



T D-218 Rev.00

PLANT STANDARD

HYDERABAD

HY 064 02 61

REV.No. 03

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PROCESS SPECIFICATION FOR STRESS RELIEF ANNEALING OF FERROUS PARTS

1.0 GENERAL:

The plant standard details the technology of stress relief annealing of various components made of steel or cast irons using furnaces. Stress caused by machining, forming, casting, gas cutting or straightening are relieved in the components by this treatment.

Stress relief annealing is done by slowly heating a component to a temperature below the lower critical point AC1, followed by slow cooling. By this treatment internal stresses present in the component are relieved significantly without modifying the mechanical properties. Dimensional stability of the component increases by stress relieving.

- 1.1 Stress relieving of components involving welding is not within the scope of this standard.

2.0 APPLICATION:

Various components requiring stress relieving treatment are as classified below.

- 2.1 Components meant for nitriding are stress relieved for dimensional stability so that distortion after nitriding operation is minimised.
- 2.2 To increase the dimensional stability, many of the machined components such as casings, shafts, valve bodies, rings etc. are stress relieved after rough machining, with 3 to 5 mm allowance on surfaces.
- 2.3 Cold straightened components shall be stress relieved after straightening.
- 2.4 Grey iron castings are usually stress relieved for reducing internal stresses before they are subjected to machining.

3.0 EQUIPMENT:

Heat treatment furnaces operating on electric power or gas or oil are suitable. Furnace condition shall be such that the uniformity of temperature in working zone is maintained within $\pm 14^{\circ}\text{C}$ during the operation.

For components of length more than 1500 mm or 1 tonne weight and above, temperature uniformity shall be ensured by keeping thermocouples at intervals of 1 metre distance.

Revisions: Brought up-to-date.			Issued: STANDARDS ENGINEERING SECTION		
Rev.No. 03	Amd.No.	Reaffirmed	Prepared	Approved	Dt. of 1st Issue
Dt. AUG. 99	Dt.	Year:	Matls. Engg. 08 - TECH.	DGM (QS)	NOV. 1983

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4.0 PROCESS:

4.1 **Loading:** Jobs shall be loaded in the furnace carefully with sufficient spacing between them for effective heating. Parts with thin sections shall be supported to minimise any distortions. There shall not be any direct impingement of flame. Jobs shall be heated to stress relieving temperature as per the Annexure-1. Initial furnace temperature before commencing heating can be upto 400°C maximum.

4.2 **Rate of heating:** Heating rate shall not exceed the limit given below:

Maximum ruling section/ thickness of the job (T) in mm	Maximum rate of heating in °C per hour
Upto 50	100
Above 50	5000/T or 50 whichever is Higher

During heating the temperature difference between any two temperature measuring points of job shall not exceed 100°C within any 4 metres interval of length.

4.3 **Soaking:** After the job is heated to the stress relieving temperature it is soaked there in accordance with the following table:

Maximum ruling section/thickness of the job (T) in mm	Soaking time in minutes (Minimum)	Soaking time in minutes (Maximum)
Upto 12 mm	30 minutes	60 minutes
13 to 100 mm	@ 2.5 minutes per mm	4 X T
Above 100 mm	250 minutes + 1 minute per every additional mm over 100 mm	4 X T

4.3.1 Stress relief annealing temperature shall be 40° less than tempering temperature for the components which are processed after hardening and tempering. This temperature difference is required to safeguard the mechanical properties in tempered condition.

4.3.2 For components soaking time shall be based on maximum thickness. In case materials of different thicknesses are to be clubbed and processed, soaking time for the lot. However, the soaking time for the thinnest item shall not generally exceed 4 x T minutes.



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4.3.3 Stress relieving at a temperature upto 30°C less than the lower limit of the specified temperature shall be acceptable provided the soaking time is increased twice the normal time as given in 4.3.

4.4 **Cooling:** After required soaking is given at the stress relieving temperature furnace is put off and jobs are allowed to cool in the furnace upto 400°C slowly. The cooling rate shall not exceed the limits given below:

Maximum ruling section/
thickness of the job (T) in mm

Maximum rate of heating
in °C per hour

Upto 50

125°C

Above 50

60°C

4.4.1 Cooling rate below 400°C to ambient temperature is not generally critical and can be done either in air or in furnace.

4.4.2 High Chromium and High Manganese steels are susceptible to temper embrittlement during slow cooling and hence shall be cooled in air from the stress relieving temperature.

4.5 Production shall maintain the following records for each batch of components stress relieved.

- a) Furnace identification and heat batch No.
- b) Work Order No., Name of Part, Part/Drg.No., No. of Parts loaded
- c) Material specs. And heat treatment/process specified.
- d) All temperature recording furnace charts

5.0 INSPECTION:

5.1 **Temperature – Time Record:** QC shall verify the process details as given in Clause 4.5

5.2 **Hardness Checking:** Generally hardness checking is not essential after stress relieving. However in case of any doubt random hardness checking may be carried out by QC.

6.0 STRESS RELIEVING TEMPERATURES:

The stress relieving temperatures for materials commonly used in Hyderabad plant are given in Annexure – 1 for general reference.

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ANNEXURE – 1

STRESS RELIEVING

BHEL Specification	Steel Grade	Condition prior to SR	Stress Relieving Temp. °C
AA 10108	IS:226 Gr.Fe 410.5	N	600-650
AA 10119	IS:2062 Gr.St 42-W	N	600-650
AA 10122	IS:961 Gr.Fe 540n W-HT	N	600-650
AA 10152	IS:1239 (Pt.1) ERW	N	600-650
AA 10208	IS:2073 Gr.C 40	N	600-650
AA 10213	IS:1570 Pt.II Gr.30 C8	N	600-630
AA 10218	IS:5517 Gr.C 40	V	520-550
AA 10305	IS:2073 Gr.C55 Mn 75	N	600-650
AA 10407	ASME:SA 516 Gr.70	N	600-650
AA 10455	ASME:SA 106 Gr.B	N	600-650
**AA 10501	IS:5517 Gr.40 Ni 6 Cr 4 Mo3	V	510-530
AA 10502	IS:5517 Gr.40 Cr 7 Al 10 Mo2	V	550-580
AA 10620	DIN:17240 Gr.21 Cr Mo V57	V	580-650
AA 10630	ASME:SA 335 Gr.P 22	V	600-650
AA 10632	ASME:SA 335 Gr.P 11	N	590-620
AA 10721	IS:6603 Gr.20 Cr 13	V	600-630
AA 19306	Gr.14 Mo V63	V	690-730
AA 19308	DIN:17240 Gr.21 Cr Mo V57	V	580-650
AA19308	Gr.21 Cr Mo Ni V 47 V	V	580-650
AA 19320	BS:970 Gr.410 S 21	V	550-580
AA 19321	DIN:17440 Gr.X 20 Cr 13	V	600-630
AA 19331	IS:2004 Cl.2	N	600-650
AA 19332	IS:2004 Cl.3	N	600-650
AA 19333	IS:2004 Cl.4	N	600-650
AA 19334	IS:2004 Cl.4	V	500-530
AA 19341	IS:4367 Gr.20 Mn 2	N	600-650
AA 19352	DIN:17200 Gr.42 Cr Mo 4	V	500-530
AA 19511	ASTM:A216 Gr.WCB	N	600-650
AA 19512	Y 87-30 Type-H	N	600-650
AA 19521	IS:2708 Gr.2	N	600-650
AA 19522	DIN:17245 Gr.GS-17 CrMo V511	V	650-710
AA 19523	DIN:17245 Gr.GS-22 Mo 4	V	660-690
AA 19701	IS:210 Gr.FG 150	-	550-580
AA 19702	IS:210 Gr.FG 200	-	550-580
AA 19703	IS:210 Gr.FG 260	-	550-580
AA 19704	IS:210 Gr.FG 300	-	550-580
AA 19721	IS:1875 Gr.SG 400 12	-	530-560
AA 19731	IS:2108 Gr.4	-	520-550
HY 10199	IS:1570 Pt.II Gr.15 C8	N	600-630
HY 10461	CSN:411416.1	N	600-650

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HY 10498	ASME SA 516 Gr.70		600-630
**HY 10561	IS:5517 Gr.40 Ni 6 Cr 4 Mo 3	NV	500-530
**HY10566	ASME:SA 320 Gr.L 7	V	590-620
HY 10568	BS:970 Gr150 M 19	N	600-650
HY 10576	ASTM A 514	V	560-590
HY 10663	DIN:17240 Gr.24 Cr Mo 5	V	550-620
HY 10664	DIN:17200 Gr.42 Cr Mo 4	V	500-530
HY 10665	Gr.21 Cr Mo Ni V 47	V	580-650
HY 10666	Gr.10 Mo 910	V	650-680
HY 10675	Gr.14 Mo V 63	V	630-660
HY 10676	DIN:17175 Gr.15 Mo 3	N	600-650
HY 10763	Gr.X20 Cr 13	V	590-620
HY10764	Gr.X20 Cr 13	V	590-620
HY 10766	TLV 9248 Gr.X22 Cr Mo V121	V	600-650
HY 10767	TLV 9248 Gr.X22 Cr Mo V121	V	600-650
HY 10776	Gr.X22 Cr Mo V 121		600-650
HY 10778	DIN:17175 Gr.X20 Cr MoV 121	VV	670-700
HY 10788	ASTM A 565 Gr.616	V	560-590
HY 10791	Gr.X 5 Cr Ni 134	V	500-530
HY 10995	UNI 6900 Gr.X 12 Cr 13	V	540-570
HY 10997	ASTM A 473 Gr.403	V	620-650
HY 10998	ASTM A 473 Gr.403	V	620-650
HY 19360	Gr.X 20 Cr 13	V	590-620
HY 19361	ASME:SA 105 (C < 0.25)	N	600-650
HY 19362	Gr.X 20 Cr 13	V	590-620
HY 19364	ASME:350 Gr.LF 2	N	600-650
**HY 19365	UNI 7874 Gr.40 Ni Cr Mo7	V	520-550
HY 19368	DIN:17200 Gr.42 Cr Mo 4	V	500-530
**HY 19369	Gr.40 Ni Cr Mo 7	V	630 Max.
**HY 19370	BS:970 Gr.817 M 40	V	500-530
HY 19372	Gr.X8 Cr Mn 18	V	340-360 5hrs min
**HY 19373	Gr.26 Ni Cr Mo V 85	V	590-620
HY 19376	ASTM A 320 Gr L43	V	590-620
**HY 19382	Gr.26 Ni Cr Mo V 115	V	540-570
HY 19387	Gr.13 Cr Mo 44	V	600-700
HY 19388	DIN:17240, 24 Cr Mo5	V	550-620
HY 19390	DIN:17440 X 20 Cr 13	V	590-620
HY 19393	Gr.X 22 Cr Mo V121	V	600-680
HY 19394	Gr.X 22 Cr Mo V 121	V	600-650
HY 19399	UNI:6900 Gr.X 12 Cr 13	V	550-580
HY 19399	UNI 6900 Gr X 12 Cr 13	V	540-570
HY 19460	---	V	520-550
HY 19461	ASTM A 473 Gr.403	V	540-570
HY 19462	---	V	520-550
HY 19467	---	V	610-640
HY 19561	ASTM:A352 Gr.LCB	N	540-570
HY 19562	ASTM:A216 Gr.WCA	N	600-650
HY 19563	IS:2707 Gr.1	V	500-530

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HY 19564	IS:2644 Gr.1	V	500-530
HY 19565	---	V	500-530
HY 19569	DIN:17245 Gr.GS-C25	V	600-650
HY 19570	DIN:17245 Gr.GS-C25	V	600-650
HY 19571	DIN:17245 Gr.GS-22 Mo4	V	660-690
HY19572	DIN:17245 Gr.GS-17 Cr Mo 55	V	660-690
HY 19573	DIN:17245 Gr.GS-17 Cr MoV511	V	680-710
HY 19576	DIN:17245 Gr.GS-17 Cr Mo 55	V	660-690
HY19591	DIN:17445 Gr.G-X 12 Cr 14	V	600-630
HY 19592	DIN:17445 Gr.G-X 20 Cr 14	V	600-630
HY 19593	BS:1504 Gr.425 C 11	V	590-650
HY 19761	CSN:422455.2	-	520-560
HY 19763	Mechanite GD	-	510-560
HY 19766	Mechanite SF	-	620-650
HY 19767	ASTM:A536 Gr.80-60-03	-	510-560

N : Normalised

V : Hardened and tempered

SR : Stress relieving

** These materials shall be air cooled from the stress relieving temperature

- Note :
- 1) Steel susceptible to temper embrittlement in the range 371-565°C
 - 2) Stress relieving temperature can be 40°C lower than the tempering temperature, where tempering temperature is clearly documented.
 - 3) For the material grades which are not included in this specification, stress relieving temperature shall be 40°C lower than the tempering temperature