



TD-106. - 2 Rev. No. : 00 Form No. :		<b>PRODUCT STANDARD</b> <b>HYDERABAD</b> <b>GT ENGINEERING</b>		Prod. Std. No. : GT10262																	
				Rev. No.01																	
				Page : 1 of 10																	
<div style="display: flex;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg); padding: 5px;"> <b>COPYRIGHT AND CONFIDENTIAL</b>          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 style="flex-grow: 1; padding: 10px;"> <p><b><u>ACCEPTANCE REQUIREMENTS - GAS TURBINE - TURBINE WHEEL FORGINGS</u></b></p> <p><b>1. <u>SCOPE</u></b></p> <p>1.1. This specification provides the engineering requirements for Gas Turbine wheel 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.</p> <p>1.2. This specification is applicable to, and limited to, the following turbine wheel forgings as follows:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">IDENTITY</th> <th style="text-align: left;">MATERIAL SPECIFICATION</th> </tr> </thead> <tbody> <tr> <td><del>MS3002 - Stages 1 &amp; 2</del></td> <td><del>HY19464, &amp; HY19467</del></td> </tr> <tr> <td>MS5001 - Stage 1</td> <td>HY19467</td> </tr> <tr> <td>Stage 2</td> <td>HY19467</td> </tr> <tr> <td><del>MS5002 - Stages 1 &amp; 2</del></td> <td><del>B50A565A</del></td> </tr> <tr> <td>MS6001 - Stages 1, 2 &amp; 3</td> <td>HY19467</td> </tr> <tr> <td>MS7001 - Stages 1, 2, &amp; 3</td> <td>HY19467</td> </tr> <tr> <td>MS9001 - Stages 1, 2 &amp; 3</td> <td>HY19467</td> </tr> </tbody> </table> <p>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 Sourcing to BHEL GT Engineering, for clarification/resolution.</p> <p>1.4. Unless otherwise specified, the requirements of this specification are applicable to all materials (Ref. Para. 1.2).</p> </div> </div>						IDENTITY	MATERIAL SPECIFICATION	<del>MS3002 - Stages 1 &amp; 2</del>	<del>HY19464, &amp; HY19467</del>	MS5001 - Stage 1	HY19467	Stage 2	HY19467	<del>MS5002 - Stages 1 &amp; 2</del>	<del>B50A565A</del>	MS6001 - Stages 1, 2 & 3	HY19467	MS7001 - Stages 1, 2, & 3	HY19467	MS9001 - Stages 1, 2 & 3	HY19467
IDENTITY	MATERIAL SPECIFICATION																				
<del>MS3002 - Stages 1 &amp; 2</del>	<del>HY19464, &amp; HY19467</del>																				
MS5001 - Stage 1	HY19467																				
Stage 2	HY19467																				
<del>MS5002 - Stages 1 &amp; 2</del>	<del>B50A565A</del>																				
MS6001 - Stages 1, 2 & 3	HY19467																				
MS7001 - Stages 1, 2, & 3	HY19467																				
MS9001 - Stages 1, 2 & 3	HY19467																				
Ref. Doc P29A-AG212 REV-'N'	<b>Revisions:</b> Refer to Record of Revisions	<b>Prepared by:</b> SS RAO	<b>Approved by:</b> KRMR	<b>Date:</b> 16.06.1995																	

TD-106. - 2 Rev. No. : 00 Form No. :		<p align="center"><b>PRODUCT STANDARD</b></p> <p align="center"><b>HYDERABAD</b></p> <p align="center"><b>GT ENGINEERING</b></p>	<b>Prod. Std. No. : GT10262</b>
			Rev. No.01
			Page : 2 of 10

**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.

**2. APPLICABLE DOCUMENTS**

2.1. The documents contained in process specification GT10047, Section 2, apply to this specification.

**3. DEFINITIONS**

3.1. The definitions contained in process specification GT10047 Section 3 apply to this specification.

**4. ENGINEERING REQUIREMENTS**


4.1. Forging Supplier-Process Qualification


4.1.1. The first step for a Supplier to achieve the status of Qualified Supplier for a given class/type of gas turbine rotor forgings is the successful production and evaluation of a First Piece Qualification forging. The 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, BHEL can select alternative evaluation methods.

When the forging supplier has made similar parts for BHEL that have similar requirements, then Materials & Processes Engineering will review the results and will decide whether or not a qualification forging is required and if a destructive cut-up qualification is needed.

4.2. 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, BHEL can select alternative evaluation methods. When the forging supplier has made similar parts for BHEL or other BHEL departments, or Manufacturing Associates that have similar requirements, then Materials & Processes Engineering will review the results and will decide whether or not a qualification forging is required and if a destructive cut-up qualification is needed.

Ref. Doc	P29A-AG212 REV-'N'
----------	-----------------------

TD-106. - 2 Rev. No. : 00	Form No. : 	<b>PRODUCT STANDARD</b> <b>HYDERABAD</b> <b>GT ENGINEERING</b>	<b>Prod. Std. No. : GT10262</b> Rev. No.01 Page : 3 of 10
<b>COPYRIGHT AND CONFIDENTIAL</b> 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>4.2.1. <u>Mechanical Properties</u> - Figure 1 is a sketch of a typical part showing test locations for the qualification of mechanical properties capability.</p> <p>4.2.1.1. The precise location of each test specimen in relation to the heat treat envelope shall be recorded. Table I - Part A further identifies the tests required.</p> <p>4.2.2. <u>Ultrasonic Examination</u> - The interior quality of the forging must be evaluated after the forging supplier has machined the forging to Sonic Shape per GT11162 requirements. Axial and radial examinations must be performed on all accessible surfaces per specifications GT10184 and GT10047.</p> <p>4.2.3. <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> <p>4.2.4. <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; and therefore tensile strength uniformity. In addition, a surface hardness survey must be performed per Para. 4.3.2.3.</p> <p>4.2.5. 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 I. 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>4.2.6. <u>Forging 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>4.3. <u>Forging Supplier Production Wheels</u></p> <p>4.3.1. <u>Manufacture</u></p> <p>The maximum number of forgings in a furnace heat treatment batch will depend on the Supplier's austenitizing and/or tempering furnaces. This information and the typical positioning of the compressor wheel forgings in the different furnaces must be submitted in the appropriate Supplier Manufacturing Process Plan (MPP), or must be documented in a Supplier's standard Manufacturing Practices Instruction.</p>	
Ref. Doc P29A-AG212 REV-'N'			

TD-106. - 2 Rev. No. : 00 Form No. :		<h2 style="text-align: center;">PRODUCT STANDARD</h2> <h3 style="text-align: center;">HYDERABAD GT ENGINEERING</h3>	<b>Prod. Std. No. : GT10262</b> Rev. No.01 Page : 4 of 10	
<p style="text-align: center;"><b>COPYRIGHT AND CONFIDENTIAL</b></p> <p>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>			<p>Additional information to be reported in the MPP or contained in the standard Manufacturing Practices Instruction is the method of positioning each forging or a number of forgings in the water tank during the quenching operation.</p> <p><b>4.3.2. <u>Testing and Evaluation</u></b></p> <p>4.3.2.1. Test specimens must be obtained per Figure 1 from the bore and rim test positions in each forging. Table I - Part B lists the required mechanical properties that must be determined and be reported in the Forging Supplier Certificate of Test.</p> <p>4.3.2.1.1. Rim testing requirements may be waived if approved by BHEL GT Engineering and documented in the MPP.</p> <p>4.3.2.2. <u>BHEL Test Material</u> - The test rings shall be retained by the Supplier in accordance with GT10047.</p> <p>4.3.2.3. A Brinell hardness test survey must be made on each forging and the results reported in the Forging Supplier Certificate of Test. All forgings must be tested near the bore surface on both faces at locations 180 degrees apart (total of four tests) and also near the rim on one surface at locations 60 degrees apart (total of six tests).</p> <p>4.3.2.4. <u>Ultrasonic Examination</u> - The interior quality of the forging must be evaluated after the Forging Supplier has machined forging to Sonic Shape per GT11162 requirements. Axial and radial ultrasonic inspections must be performed on all accessible surfaces per specification GT10184 and GT10047.</p> <p>4.3.2.5. The microstructure and the grain size shall be determined from a specimen from the bore test location, and they shall meet the requirements of the appropriate material specification. The grain size as determined per ASTM E112 shall be reported. Photomicrographs shall be contained in the Certificate of Test to document any unusual features that are observed during the metallographic examination.</p> <p>4.3.2.6. The mechanical properties, hardness values and all other quality attributes measured must meet the requirements of the applicable material specification.</p>	
			Ref. Doc P29A-AG212 REV-'N'	

**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.

## 5. BHEL QUALITY ASSURANCE TESTING

- 5.1. Magnetic Particle Inspection - All accessible surfaces of the forging shall be magnetic particle inspected in the finish machined state. If the wheel is spin tested, it shall be magnetic particle inspected after spin testing. The magnetic particle inspection shall be per specification GT10146.
- 5.2. Ultrasonic Inspection - All accessible surfaces of the forging shall be ultrasonic inspected in the Sonic Shape configuration per GT11162 and required are axial and radial examinations per Specification GT10184.  
  
 Forgings that are spin tested must be again ultrasonic examined after all spin tests are completed. Required is an axial ultrasonic examination of the bore region which is defined as from the bore surface and outward radially for a distance of 6 inches.
- 5.3. An approved audit program will be used to Brinell Hardness test wheel forgings (Periphery - 4 places - 90 degrees apart on one surface). This audit program shall be the responsibility of BHEL.
- 5.4. Spin Testing - All turbine wheels, that require a spin test, shall be spin tested per Process Specification GT10186 or per specific Design Engineering instructions that shall supersede GT10186.
- 5.5. Supplemental Material Acceptance Testing - BHEL has the right to make any additional non-destructive tests, chemical analyses or mechanical properties tests that are considered necessary to demonstrate that the forging meets the requirements of this specification and the needs of the intended compressor wheel application. Forgings failing these tests will be the responsibility of the forging supplier.

## 6. NOTES

- 6.1. The Forging Supplier is responsible for conducting all tests under Section 4.
- 6.2. BHEL is responsible for conducting all tests under Section 5.

**RESTRICTED USE**



**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.

Ref. Doc  
 P29A-AG212  
 REV-'N'

**TABLE I**  
**REQUIRED MECHANICAL PROPERTIES TESTING <sup>(1)(7)</sup>**  
**HY19467, HY19464 MATERIAL SPECIFICATIONS**  
**(REFER TO FIGURE #1)**

A. Qualification Wheel Mechanical Properties Requirements


Test Ring Location	RT	CVN Energy <sup>(5)</sup>		CVN <sup>(2)(5)</sup>	Stress
	Tensile (KSI)	@ RT (ft. lbs)	@ 0°F (ft. lbs)	FATT (°F)	Rupture (3)
R Ring	2X <sup>(4)</sup>	1X	1X	1X	1X
B Ring	2X <sup>(4)</sup>	1X	1X	1X	--
#2	1X	1X	1X	1X	1X
#3	1X	1X	1X	--	--
#4	1X	1X	1X	1X	--
#5	1X	1X	1X	1X	--
#6	1X	1X	1X	--	--
#7	1X	1X	1X	--	--
#8	1X	1X	1X	--	--
#9 Core Bar	1X <sup>(6)</sup>	--	--	--	--
#10 Core Bar	1X <sup>(6)</sup>	--	--	--	--

B. Production Wheel Mechanical Properties Requirements

Test Ring Location	RT	CVN Energy <sup>(5)</sup>		CVN <sup>(2)(5)</sup>	Stress
	Tensile (KSI)	@ RT (ft. lbs)	@ 0°F (ft. lbs)	FATT (°F)	Rupture (3)
B Ring	2X <sup>(4)</sup>	1X	1X	1X	1X
#9 Core Bar	1X <sup>(6)</sup>	--	--	--	--
#10 Core Bar	1X <sup>(6)</sup>	--	--	--	--

RESTRICTED USE





TD-106. - 2 Rev. No. : 00	Form No. : 	<b>PRODUCT STANDARD</b> <b>HYDERABAD</b> <b>GT ENGINEERING</b>	<b>Prod. Std. No. : GT10262</b>
			Rev. No.01
			Page : 7 of 10
<b>COPYRIGHT AND CONFIDENTIAL</b> 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.		<b>NOTES FOR TABLE I:</b>  (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. Core bar HY19464 tensile specimens may be in longitudinal direction.  (2). The FATT must be estimated from a minimum of four specimens tested at different temperatures. Two of these test temperatures must be 0°F and room temperature. The test temperature must be selected in a manner that will result in a 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. Required only for HY19467 and HY19464 materials.  (4). Test specimens are to be located 180 degrees apart.  (5). Tests not required for HY19464 turbine wheels.  (6). Tests only required for HY19464 turbine wheels.  (7). Hardness testing is required for qualification and production forgings and it must respectively be performed per Paras. 4.2.4 and 4.3.2.3.	
		Ref. Doc P29A-AG212 REV-'N'	







TD-106. - 2 Rev. No. : 00	Form No. : 	<b>PRODUCT STANDARD</b> <b>HYDERABAD</b> <b>GT ENGINEERING</b>	<b>Prod. Std. No. : GT10262</b>	
			Rev. No.01	
			Page : 9 of 10	
<b>COPYRIGHT AND CONFIDENTIAL</b> 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). <u>Specimens #2, #4, #5 and #10</u> - The test specimen centers must be located at the forging's mid height or thickness. In addition, Specimen #4 must also be located at the forging's mid radius.</p> <p>(5). <u>Specimens #6 and #7</u> - The test specimen centers must be located .5" to .75" below the as-heat treated radial-circumferential surface and also at the mid radius of the forging.</p> <p>(6). <u>Specimens #5 and #8</u> - The test specimen centers must be located .5" to .75" below the bore surface and .5" to .75" below the respective radial-circumferential surface, for Specimen #8.</p> <p>(7). <u>Specimens #9 and #10</u> - These are core bar test specimens and are only made from HY19464 material.</p>	
			Ref. Doc P29A-AG212 REV-'N'	

TD-106. - 2 Rev. No. : 00	Form No. : 	<b>PRODUCT STANDARD</b> <b>HYDERABAD</b> <b>GT ENGINEERING</b>			<b>Prod. Std. No. : GT10262</b> Rev. No.01 Page : 10 of 10																																																																																					
<b><u>RECORD OF REVISIONS</u></b>																																																																																										
<table border="1"><thead><tr><th data-bbox="220 443 363 607">Rev. No.</th><th data-bbox="363 443 579 607">Date</th><th data-bbox="579 443 1035 607">Revision Details</th><th data-bbox="1035 443 1270 607">Revised By</th><th data-bbox="1270 443 1497 607">Approved By</th></tr></thead><tbody><tr><td data-bbox="220 607 363 683">00</td><td data-bbox="363 607 579 683">16.06.1995</td><td data-bbox="579 607 1035 683">FIRST MADE</td><td data-bbox="1035 607 1270 683">SS RAO</td><td data-bbox="1270 607 1497 683">KRM R</td></tr><tr><td data-bbox="220 683 363 851">01</td><td data-bbox="363 683 579 851">22.06.2021</td><td data-bbox="579 683 1035 851">SPEC COMPLETELY REVISED AND RETYPED AS PER OEM SPEC P29A-AG212 REV-'N'</td><td data-bbox="1035 683 1270 851">SHRIDHAR</td><td data-bbox="1270 683 1497 851">KAMALDEEP</td></tr><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr></tbody></table>						Rev. No.	Date	Revision Details	Revised By	Approved By	00	16.06.1995	FIRST MADE	SS RAO	KRM R	01	22.06.2021	SPEC COMPLETELY REVISED AND RETYPED AS PER OEM SPEC P29A-AG212 REV-'N'	SHRIDHAR	KAMALDEEP																																																																						
Rev. No.	Date	Revision Details	Revised By	Approved By																																																																																						
00	16.06.1995	FIRST MADE	SS RAO	KRM R																																																																																						
01	22.06.2021	SPEC COMPLETELY REVISED AND RETYPED AS PER OEM SPEC P29A-AG212 REV-'N'	SHRIDHAR	KAMALDEEP																																																																																						
Ref. Doc P29A-AG212 REV-'N'																																																																																										