





TD-201 Rev No. 00 Form No.	 HYDERABAD	PRODUCT STANDARD PROJECT ENGINEERING HYDERABAD		GT10263																															
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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>ACCEPTANCE REQUIREMENTS – LARGE BORE TURBINE WHEEL SPACER AND COMPRESSOR WHEEL FORGINGS</u>																																	
		1. <u>SCOPE</u>																																	
		1.1 This specification provides the Engineering Requirements for Gas Turbine, turbine spacer and compressor wheel large bored forgings. It supplements the general requirements for rotating forgings that are specified in process specification GT10047 and it must be used with GT10047 and the material specification called for on the respective forging drawing.																																	
		1.2 This specification is applicable to, and limited to, the following forgings identified by Part Identity and material specification as follows:																																	
		<table border="1"> <thead> <tr> <th></th> <th>Identity</th> <th>Material Specification</th> </tr> </thead> <tbody> <tr> <td rowspan="2">MS6001</td> <td>1/2 Stage Spacer</td> <td>HY19467 A</td> </tr> <tr> <td>2/3 Stage Spacer</td> <td>HY19467 A</td> </tr> <tr> <td rowspan="2">MS7001</td> <td>1/2 Stage Spacer</td> <td>HY19467 A</td> </tr> <tr> <td>2/3 Stage Spacer</td> <td>HY19467 A</td> </tr> <tr> <td>MS7001F</td> <td>15th Stage Compressor Wheel</td> <td>HY19467 A</td> </tr> <tr> <td>MS7001FA</td> <td>15th Stage Compressor Wheel</td> <td>HY19467 A</td> </tr> <tr> <td rowspan="2">MS9001</td> <td>1/2 Stage Spacer</td> <td>HY19467 A</td> </tr> <tr> <td>2/3 Stage Spacer</td> <td>HY19467 A</td> </tr> <tr> <td>MS9001F</td> <td>15th Stage Compressor Wheel</td> <td>HY19467 A</td> </tr> <tr> <td>MS9001FA</td> <td>15th Stage Compressor Wheel</td> <td>HY19467 A</td> </tr> </tbody> </table>					Identity	Material Specification	MS6001	1/2 Stage Spacer	HY19467 A	2/3 Stage Spacer	HY19467 A	MS7001	1/2 Stage Spacer	HY19467 A	2/3 Stage Spacer	HY19467 A	MS7001F	15th Stage Compressor Wheel	HY19467 A	MS7001FA	15th Stage Compressor Wheel	HY19467 A	MS9001	1/2 Stage Spacer	HY19467 A	2/3 Stage Spacer	HY19467 A	MS9001F	15th Stage Compressor Wheel	HY19467 A	MS9001FA	15th Stage Compressor Wheel	HY19467 A
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1.3 Parts other than those specifically set forth above (Ref. Para. 1.2) which are ordered to the requirements of this specification should be referred promptly through BHEL Engineering, for clarification/resolution.																																			
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Ref. Doc.	P29A-AG213	Revisions :		Prepared :	Checked :																														
		Refer to record of revisions :		Shridhar Tripathi	Sathpal Reddy	Approved : Kamaldeep Gupta																													
				Date : 11.12.2019																															





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<div style="display: flex; justify-content: space-between;"> <div style="width: 15%;"> <p style="text-align: center;">COPYRIGHT AND CONFIDENTIAL</p> <p style="font-size: small;">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.</p> </div> <div style="width: 85%;"> <p>2. <u>APPLICABLE DOCUMENTS</u></p> <p>2.1 The following documents shall form an integral part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue shall apply.</p> <p>2.1.1 <u>Bharat Heavy Electricals Limited</u></p> <table border="0"> <tr> <td style="padding-right: 20px;">HY19467</td> <td>Chromium-Molybdenum-Vanadium Alloy Steel Forgings</td> </tr> <tr> <td>GT10146</td> <td>Magnetic Particle Test - General</td> </tr> <tr> <td>GT10047</td> <td>Rotor Forgings - General</td> </tr> <tr> <td>GT10185</td> <td>Turbine Wheels & Spacers, Etching</td> </tr> <tr> <td>GT10186</td> <td>Spin Testing - Gas Turbine Rotor Components</td> </tr> <tr> <td>GT10184</td> <td>Ultrasonic Testing of Low Alloy Gas Turbine Forgings</td> </tr> <tr> <td>P14A-AL-0217</td> <td>Forging Sonic Shape & Machining Requirements for 100% Ultrasonic Inspection Coverage</td> </tr> </table> <p>2.1.2 <u>American Society for Testing & Materials</u></p> <table border="0"> <tr> <td style="padding-right: 20px;">ASTM E45</td> <td>Standard Test Method for Determining the Inclusion Content of Steel</td> </tr> <tr> <td>ASTM E112</td> <td>Standard Test Methods for Determining Average Grain Size</td> </tr> </table> <p>3. <u>DEFINITIONS</u></p> <p>3.1 The definitions contained in process specification GT10047 , Section 3 apply to this specification.</p> <p>4. <u>ENGINEERING REQUIREMENTS</u></p> <p>4.1 <u>Forging Supplier - Process Qualification</u></p> <p>4.1.1 The Forging Supplier shall provide for each type of part the following information for B.H.E.L. review and approval:</p> </div> </div>				HY19467	Chromium-Molybdenum-Vanadium Alloy Steel Forgings	GT10146	Magnetic Particle Test - General	GT10047	Rotor Forgings - General	GT10185	Turbine Wheels & Spacers, Etching	GT10186	Spin Testing - Gas Turbine Rotor Components	GT10184	Ultrasonic Testing of Low Alloy Gas Turbine Forgings	P14A-AL-0217	Forging Sonic Shape & Machining Requirements for 100% Ultrasonic Inspection Coverage	ASTM E45	Standard Test Method for Determining the Inclusion Content of Steel	ASTM E112	Standard Test Methods for Determining Average Grain Size
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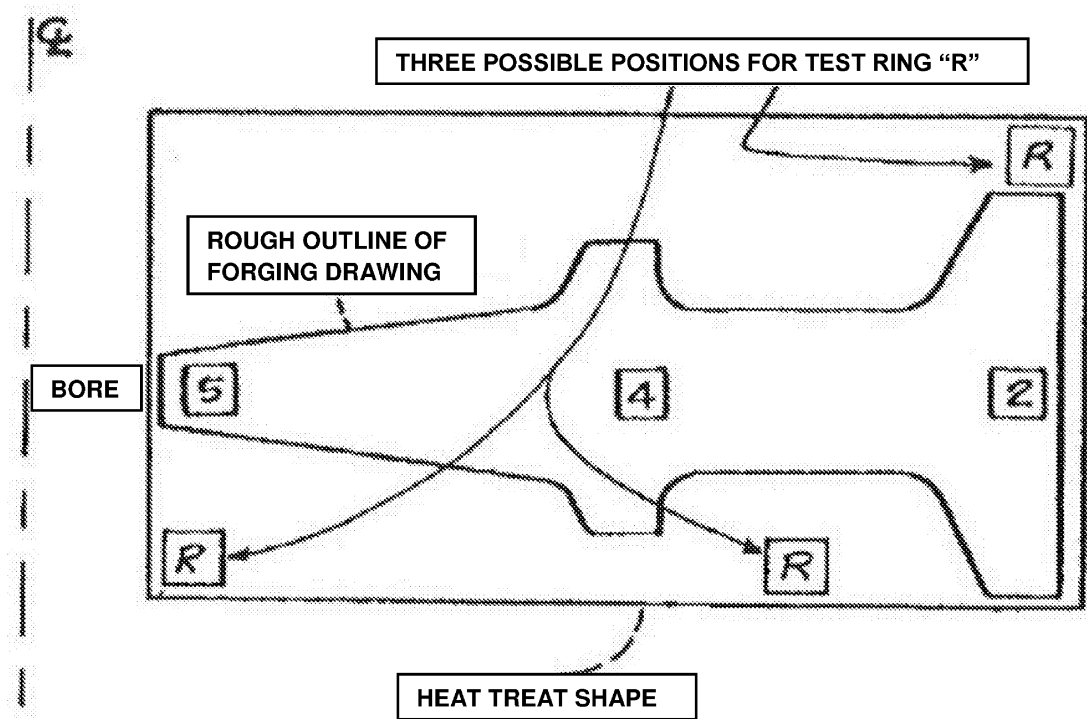



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COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company.		<ul style="list-style-type: none"> - detailed processing plan - dimensional drawing showing the configuration during heat treatment - production test specimen locations and orientations in forging - type of test at each location. <p>4.1.2 A first piece qualification (FPQ) forging shall be required of a new supplier, a new plant of a current supplier, or when there is a significant change in the shape, the composition or the processing of the forging. This FPQ generally requires the destructive sectioning and evaluation of the forging; however, when the forging's configuration permits the deep seated characteristics to be measured with prolongations or trepans, B.H.E.L. can select alternative evaluation methods. When the forging supplier has made similar parts for B.H.E.L. or other B.H.E.L. departments, or Manufacturing Associates that have similar requirements, then Materials & Processes Engineering, Design Engineering and Quality Assurance representatives will review the results. Materials & Processes Engineering will then decide whether or not a qualification forging is required and if a destructive cut-up qualification is needed. The FPQ shall, as a minimum, include the following:</p> <p>4.1.2.1 Figure 1 is a sketch showing the qualification mechanical properties test locations for a typical part.</p> <p>4.1.2.2 The precise location of each test specimen in relation to the heat treat envelope shall be recorded. Table I further identifies the tests required.</p> <p>4.1.2.3 <u>Ultrasonic Examination</u> - The interior quality of the forging must be evaluated after the forging supplier has machined forging to Sonic Shape per P14A-AL-0217 requirements. Axial and radial ultrasonic inspections must be performed on all accessible surfaces per Specification GT10184 and GT10047 .</p> <p>4.1.2.4 <u>Macro Cross-Section</u> - When a complete cut-up destructive qualification procedure is specified, an axial-radial cross-section of the qualification forgings shall be etched and photographs shall be taken to reveal grain flow and chemical segregation (Figure 1). Etch in accordance to Process Specification GT10185 .</p>	
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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.		<p>4.1.2.5 <u>Hardness Survey</u> - When a complete cut-up destructive qualification procedure is specified, a hardness survey shall be made on the face of the axial-radial cross-section cut, and there must be a sufficient number of test positions to accurately reflect hardness; therefore tensile strength uniformity. In addition, a circumferential hardness survey must be performed per Para. 4.2.2.3.</p> <p>4.1.2.6 The microstructure and the grain size shall be determined for a sample obtained from all of the specified Qualification Forging testing locations, Table I and Figure 1. The grain size shall be determined per specification ASTM E112 and the cleanliness rating per specification ASTM E45. The microphotographs shall be at 100X after etching with a 2 percent Nital solution. All metallographic examination results must meet the requirements of the appropriate material specification and they shall be contained in the Qualification Program Report.</p> <p>4.1.2.7 <u>Production/Part Chemical Composition</u> - The chemical composition must be determined for the bore location and carbon check analyses for all of the other testing locations. All results shall be contained in the Qualification Program Report.</p> <p>4.1.3 In order for the Forging Supplier to achieve qualification status for a specific forging, capability must be demonstrated for the consistent development of all BHEL required mechanical properties and material qualities. Important for the proof of capability is the production of a forging that exhibits the properties and qualities that are expected with the applied processing operations. A part of this expectation is the development of characteristics that are similar to those that are developed in the same or similar forgings produced by other current forging suppliers. It follows that simply producing a forging that just meets the minimum requirements does not earn a supplier qualification status.</p> <p>After a forging supplier achieves qualification status, this status might be extended to apply to other forgings that present the same or lesser degrees of difficulty during manufacture. Decisions regarding the expansion of qualification status to forgings will be made by Materials & Processes Engineering.</p> <p>Production status, i.e. the authority to proceed with production forgings, shall be given by B.H.E.L.</p>	Ref. Doc.	P29A-AG213

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<div>COPYRIGHT AND CONFIDENTIAL</div> <div>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.</div>		<div>FIGURE 1 – TEST SPECIMEN LAYOUT FOR MECHANICAL PROPERTIES TESTING</div> <div>HY19467A FORGINGS</div> <div></div>				
		<div>NOTES FOR FIGURE 1:</div> <div><div>(1) <u>Specimens #2, #4, #5</u> - The test specimen centers must be located at the forging's mid height or thickness. In addition, Specimen #2 is to be located 1.25" to 1.50" below the as-heat treated outer diameter; Specimen #4 located at the forging's mid radius and Specimen #5 located 0.50" to 0.75" from the bore surface.</div><div>(2) <u>Test Ring (R)</u> - Charpy V Notch (CVN) test specimens must be positioned 0.50" to 0.75" below the adjacent as-heat treated surface or surfaces. Stress rupture test specimens must be positioned 1.0" to 1.25" below the adjacent as-heat treated surface or surfaces. The different test specimen locations shall be obtained by removing an "R" test ring with adequate dimensions or two different "R" test rings.</div></div>				
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TABLE I - REQUIRED MECHANICAL PROPERTIES TESTING (1)

A. Qualification Mechanical Properties Requirements

Test Ring Location	RT Tensile	Charpy V-Notch Impact @ 0°F	CVN FATT (°F) (2)	Stress Rupture (3) (5) (1100°F & 35 ksi)
Ring (R)	2X	1X	1X	1X
2	1X	1X	1X	1X
4	1X	1X	1X	-
5	1X	1X	1X	-

B. Production Mechanical Properties Requirements


Test Ring Location	RT Tensile	Charpy V-Notch Impact @ 0°F	CVN FATT (°F) (2)	Stress Rupture (3) (5) (1100°F & 35 ksi)
Ring (R)	1X at 0°F 1X at 18 0°F	2X	2X	1X

NOTES FOR TABLE I:

- (1) All specimens must be in the tangential or circumferential direction. The Charpy V-notch specimens must have the root of the notch parallel with the centerline of the forging and the notch opening facing the bore.
- (2) The FATT must be estimated from a minimum of four specimens tested at four different temperatures. One of these temperatures must be 0°F. The test temperatures must be selected in a manner that will result in high probability that two test temperatures are above the FATT at 50 percent and two test temperatures are below.
- (3) Combination smooth-notch tangential rupture test specimen.
- (4) Hardness testing is required for all qualification and production HY19467A forgings and it must respectively be performed per Paras. 4.1.2.5 and/or 4.2.2.3.
- (5) Stress rupture test required only for turbine spacer forgings.

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