

## AISI 422, SUH 616, B50A951, 1.4935, X20CrMoWV12-1 - Turbine Blade Steels Datasheet

AISI 422, Alloy 616, [1.4935](#), [X20CrMoWV12-1](#) creep resistant martensitic stainless steels are high-alloy steels that exhibit better corrosion resistance than other steels, 12% Chromium stainless steel used for thermal engine components in power plants, mainly turbine blades, Steam Turbine buckets, bolting fasteners, valves, and other miscellaneous components. Max temperature for continuous operating is 580 ° C. Chrome-nickel steel with an austenitic structure with carbides. Alloying additions of molybdenum, vanadium and tungsten increase the melting temperature, thus having a positive effect on creep resistance. acc.to B50A951 A1, A2, SIEMENS 10705BL/M, 10705BR, 10705BU. ASME SA-437 Grade B4B Alloy Steel Turbine-Type Bolting Material Specially Heat Treated for High-Temperature Service. ASTM A437 Grade B4B Stainless and Alloy-Steel Turbine-Type Bolting Specially Heat Treated for High-Temperature Service. ASTM A565 Grade 616 Martensitic Stainless Steel Bars for High-Temperature Service. JIS G4311 SUH 616 Heat-resisting steel bars and wire rods. SAE J 775 SUH 616 Engine poppet valve information report.

Melt Practice: EAF+AOD+IC+ESR

### Chemical Composition

Grade	Chemical composition WT %														
	C	Si	Mn	P	S	Cr	Mo	Ni	V	W	Cu	Sn	Al	Co	Ti
Ge Power B50A951 A1	0.20-0.25	0.20-0.50	0.50-1.00	Max 0.025	Max 0.015	11.00-12.50	0.90-1.25	0.50-1.00	0.20-0.30	0.90-1.25	Max 0.15	Max 0.02	Max 0.025	0.20	0.025
Ge Power B50A951 A2	0.20-0.25	0.20-0.50	0.50-1.00	Max 0.020	Max 0.010	11.00-12.50	0.90-1.25	0.50-1.00	0.20-0.30	0.90-1.25	Max 0.15	Max 0.02	Max 0.025	0.20	-
Ge Power B50A249 S12	0.20-0.25	0.20-0.50	0.50-0.90	0.025	0.025	11-12.50	0.9-1.25	0.5-1.0	0.2-0.3	0.9-1.25	-	0.02	0.025	0.20	0.05
ASME B4B, ASTM Grade B4B	0.20-0.25	0.20-0.50	0.50-1.00	Max 0.025	Max 0.025	11.00-12.50	0.90-1.25	0.50-1.00	0.20-0.30	0.90-1.25	-	Max 0.04	Max 0.05		Max 0.050
ASTM A565 616	0.20-0.25	Max 0.50	0.50-1.00	Max 0.025	Max 0.025	11.00-12.50	0.90-1.25	0.50-1.00	0.20-0.30	0.90-1.25	-	-	-	-	-
EN 1.4935, X20CrMoWV12-1	0.17-0.24	0.10-0.50	0.30-0.80	Max 0.025	Max 0.015	11.0-12.5	0.80-1.20	0.3-0.8	0.25-0.35	0.4-0.6	-				
JIS SUH 616	0.20-0.25	Max 0.50	0.50-1.00	Max 0.040	Max 0.03	11.0-13.0	0.75-1.25	0.5-1.0	0.2-0.3	0.75-1.25	Max 0.3				
ASTM AISI 422, AISI 616, S42200	0.20-0.25	Max 0.75	Max 1.00	Max 0.040	Max 0.03	11.0-12.5	0.75-1.25	0.5-1.0	0.15-0.30	0.75-1.25	Max 0.5				

### Mechanical Properties

- Type 422 Class A1, A2, A4
  - Tensile strength KSI(MPa): Min 140(965)
  - Yield Strength 0.02%, Offset KSI(MPa): Min 90(620) \*
  - Elong. In 2": Min 13 %
  - RA: Min 35%
  - Brinell Hardness, 3000Kg laod: 285-331
  - Kv, Min at R.T. ft-lb(J): 10(13.36)
  
- Type 422 Class A3
  - Tensile strength KSI(MPa): Min 110(759)
  - Yield Strength 0.02%, Offset KSI(MPa): Min 80(555) \*
  - Elong. In 2": Min 18 %
  - RA: Min 50%
  - Brinell Hardness, 3000Kg laod: 223-269
  - Kv, Min at R.T. ft-lb(J): 25(33.90)

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- Tensile Strength, psi, min. 140,000
  - Yield Strength, psi, 0.02%, min. 90,000
  - Elongation, % in 2 inches, min. 12
  - Reduction of Area, %, min. 25
  - Charpy V-Notch Impact Energy Requirements (B50A249B Only)

Two Charpy V-Notch Impact energy tests shall be conducted at room temperature (70F +/-10F) and have following properties:

Standard Charpy V-Notch Impact, ft-lb, min. 10

- Hardness Requirements

Two Brinell Hardness measurements shall be taken at the 0-degree and 180 Degree locations on one end and at the 90-degree and 270-degree locations on the opposite end of each forging. The measurements shall be taken at each end, on either the end face or a radial face in close proximity to the end. All measurements must meet the following requirements:

Brinell Hardness Number, 3000 kg load 290-332

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Smooth bar stress rupture tests shall be conducted on each forging or each heat treated forging length. The test may be discontinued after the minimum requirement for time to rupture has been exceeded. The test must meet the following requirements:

- Temperature (Degree F): 1200
- Stress (psi): 26,000
- Min. Time to Rupture (hrs.): 25

- +QT700
  - Tensile strength KSI(MPa): 700 to 850
  - Yield Strength 0.02%, Offset KSI(MPa): Min 500
  - A5 15%

- +QT800
  - Tensile strength KSI(MPa): 800 to 950
  - Yield Strength 0.02%, Offset KSI(MPa): Min 600
  - A5 14%

• Test Method: ASTM E139

• Temperature: 650 ° C

• Load:200 MPa

• Result: Life = 25 hours,Elongation and Reduction of Area = For information On bar having lowest hardness for each heat lot.

temperature,( )	Time,(h)	1% Rp1(MPa)	0.5% Rp0.5(MPa)	0.2% Rp0.2(MPa)	0.1% Rp0.1(MPa)	CRS(MPa)
470	10000.0h	324.0	-	-	-	368.0
470	100000.0h	260.0	-	-	-	309.0
470	200000.0h	-	-	-	-	285.0
480	10000.0h	299.0	-	-	-	345.0
480	100000.0h	236.0	-	-	-	284.0
480	200000.0h	-	-	-	-	262.0
490	10000.0h	269.0	-	-	-	319.0
490	100000.0h	213.0	-	-	-	260.0
490	200000.0h	-	-	-	-	237.0
500	10000.0h	247.0	-	-	-	294.0
500	100000.0h	190.0	-	-	-	235.0
500	200000.0h	-	-	-	-	215.0
510	10000.0h	227.0	-	-	-	274.0
510	100000.0h	169.0	-	-	-	211.0
510	200000.0h	-	-	-	-	191.0
520	10000.0h	207.0	-	-	-	253.0
520	100000.0h	147.0	-	-	-	186.0
520	200000.0h	-	-	-	-	167.0
530	10000.0h	187.0	-	-	-	232.0
530	100000.0h	130.0	-	-	-	167.0
530	200000.0h	-	-	-	-	147.0
540	10000.0h	170.0	-	-	-	213.0
540	100000.0h	114.0	-	-	-	147.0
540	200000.0h	-	-	-	-	128.0
550	10000.0h	151.0	-	-	-	192.0
550	100000.0h	98.0	-	-	-	128.0
550	200000.0h	-	-	-	-	111.0
560	10000.0h	135.0	-	-	-	173.0
560	100000.0h	85.0	-	-	-	112.0
560	200000.0h	-	-	-	-	96.0
570	10000.0h	118.0	-	-	-	154.0
570	100000.0h	72.0	-	-	-	96.0
570	200000.0h	-	-	-	-	81.0
580	10000.0h	103.0	-	-	-	136.0

temperature,( )	Time,(h)	1% Rp1(MPa)	0.5% Rp0.5(MPa)	0.2% Rp0.2(MPa)	0.1% Rp0.1(MPa)	CRS(MPa)
580	100000.0h	61.0	-	-	-	82.0
580	200000.0h	-	-	-	-	68.0
590	10000.0h	90.0	-	-	-	119.0
590	100000.0h	52.0	-	-	-	70.0
590	200000.0h	-	-	-	-	58.0
600	10000.0h	75.0	-	-	-	101.0
600	100000.0h	43.0	-	-	-	59.0
600	200000.0h	-	-	-	-	48.0
610	10000.0h	64.0	-	-	-	87.0
610	100000.0h	36.0	-	-	-	50.0
610	200000.0h	-	-	-	-	40.0
620	10000.0h	53.0	-	-	-	73.0
620	100000.0h	30.0	-	-	-	42.0
620	200000.0h	-	-	-	-	33.0
630	10000.0h	44.0	-	-	-	60.0
630	100000.0h	25.0	-	-	-	34.0
630	200000.0h	-	-	-	-	27.0
640	10000.0h	36.0	-	-	-	49.0
640	100000.0h	20.0	-	-	-	28.0
640	200000.0h	-	-	-	-	22.0
650	10000.0h	29.0	-	-	-	40.0
650	100000.0h	17.0	-	-	-	23.0
650	200000.0h	-	-	-	-	18.0

## Physical Properties

Density: 7.7 g/cm<sup>3</sup>

Linear expansion coefficient: 10.5-12.5 \*10<sup>-6</sup>m/(m\*K)

Thermal conductivity: 24 W/(m\*K)

Specific heat capacity: 460 J/(kg\*K)

Young's modulus: 216 GPa

Electrical resistivity: 0.6 μ \*m

Tensile strength Rm: > 600 MPa

Creep limit for max elongation 0.2% Rp0.2: Min 800 MPa

Creep-rupture strength Ru: Min 275 MPa; 500 ° C; 100000h

## Heat Treatment

Austenitization-Material shall be heat treated to 1875-1925F and held at temperature for a sufficient time to assure uniform temperature within the load and each part thereof.

Quenching -Material shall be quenched to a temperature below 600 and then cooled to a temperature below the M (approximately 150 ) to assure complete transformation.

B50A951 A1 -Material shall be oil quenched. Use of air quenching is prohibited.

B50A951 A2, A3, A4 -Material shall be quenched in oil or rapidly moving air.

Tempering -Material shall be uniformly heated to the tempering temperature of 1150F ° minimum.

- Quenching: 1020-1070 ° C
- Tempering: 680-780 ° C

- Austenitization (All Classes)

Forging shall be heated slowly to 1875°F- 1925°F and held at temperature approximately 30 minutes per inch of thickness or diameter, to assure uniform temperature within the load and each part thereof.

- Quenching

- B5QA249B

Each forging shall be oil quenched to a temperature below 600F. The forging shall then be cooled to a temperature below the Mf temperature (approximately 300F) to assure complete transformation. GE Test Method E50A209 is to be used as a guide for selecting adequate quenching times. Time of immersion in oil, and the maximum surface temperature of the forging during the first ten minutes after removal from the oil shall be reported.

- B50A249C

Forging shall be forced air quenched to a temperature below the Mf temperature (approximately 300F) to assure complete transformation.

- Tempering (All Classes)

Forging shall be double tempered. The first temper shall be at 1100F minimum. The second temper shall be at 11 50F minimum. The forging shall be held at the temperature for one (1) hour per inch of maximum thickness or diameter during the tempering cycle and then cooled uniformly to room temperature.

- Stress Relief Anneal (SRA)

When a stress relief heat treatment is performed, the forging shall be stress relieved at a temperature 50F below the final tempering temperature and shall be still air or furnace cooled.

## Welding Properties

welding of this material is not straightforward owing to its crack sensitivity.

## Machining Properties

Machining

## Similar or Equivalent Steel Grade

AISI 422, AISI 616, S42200, 1.4935, X22CrMoWV12-1, SUH616, 20VNiWMoCr120, ,EW 4935, T502, 56B.I., DE 4935, HWMoV3, Grade 616, B50A951 A1, A2, A3, A4, HT9