

Sara Sae	SARA SAE ENGINEERING SPECIFICATION	
	SECTION SES 26 – 721	
	ISSUE “B”	REV NO “2”
	EFF. DATE 20-10-2011	Page 1 of 2

MATERIAL SPECIFICATION AISI 440C STAINLESS STEEL

1.0 PURPOSE

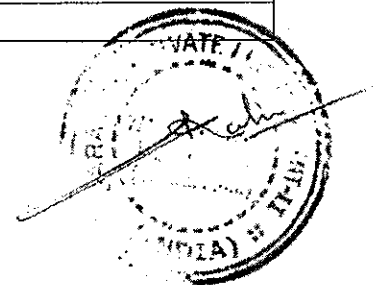
- 1.1 It is the purpose of this material specification to list in concise form of the material requirement for AISI 440C stainless steel for use, wherever specified.
- 1.2 This material specification is intended to aid the purchasing department in procuring and the vendor in supplying a material which meets the needs of its intended use, and the quality control department in the inspection and release of incoming material.

2.0 REQUIREMENTS

- 2.1 The requirements of specification S.E.S. 26-590 shall apply in addition to the following specific requirements.

- 2.1.1 Chemical composition: Chemical composition limits are listed below. An analysis of each heat of steel is made by the manufacturer, preferably from a ladle sample taken at or near the time of pouring. The listed elements shall be reported in weight percent. Reporting of residual elements is not required, but total residuals must not exceed 1%.

ELEMENTS	COMPOSITION RANGE (%)
Carbon (C)	0.95~1.20 (max.)
Manganese (Mn)	1.0 (max.)
Silicon (Si)	1.0 (max.)
Sulphur (S)	0.03 (max.)
Phosphorus (P)	0.04 (max.)
Chromium (Cr)	16.0~18.0
Molybdenum (Mo)	0.75
Iron (Fe)	Balance



Sara Sae	SARA SAE ENGINEERING SPECIFICATION	
	SECTION SES 26 – 721	
	ISSUE “B”	REV NO “2”
	EFF. DATE 20-10-2011	Page 2 of 2

2.1.2 **Mechanical Properties:** Mechanical Properties are required as listed below each heat shall be tested and the listed mechanical properties shall be reported.

Tensile strength PSI (MPa) = 2,85,000 (1970) min

Yield strength PSI (MPa) = 2,75,000 (1900) min

Elongation in 2” Gauge Length= 2%

Reduction in area : 2% min.

2.1.3 **HEAT TREATMENT:** - Heat treatment

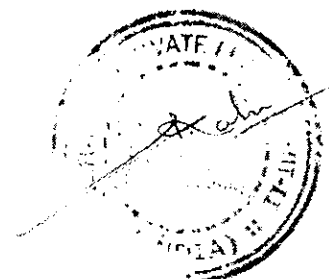
PROCESS	ATMOSPHERE/MEDIA	TEMPERATURE	TIME AT TEMPERATURE
Hardening	Air	950 °C -1050 °C	1/2 hour per inch of minimum through Thickness.
Quenching	Oil	(38 °C) at the start of quench	50°C Max. at the completion of the quench
Tempering	Air	250 °C - 300 °C	Depending on the thickness .1/2 hour /inch thickness.

2.1.4 **HARDNESS:** 50 ~ 55 HRc .

3. **DOCUMENTATION REQUIRED:-**

3.1 Each shipment shall be accompanied by material certifications for each lot of material, certifications must be positively relatable to the lot of material represented.

3.2 Recheck of Chemical properties to be carried out by SARA SAE.



DT: 08.06.2014

Recipe for validation of 440C

Target to set the following properties in component

Mechanical Properties	Range
Tensile Strength	1970 MPA Min
Yield Strength	1900 Mpa Min
Elongation	2% Min
Reduction in Area	2 % Min
Hardness	50-55 HRC

Microstructure

Tempered martensitic

Part / Component Detail

Material : AISI-440C

Drawing No. : 01-0277-3G

Material Description : Rotor 1" Selector Valve

Code : IR098

Heat No. : 5623J

Qty : 10 Pcs + QTC SI No S134

Item weight per piece : 1.42 Kg

HEAT TREATMENT VARIABLE

Heat Treatment Variable Possible Consideration

Composition Required as per SES 26-721 Issue 'B' Rev 2

	C	Mn	Si	P	S	Cr	Mo
MIN	0.95	--	--	--	--	16.0	--
MAX	1.20	1.00	1.00	0.040	0.030	18.0	0.75

Note:-Total Residual Elements not to exceed 1%

Section Size : As per Drawing 01-0277-3G

Weight Max. Section Size : 1.42 Kg

Prior Heat Treatment Surface Condition : Not applicable

After Heat Treatment Surface Condition : To be descaled after Heat treatment

Accepted.
7/1/14

HEAT TREATMENT AS PER SES 26-721 Issue 'B' Rev 2:

PROCESS	ATMOSPHERE/ MEDIA	TEMPERATURE	TIME AT TEMPERATURE
Hardening	Air	950 °C -1050 °C	1/2 hour per inch of minimum through Thickness.
Quenching	Oil	(38 °C) at the start of quench	50°C Max. at the completion of the quench
Tempering	Air	250 °C - 300 °C	Depending on the thickness .1/2 hour /inch thickness.

Heat Treatment Equipment

Continuous Solution annealing Furnace

Specification	Description	
Tray size in mm	Outer [W X L X H]: 1100 X 1100 X 360	Base Tray is designed to optimize structural strength while maintaining maximum open area. Tray should accommodate about 340 kgs of reference components.
Tray weight in kgs	258 kgs	
Load per tray	340 kgs	Up to 340 kgs of components may be loaded per tray for 40 minute cycle to achieve the planned capacity of 500 kgs/hour. However, larger and heavier jobs can be fitted on the Tray by using a slower push cycle.
Cycle time	40 mins	During continuous operation, one tray carrying 340 kgs of charge enters and exits the plant every 40 minutes. So 1.5 trays are treated per hour delivering a total plant heat treatment capacity of 510 kgs/hour. This calculation is used as the basis of predicting capacity of this plant.
Nos. of Trays	HRS Trays have been supplied as follows: Annealing Plant: 7 nos. HN Grade HRS Trays	

Continuous Tempering Furnace

Hardening & Tempering - Pusher Type Specification		Description
No. of Trays	10	Furnace length is designed to accommodate 10 contiguous trays
Dimensions		
Furnace Inner usable area		[W X L X H] in mm: 1150 X 6430 X 600
(Approximate) External area		[W X L X H] in mm: 2050 X 7085 X 2425
Construction		
Refractory lining		Furnace Hearth will be lined with IS8 quality dense Refractories backed by Cold

	Face Insulation Refractories. The side walls will be lined with Ceramic Fibre Blankets. Roof will be lined with Ceramic Fibre Module Blocks.
Furnace doors	Doors are rise and fall type - pneumatically operated and counter balanced. Doors are lined with hot face insulation refractories.
Temperature	Operating between 480°C - 700°C; Maximum 700°C
Temp	± 8°C in soaking zone

Setting of Hardening Parameters

Hardening Temperature	:	1020 °C
Heating time	:	A thermocouple was inserted in the component to get Check min time to achieve the temp it was observed that after 55 min temperature was achieved in the Core of the component. No of
Soaking time	:	After checking heating time soaking time was given ½ Hour per inch of maximum size thickness with 15 min cycle 12*15=180 Min Soaking time = Total time - Heating time 125 Min
No of Trays in Furnace	:	12
Cycle time for Hardening	:	15 Min
Quenching Media	:	Air
Initial Quench Temperature	:	NA
Initial Load Temperature	:	1020 °C

Tempering Parameters

Tempering Temperature	:	280 °C
Cycle time	:	15 Minuets
Test Coupon	:	Test coupon of same heat no and of same thickness was heat treated with lot.
Cooling Parameter after tempering	:	Air

Results

Results are checked for Min and Maximum chemical composition and with one sample from Chemical

	Heat No		C	Mn	P	S	Si	Cr	Mo
Required		Min	0.95	--	--	--	--	16.0	--
		Max	1.20	1.00	0.040	0.030	1.00	18.0	0.75

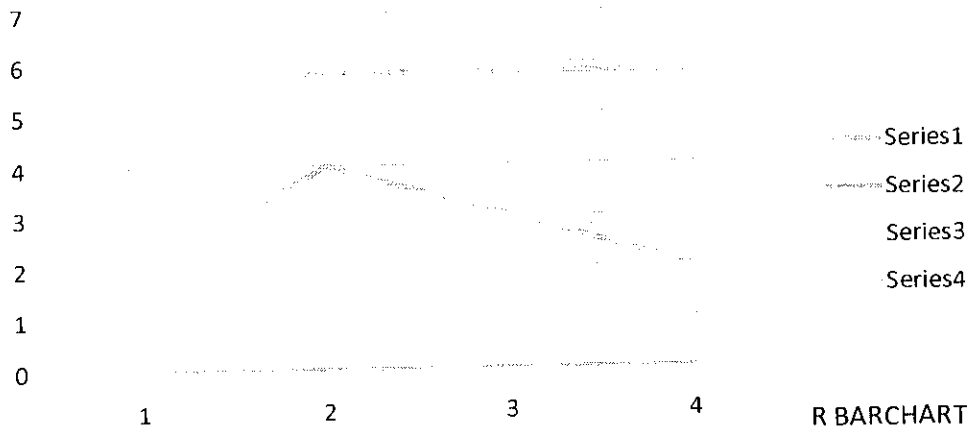
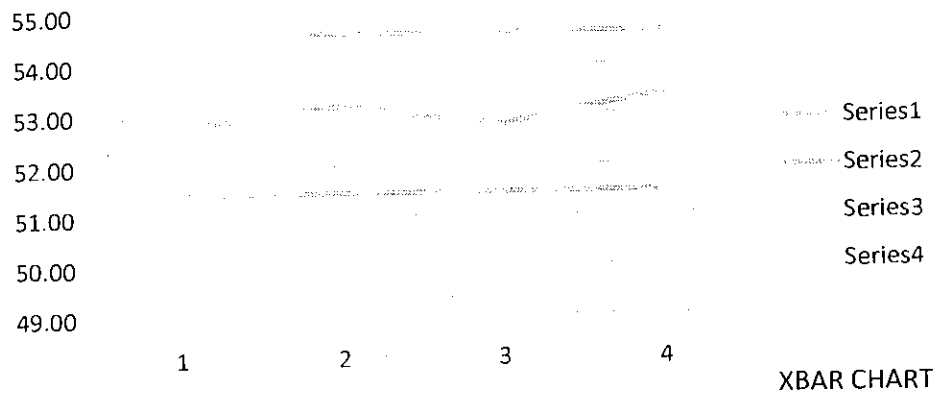
Component Chemical	5623J		0.98	0.48	0.024	0.021	0.34	16.08	0.77
--------------------	-------	--	------	------	-------	-------	------	-------	------

Mechanical Properties achieved with min chemical

	TS Mpa	YS Mpa	EL% Min	RA% Min	HARDNESS BHN	Result	Remarks
Required	1970 Min	1900 Min	2 Min	2 Min	50-55 HRC		
Achieved (Sample from QTC SNO S130) In House	1979.99	1928.00	3.13	4.25	53 HRC	OK	No significant difference in In house and third party reports
Achieved (Sample from Component SNO S131) Third Party	1990.00	1940.3	2.95	3.80	54HRC	OK	

Component hardness

A SPC x-bar chart and r-bar chart was prepared for 10 samples and items showing OK results



Sample	Obj1	Obj2	Obj3	Obj4	Obj5
1	52	54	52	54	52
2	53	55	51	55	52
3	53	54	53	53	51
4	52	54	54	54	53

Note :-The chart shows that process is controlled to achieve required hardness

Tempering Chart

Tempering Temperature °C	Hardness (HRC)
100	60-62
200	58-60
300	55-58
400	52-55
500	48-52
600	44-48

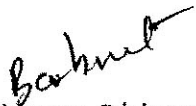
Microstructure

Summary:

Results of Mechanical, hardness and microstructure being within limits, as per reference Spec SES-26-721 Issue 'B' Rev 2, show that the set parameter of temperatures are OK.

Conclusion – The Heat treatment procedure specified in SES-26-721 Issue 'B' Rev 2 stands validated .

Dated: 8.06.2014


(Babneet Dhiman)
Engineer (HT)


(Nandan Dimri)
Engineer QC (SARA Corp Gp)

Sara Sae

Sara Sae Private Limited DIV-IV

Back Side Radha Sowami Satsang Ghar
Mahal Road Goraya -144409 Distt. Jalandhar (Punjab)

DOC NO: QC/F/04

REV:0

Work Order No : S134

Report No : 613A

Customer : Sara Sae Pvt. Ltd. DIV-II

A-2 Sara Industrial Estate, Chakrata Road, Chota Rampur Selaqui, Dehradun

Ref : Job Card No. 1676A

Description : Roter 1" Selector

Item Code : IR098

Heat No. 5623J

Test Method : ASTM A-370

Inspection Authority: Sara Sae Pvt. Ltd. DIV-IV Mechanical Test Report

Date of Testing: 08-06-2014

	ID MARK	Gauge Size in MM	Yield Load (N)	Tensile Load (N)	Yield Stress Mpa	Ultimate Tensile Stress Mpa	Elongation %	Reduction Area %	Hardness BHN / HRB
Requirement as per : SES 26-721					1900 Mpa Min	1970 Mpa Min	2% Min	2% Min	50-55 HRC
	S134	50.08	238985	245430	1928.00	1979.99	3.13	4.25	53 HRC

Test STD: ASTM A-370

Charpy V Notch Impact Test				Size: 10x10x55 MM CVN 2 MM Deep				At Temp.			
Code :				Value in Joules							
Direction				(I)	(II)	(III)	Average				
Required :											
Achieved :											

S No.	C %	Mn %	Si %	P %	S %	Cr %	V %	Mo %	Ni %	Cu %	Sn %	Al %	Ti %	Co %	Fe %	W %	B %	Others
5632J	0.98	0.48	0.34	0.024	0.021	16.08	-	0.77	-	-	-	-	-	-	-	-	-	-

Authorized Signatory
(Sub Incharge)

Remarks:-

Sara Sae

Sara Sae Private Limited DIV-IV

Back Side Radha Sowami Satsang Ghar
Mahal Road Goraya -144409 Distt. Jalandhar (Punjab)

DOC NO: QC/F/04

REV:0

Work Order No : S134

Report No : 613B

Customer : Sara Sae Pvt. Ltd. DIV-II

A-2 Sara Industrial Estate, Chakrata Road, Chota Rampur Selaqui, Dehradun

Ref : Job Card No. 1676A

Description : Roter 1" Selector

Item Code : IR098

Heat No. 5623J

Test Method : ASTM A-370

Date of Testing: 08-06-2014

Inspection Authority: Sara Sae Pvt. Ltd. DIV-IV Mechanical Test Report

ID MARK	Gauge Size in MM	Yield Load (N)	Tensile Load (N)	Yield Stress Mpa	Ultimate Tensile Stress Mpa	Elongation %	Reduction Area %	Hardness BHN / HRB
Requirement as per : SES 26-721								
S134	50.23	238217	244319	1900 Mpa Min 1940.30	1970 Mpa Min 1990.00	2% Min 2.95	2% Min 3.80	50-55 HRC 54 HRC

Test STD: ASTM A-370

Charpy V Notch Impact Test

Size: 10x10x55 MM CVN 2 MM Deep

At Temp.

Value in Joules		
(I)	(II)	(III)
Average		
Required :		
Achieved :		

S No.	C %	Mn %	Si %	P %	S %	Cr %	V %	Mo %	Ni %	Cu %	Sn %	Al %	Ti %	Co %	Fe %	W %	B %	Others
5632J	0.98	0.48	0.34	0.024	0.021	16.08	-	0.77	-	-	-	-	-	-	-	-	-	-

Authorized Signatory
(Lab Incharge)

Remarks:-

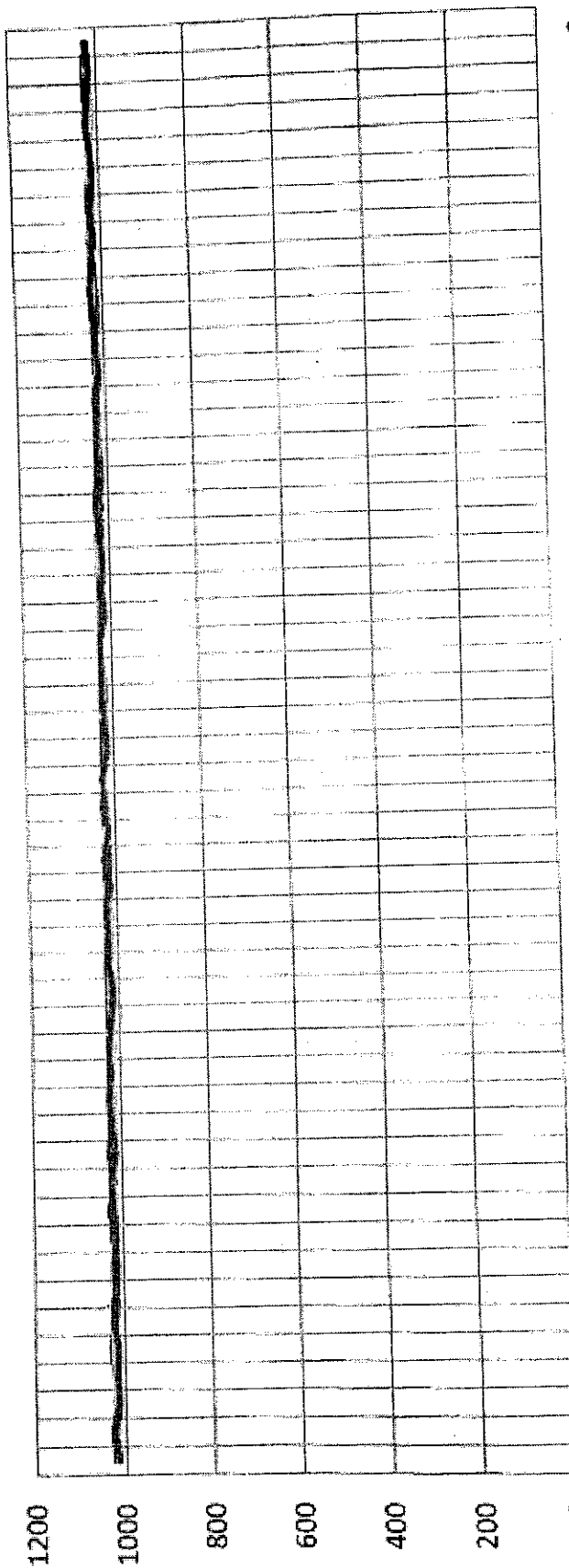
TEMPERATURE RECORD

SOLUTION ANNEALING PALNT : NORMALIZING FURNACE

Start time : 07/06/2014 10:00 AM Stop time : 07/06/2014 3:00 PM

Item HeatNo

LR098 5633J



— Z1PV1 — Z1SV1 — Z2PV — Z2SV

DT: 16.06.2014

Post validation of 440C

Target to set the following properties in component

Mechanical Properties	Range
Tensile Strength	1970 MPA Min
Yield Strength	1900 Mpa Min
Elongation	2% Min
Reduction in Area	2 % Min
Hardness	50-55 HRC

Microstructure

Tempered martensitic

Part / Component Detail

Material : AISI-440C

Drawing No. : 01-0242-4E

Material Description : Sear Seal Seat

Code : IS096

Heat No. : 6367A

Qty : 50 Pcs + QTC SI No S136

Item weight per piece : 0.008 Kg

HEAT TREATMENT VARIABLE

Heat Treatment Variable Possible Consideration

Composition Required as per SES 26-721 Issue 'B' Rev 2

	C	Mn	Si	P	S	Cr	Mo
MIN	0.95	--	--	--	--	16.0	--
MAX	1.20	1.00	1.00	0.040	0.030	18.0	0.75

Note:-Total Residual Elements not to exceed 1%

Section Size : As per Drawing 01-242-4E

Weight Max. Section Size : 0.008 kg

Prior Heat Treatment Surface Condition : Not applicable

After Heat Treatment Surface Condition : To be descaled after Heat treatment

Accepted.
7/1/10

HEAT TREATMENT AS PER SES 26-721 Issue 'B' Rev 2:

PROCESS	ATMOSPHERE/ MEDIA	TEMPERATURE	TIME AT TEMPERATURE
Hardening	Air	950 °C -1050 °C	1/2 hour per inch of minimum through Thickness.
Quenching	Oil	(38 °C) at the start of quench	50°C Max. at the completion of the quench
Tempering	Air	250 °C - 300 °C	Depending on the thickness .1/2 hour /inch thickness.

Heat Treatment Equipment

Continuous Solution annealing Furnace

Specification	Description	
Tray size in mm	Outer [W X L X H]: 1100 X 1100 X 360	Base Tray is designed to optimize structural strength while maintaining maximum open area. Tray should accommodate about 340 kgs of reference components.
Tray weight in kgs	258 kgs	Up to 340 kgs of components may be loaded per tray for 40 minute cycle to achieve the planned capacity of 500 kgs/hour. However, larger and heavier jobs can be fitted on the Tray by using a slower push cycle.
Load per tray	340 kgs	
Cycle time	40 mins	During continuous operation, one tray carrying 340 kgs of charge enters and exits the plant every 40 minutes. So 1.5 trays are treated per hour delivering a total plant heat treatment capacity of 510 kgs/hour. This calculation is used as the basis of predicting capacity of this plant.
Nos. of Trays	HRS Trays have been supplied as follows: Annealing Plant: 7 nos. HN Grade HRS Trays	

Continuous Tempering Furnace

Hardening & Tempering - Pusher Type Specification		Description
No. of Trays	10	Furnace length is designed to accommodate 10 contiguous trays
Dimensions		
Furnace Inner usable area		[W X L X H] in mm: 1150 X 6430 X 600
(Approximate) External area		[W X L X H] in mm: 2050 X 7085 X 2425
Construction		
Refractory lining		Furnace Hearth will be lined with IS8 quality dense Refractories backed by Cold

	Face Insulation Refractories. The side walls will be lined with Ceramic Fibre Blankets. Roof will be lined with Ceramic Fibre Module Blocks.
Furnace doors	Doors are rise and fall type - pneumatically operated and counter balanced. Doors are lined with hot face insulation refractories.
Temperature	Operating between 480°C - 700°C; Maximum 700°C
Temp	± 8°C in soaking zone

Setting of Hardening Parameters

Hardening Temperature	:	1020 °C
Heating time	:	A thermocouple was inserted in the component to get Check min time to achieve the temp it was observed that after 55 min temperature was achieved in the Core of the component. No of
Soaking time	:	After checking heating time soaking time was given ½ Hour per inch of maximum size thickness with 15 min cycle 12*15=180 Min Soaking time = Total time - Heating time 125 Min
No of Trays in Furnace	:	12
Cycle time for Hardening	:	15 Min
Quenching Media	:	Air
Initial Quench Temperature	:	NA
Initial Load Temperature	:	1020 °C

Tempering Parameters

Hardening Temperature	:	280 °C
Cycle time	:	15 Minuets
Test Coupon	:	Test coupon of same heat no and of same thickness was heat treated with lot.
Cooling Parameter after tempering	:	Air

Results

Results are checked for Min and Maximum chemical composition and with one sample from Chemical

	Heat No		C	Mn	P	S	Si	Cr	Mo
Required		Min	0.95	--	--	--	--	16.0	--
		Max	1.20	1.00	0.040	0.030	1.00	18.0	0.75

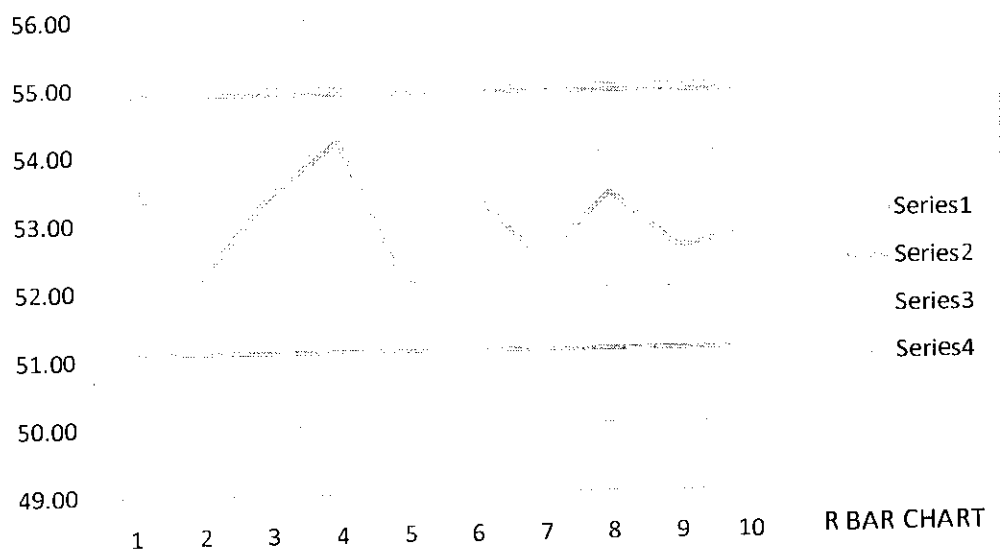
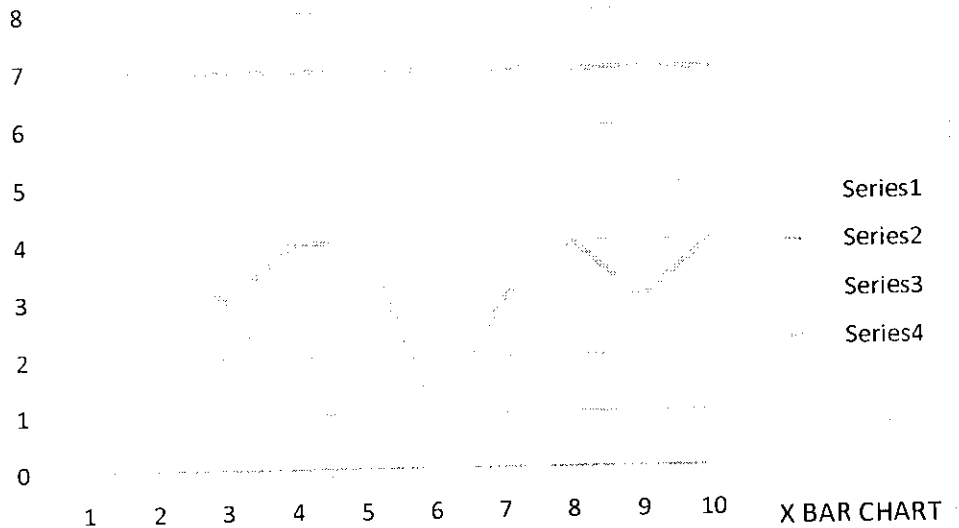
Component Chemical	6367A		0.98	0.52	0.025	0.018	0.19	16.20	0.78
--------------------	-------	--	------	------	-------	-------	------	-------	------

Mechanical Properties achieved with min chemical

	TS Mpa	YS Mpa	EL% Min	RA% Min	HARDNESS BHN	Result	Remarks
Required	1970 Min	1900 Min	2 Min	2 Min	50-55 HRC		
Achieved (Sample from QTC SNO S137) In House	1999.0	1940.0	3.15	3.97	53 HRC	OK	No significant difference in In house and third party reports
Achieved (Sample from Component SNO S138) Third Party	1986.5	1948.83	3.19	4.12	54HRC	OK	

Component hardness

A SPC x-bar chart and r-bar chart was prepared for 10 samples and items showing OK results



Sample	Obj1	Obj2	Obj3	Obj4	Obj5
1	52	53	55	54	54
2	51	55	51	52	52
3	55	55	53	52	52
4	51	55	55	55	55
5	55	51	51	52	51
6	54	54	53	53	53
7	54	51	54	52	51
8	53	53	55	55	51
9	53	54	54	51	51
10	55	52	51	55	51

Note :-The chart shows that process is controlled to achieve required hardness

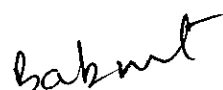
Microstructure : Confirmed Tempered Martensite

Summary:

Results of Mechanical, hardness and microstructure being within limits, as per reference Spec SES-26-721 Issue 'B' Rev 2, show that the set parameter of temperatures are OK.

Conclusion – The Heat treatment procedure specified in SES-26-721 Issue 'B' Rev 2 stands validated .

Dated: 16.06.2014


(Babneet Dhiman)
Engineer (HT)


(Nandan Dimri)
Engineer QC (SARA Corp Gp)

Sara Sae

Sara Sae Private Limited DIV-IV

Back Side Radha Sowami Satsang Ghar
Mahal Road Goraya -144409 Distt. Jalandhar (Punjab)

DOC NO: QC/F/04

REV:0

Work Order No : 5137

Report No : 617A

Customer : Sara Sae Pvt. Ltd. DIV-II

A-2 Sara Industrial Estate, Chakrata Road, Chota Rampur Selaqui, Dehradun

Ref : Job Card No. 1680A

Description : Sear Seal Seat

Item Code : IS096

Heat No. 6367A

Test Method : ASTM A-370

Date of Testing: 16-06-2014

Inspection Authority: Sara Sae Pvt. Ltd. DIV-IV

Mechanical Test Report

	ID MARK	Gauge Size in MM	Yield Load (N)	Tensile Load (N)	Yield Stress Mpa	Ultimate Tensile Stress Mpa	Elongation %	Reduction Area %	Hardness BHN / HRB
Requirement as per	SES 26-721				1900 Mpa Min	1970 Mpa Min	2% Min	2% Min	50-55 HRC
	5137	50.14	237419	244639	1940.00	1999.00	3.15	3.97	53 HRC

Test STD: ASTM A-370

At Temp.

Size: 10x10x55 MM CVN 2 MM Deep

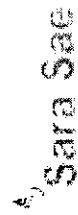
Charpy V Notch Impact Test

Code :	Value in Joules		
Direction	(I)	(II)	(III) Average
Required :			
Achieved :			

S No.	C %	Mn %	Si %	P %	S %	Cr %	V %	Mo %	Ni %	Cu %	Sn %	Al %	Ti %	Co %	Fe %	W %	B %	Others
6367A	0.98	0.52	0.19	0.025	0.018	16.2	-	0.78	-	-	-	-	-	-	-	-	-	

Authorised Signatory
(Lab Incharge)

Remarks:-



Sara Sae Private Limited DIV-IV

Back Side Radha Sowami Satsang Ghar
Mahal Road Goraya -144409 Distt. Jalandhar (Punjab)

DOC NO: QC/F/04

REV:0

Work Order No : S138

Report No : 617B

Customer : Sara Sae Pvt. Ltd. DIV-II

A-2 Sara Industrial Estate, Chakrata Road, Chota Rampur Selaqui, Dehradun

Ref : Job Card No. 1680A

Description : Sear Seal Seat

Item Code : IS096

Heat No. 6367A

Test Method : ASTM A-370

Inspection Authority: Sara Sae Pvt. Ltd. DIV-IV Mechanical Test Report

Date of Testing: 16-06-2014

	ID MARK	Gauge Size in MM	Yield Load (N)	Tensile Load (N)	Yield Stress Mpa	Ultimate Tensile Stress Mpa	Elongation %	Reduction Area %	Hardness BHN / HRB
Requirement as per :	SES 26-721				1900 Mpa Min	1970 Mpa Min	2% Min	2% Min	50-55 HRC
	S138	50.14	238500	243110	1948.83	1986.50	3.19	4.12	54 HRC

Test STD: ASTM A-370

Charpy V Notch Impact Test

Size: 10x10x55 MM CVN 2 MM Deep

At Temp.

Code :	Value in Joules		
Direction	(I)	(II)	(III) Average
Required :			
Achieved :			

S No.	C %	Mn %	Si %	P %	S %	Cr %	V %	Mo %	Ni %	Cu %	Sn %	Al %	Ti %	Co %	Fe %	W %	B %	Others
6367A	0.98	0.52	0.19	0.025	0.018	16.2	-	0.78	-	-	-	-	-	-	-	-	-	

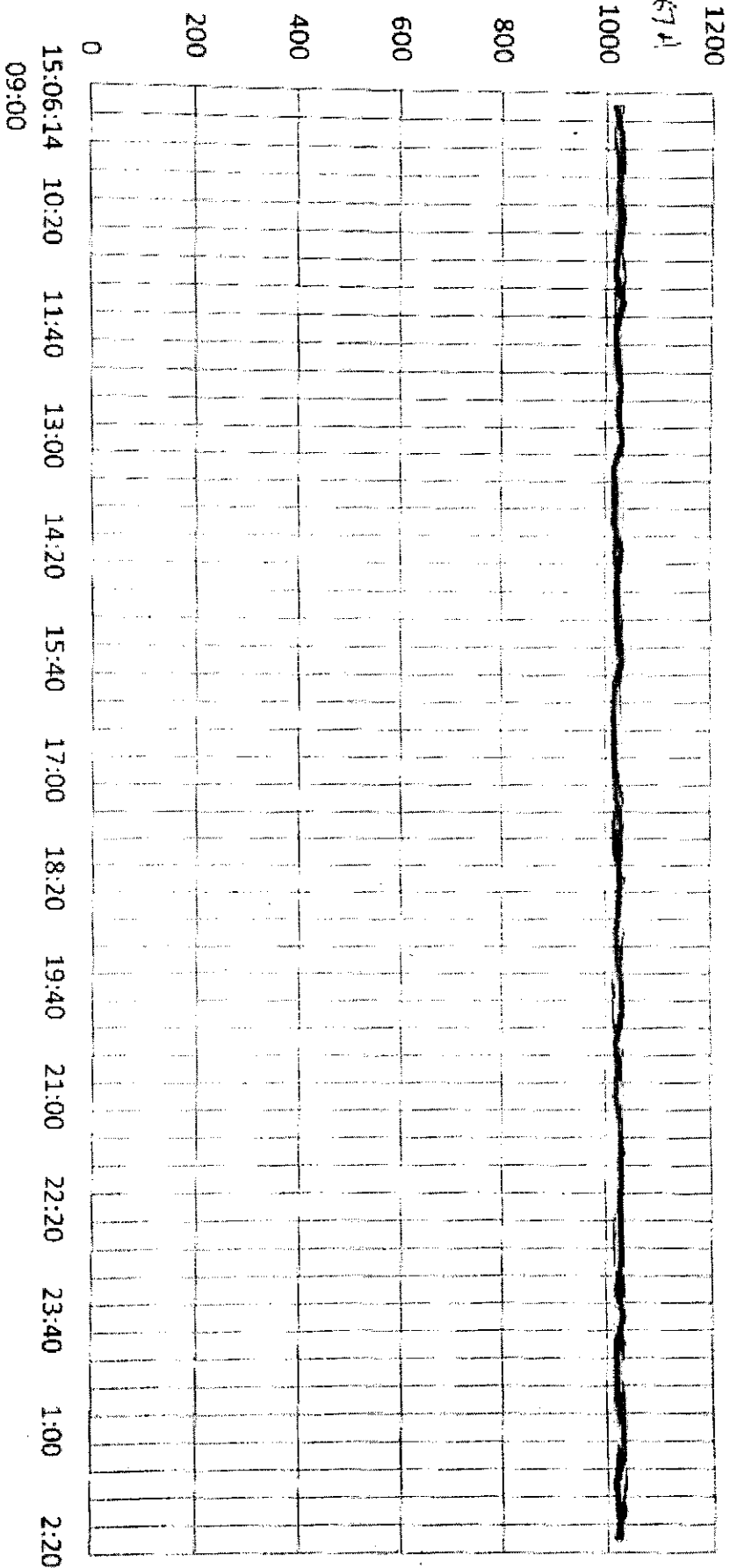
Authorised Signatory
(Lab In-charge)

Remarks:-

TEMPERATURE RECORD

SOLUTION ANNEALING PALNT : NORMALIZING FURNACE

Start time : 15/06/2014 9:00 AM Stop time : 15/06/2014 2:20 PM



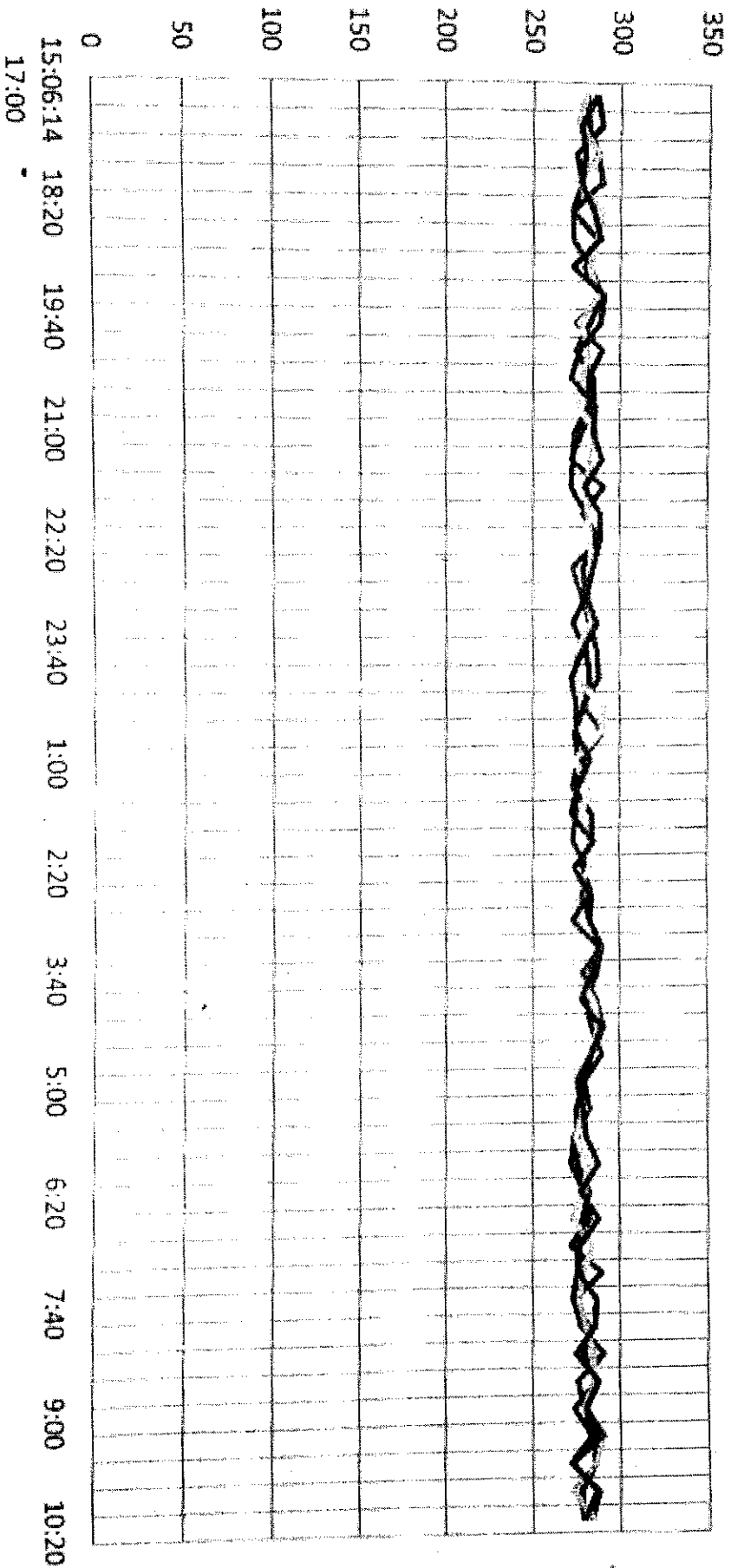
— Z1PV1 — Z1SV1 Z2PV — Z2SV

Heat No
Cool Heat No
IS096 63674

TEMPERATURE RECORD

CONTINUOUS PLANT : TEMPERING FURNACE

Start time : 15/06/2014 5:00 PM Stop time : 16/06/2014 10:20 PM



— Z1PV1 — Z1SV1 — Z2PV — Z2SV