

TD-106-1 Rev No. 5	Form No.	 HYDERABAD	PRODUCT STANDARD PUMPS HYDERABAD		FP50654 Rev No. 07 Page 1 of 5
COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED, It must not be used directly or indirectly in any way detrimental to the interest of the company. <u>FORGED BARS-ROUGH MACHINED, FOR PUMP SHAFTS</u> 1.0 <u>GENERAL</u> This standard specifies the quality requirements of rough machined forged bars intended for Pumps Shafts of BFP, BP & CEP in Super Critical Power Plants. 2.0 <u>CONDITION OF DELIVERY</u> 2.1 Forgings shall be supplied in rough machined condition with surface finish of 6.3 microns or better. 2.2 Forgings shall be hardened and tempered before rough machining. 2.3 Forgings shall be stress relieved after rough machining. 3.0 <u>REFERENCE STANDARDS</u> (for internal information only, not for manufacturer) International standards: JIS G4303 SUS403Q-HT & ASTM A276-S40300 MHI, Japan G.P. Spec no. GPS-0281-R5 4.0 <u>DIMENSIONS, TOLERANCES & HEAT TREATMENT</u> 4.1 <u>DIMENSIONS:</u> The forgings shall be supplied in rough machined condition as per the dimensions given in Variant Table. The minimum reduction ratio when forgings are made of ingots shall be 4:1 4.2 <u>TOLERANCES:</u> Tolerances on diameter shall be + 1.0 mm and on length $\pm$ 5.0 mm. Maximum permissible run out shall be 0.50 mm. 4.3 <u>HEAT TREATMENT:</u> <u>Hardening & Tempering:</u> Forgings shall be hardened and tempered before rough machining, to give the mechanical properties specified. Recommended temperatures are given below for guidance. The manufacturer may decide actual temperatures and HT charts shall be furnished. Test pieces shall also be heat treated along with the forgings they represent.					
Ref. Doc	Revisions : Refer to record of revisions :		Prepared : M.S.RAM	Approved : P.S	Date : 31.12.13



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COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company.		<u>Recommended temperatures for SUS403Q Hardened:</u> Hardening: 950-1000°C, Oil quenching Tempering: 610-650°C, Water cooling <u>Recommended temperatures for SUS403Q:</u> Hardening: 950-1000°C, Oil quenching Tempering: 700-750°C, Water cooling <u>Stress relieving:</u> The forgings shall be stress relieved after rough machining. Stress relieving temperature shall be within (-)20°C of tempering temperature with atmospheric radiation.															
		5.0 <u>FREEDOM FROM DEFECTS</u> Forgings shall be free from defects such as cracks, flakes, seams, segregation, harmful non-metallic inclusions and other defects, which may affect the utility of the forgings. Bars shall be free from internal and surface defects.															
		5.1 Inclusion rating per each melt and heat treatment batch as per ASTM: E45, 2 series for all types shall be acceptable.															
		5.2 Microstructure per each melt and heat treatment batch as per ASTM: E112, plate II. The grain size of 5 or better shall be acceptable															
		6.0 <u>CHEMICAL COMPOSITION</u> <table border="1"> <thead> <tr> <th>Carbon % max.</th> <th>Silicon % max.</th> <th>Manganese % max.</th> <th>Phosphorus % max.</th> <th>Sulphur % max.</th> <th>Chromium %</th> <th>Nickel % max.</th> </tr> </thead> <tbody> <tr> <td>0.15</td> <td>0.50</td> <td>1.00</td> <td>0.04</td> <td>0.03</td> <td>11.50 to 13.00</td> <td>0.60</td> </tr> </tbody> </table>				Carbon % max.	Silicon % max.	Manganese % max.	Phosphorus % max.	Sulphur % max.	Chromium %	Nickel % max.	0.15	0.50	1.00	0.04	0.03
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7.0 <u>MECHANICAL PROPERTIES</u> 7.1 <u>SUS403Q Hardened</u> <table border="1"> <thead> <tr> <th>Tensile strength N/mm² min.</th> <th>Yield stress N/mm² min.</th> <th>Elongation % Min.</th> <th>Charpy Impact (2mm U-notch) J/cm², min.</th> <th>Reduction of area % min.</th> <th>Hardness HB</th> </tr> </thead> <tbody> <tr> <td>740</td> <td>570</td> <td>15</td> <td>39</td> <td>45</td> <td>223-277</td> </tr> </tbody> </table>				Tensile strength N/mm ² min.	Yield stress N/mm ² min.	Elongation % Min.	Charpy Impact (2mm U-notch) J/cm ² , min.	Reduction of area % min.	Hardness HB	740	570	15	39	45	223-277		
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COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company.		8.0 <u>NON DESTRUCTIVE TESTS</u>		
		8.1 100% Ultrasonic examination shall be carried out after heat treatment and rough machining as per AA0850118 and <u>acceptance standard</u> AA0850102 category 2. Frequency shall be 2 MHz minimum and back wall echo shall be minimum 80%. <u>Additional acceptance criteria:</u> The reflected wave from the defects is less than 20% of the height of reflected wave from the bottom of a part without defects. And, the reflected wave from the bottom is more than 50% of the reflected wave from the bottom of a part without defects. The above shall be accepted.		
		8.2 100% magnetic particle examination shall be carried out after heat treatment and rough machining as per AA0850102 category 2.		
		9.0 <u>INSPECTION:</u> Forgings shall be supplied with inspection and certification by BHEL or BHEL nominated Third Party Inspection Agency (TPIA).		
		10.0 <u>TEST CERTIFICATES:</u> The supplier shall furnish 2 copies of following test certificates (in English) duly certified by the inspection agency. The test certificates shall consists of the information like BHEL order No, material specn, Var.no. Supplier's name, description of item etc. a) Dimension report. b) Chemical analysis. c) Mechanical properties. d) Heat treatment charts for Hardening, tempering and stress relieving. e) NDT reports for Ultrasonic and Magnetic Particle. The UT report shall cover both the acceptance criteria indicated in cl.no.8.1. f) Run-out record. g) Inclusion rating report. h) Microstructure report.		
		11.0 <u>MARKING:</u> The following details shall be punched on both end faces of each forging, leaving enough place for drilling center holes. Specn No: FP50654-VAR.No.XX & Dimension: ODxL Melt No: / Heat No: & Name of supplier		
Ref. Doc		12.0 <u>PRESERVATION & PACKING</u> The forgings shall be properly protected from damage and corrosion during transport. Machined surfaces shall be protected with anti-greasy, anti corrosive coating. Painting is not permitted.		



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13.0 REJECTION AND REPLACEMENT: The final decision regarding acceptance or rejection rests with BHEL, if the forging is not found as per specification or drawing at any time during further operation on the forging. The supplier shall replace the rejected forging at his own cost. 14.0 VARIANT TABLE: <table border="1"> <thead> <tr> <th>VAR. NO.</th> <th>DIA x L (mm x mm)</th> <th>MATERIAL</th> <th>APPRX. WT. (kg)</th> <th>PUMP TYPE</th> <th>MATL CODE</th> </tr> </thead> <tbody> <tr> <td>01</td> <td>Ø190 x 3250</td> <td>SUS403Q HARDENED</td> <td>723</td> <td>MDG455</td> <td>FP9550654010</td> </tr> <tr> <td>02</td> <td>Ø170 x 3100</td> <td>SUS403Q HARDENED</td> <td>552</td> <td>MDG405</td> <td>FP9550654028</td> </tr> <tr> <td>03</td> <td>Ø160 x 3050</td> <td>SUS403Q HARDENED</td> <td>482</td> <td>MDG366</td> <td>FP9550654036</td> </tr> <tr> <td>04</td> <td>Ø150 x 3000</td> <td>SUS403Q HARDENED</td> <td>416</td> <td>MDG346</td> <td>FP9550654044</td> </tr> <tr> <td>05</td> <td>Ø160 x 2360</td> <td>SUS403Q HARDENED</td> <td>373</td> <td>MLC450x350</td> <td>FP9550654052</td> </tr> <tr> <td>06</td> <td>Ø140 x 2080</td> <td>SUS403Q HARDENED</td> <td>252</td> <td>MLC400x300</td> <td>FP9550654060</td> </tr> <tr> <td>07</td> <td>Ø140 x 4260</td> <td>SUS403Q</td> <td>515</td> <td>144RND Upper & Lower</td> <td>FP9550654079</td> </tr> <tr> <td>08</td> <td>Ø180 x 3400</td> <td>SUS403Q HARDENED</td> <td>680</td> <td>MDG436</td> <td>FP9750654080</td> </tr> </tbody> </table>						VAR. NO.	DIA x L (mm x mm)	MATERIAL	APPRX. WT. (kg)	PUMP TYPE	MATL CODE	01	Ø190 x 3250	SUS403Q HARDENED	723	MDG455	FP9550654010	02	Ø170 x 3100	SUS403Q HARDENED	552	MDG405	FP9550654028	03	Ø160 x 3050	SUS403Q HARDENED	482	MDG366	FP9550654036	04	Ø150 x 3000	SUS403Q HARDENED	416	MDG346	FP9550654044	05	Ø160 x 2360	SUS403Q HARDENED	373	MLC450x350	FP9550654052	06	Ø140 x 2080	SUS403Q HARDENED	252	MLC400x300	FP9550654060	07	Ø140 x 4260	SUS403Q	515	144RND Upper & Lower	FP9550654079	08	Ø180 x 3400	SUS403Q HARDENED	680	MDG436	FP9750654080
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		Rev. No.	Date	Revision Details	Revised By	Approved By
		01	21.01.14	Chemical composition and mechanical properties revised, heat treatment cycles added as per MHI purchase specn GPS-0281-R5.	M.S.RAM	P.S
		02	20.02.15	Var.no.01 dimn 'L' & Wt. were 3200 & 712. Var.no.03 dimn 'L' & Wt. were 2900 & 482. Matl codes FP9750... corrected to FP9550....	M.S.RAM	P.S
		03	22.10.15	Cl.no. 2.0, 4.3 & Variant Table revised.	M.S.RAM	KHRK
		04	22.02.16	Cl.nos.4.3(stress relieving), 8.0&10.0 revised as per MHI comments.	M.S.RAM	KHRK
		05	19.04.17	HT temperatures and mechanical properties added for the two conditions of material. Variant table revised to indicate material condition for each variant. Length and wt. revised for Var.no.05,06&07.	M.S.RAM	KHRK
		06	30.06.17	Var.no.08 added. Cl.no.7.3 deleted since the requirement is indicated in property tables.	M.S.RAM	KHRK
		07	28.05.18	Clause 5.2 added. Sub clauses f, g, h added under clause 10.0.	ASK	MSR
		Ref. Doc.				

