

Simulated Post Weld Heat Treatment applies only to the test material as described in section 4.

The simulated post weld heat treatment shall be 1200 °F (650°C) for 20 hours, followed by still air cooling.

A contact thermocouple shall be used to monitor the test material temperature to ensure the test material is within +/- 15 °F (+/- 8 °C) of target temperature for a minimum of 20 hours. A furnace chart containing the details of the SPWHT shall be included with each delivery. The 20 hour hold time may be completed as a single 20 hour soak or two 10 hour soaks.

## 6.0 WORKMANSHIP

Material shall be inspected in accordance with part report (DBI). Material shall be free of injurious defects that are detrimental to the integrity of the final product, such as laps, scabs, cracks and exogenous inclusions.

Suppliers shall retain heat treat charts in a secure area for a period of no less than 10 years (e.g. electronic or paper).