BHARAT HEAVY ELECTRICAL LTD.
COPRORATE R&D
VIKASNAGAR
HYDERABAD 500093

SPECIFICATION FOR MICRO-DRILLING PROCESS FOR GT BLADE USING EDM

Specification Number: BE-20-15-010-RD39/SPEC01 REV02

A. Purpose:

To establish the process of micro-hole drilling and turbulations on GT Blade or Block (as per BHEL Drg. No. BE-2015-010-RD39/DRG01 REV00) using EDM drilling process.

B. Scope:

Sr. No.	Description	Vendor's Acceptance	Remarks
1	Design and development of EDM micro-drilling tool for micro-drilling of straight and angular holes as specified in the **Drg. No. BE-2015-010-RD39/DRG01 REV 00**		
2	Design and development of EDM drilling tool/electrode, tool path, fixtures, tool for turbulation of holes, EDM process, turbulation process etc.		
3	Optimizing of EDM parameters such as discharge voltage, frequency of current, gap between tool electrode & work piece, ignition delay time, pulse on time, pulse off time, polarity, flushing type, properties of dielectric media, conductivity of electrodes, eroding area etc., for straight, angular and turbulated holes.		
4	Inspection of drilled holes w.r.t. visual, position and dimensional checks by destructive or non-destructive methods.		
5	Process should be established by using minimum one sample and maximum three samples of blade/block.		

6	Deliverables by the vendor shall be:		
	a. Detailed technical report, in MS word format, with detailed drawings, procedures etc. with recommendation for EDM micro-hole drilling for GT blades		
	b. Drilled blade samples (undrilled blades will be supplied by BHEL)		
	c. Drill bits and/or electrodes used for drilling during the process		
	d. Holding fixtures developed and used during the process		
	e. Code of the program developed during the process		

C. Details to be submitted at the time of quotation

Sr. No.	Description	Vendor's Acceptance	Remarks
1	Description of the proposed process or processes. (Use separate page, if required).		

2	Description of the proposed machine (s). Use Separate page, if required.		

3	Estimated time required for the proposed drilling process for each hole. This is for information only and will not be used as evaluation criteria.		
4	Estimated time required for the proposed turbulation process for each hole. This is for information only and will not be used as evaluation criteria.		

D. Notes and conditions

Sr. No.	**Description**	**Vendor's Acceptance**	**Remarks**
1	The super-alloy material i.e. sample GT blades or blocks to be drilled and turbulated will be provided by BHEL. Electrodes, holding fixtures etc. and all other material, including any consumables, shall be in scope of supplier.		
2	The material used for Blade/Block is Nickel based super alloy, GTD111. Properties of GTD111 are mentioned in Annexure-1 for information.		
3	All designs and drawings related to development of EDM drilling and turbulation process for the blade/block, tools, tool path, fixtures, tool for turbulation of holes etc. shall be approved by BHEL personnel before manufacture of tools, fixtures etc. for carrying out the process.		

4	All designs and drawings related to development of EDM drilling and turbulation process for the blade/block will be property of BHEL.		
5	All Intellectual Property Rights i.e. patents, copyrights and design rights etc. arising during or after development of this order shall be property of BHEL and vendor shall not apply or claim for any IPR arising during or after development of this order.		

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ANNEXURE-1

Properties of GTD111 Material

Mechanical Properties

Master heat qualification by the supplier shall include mechanical property tests from cast-to-size bars or bars machined from parts in accordance with the following:

.1 Tensile Properties (Min.)

	B50A858A	
Test Temperature (F)	70	1,200
Tensile Strength, KSI	145	145
0.2% Yield Strength, KSI	125	110
Elongation, % in 4D	5	5
Reduction of Area, %	5	5

.2 Stress Rupture Properties (Min.)

Test Temperature (F)	1,800
Stress, KSI	27
Life, hours	30
Elongation, % in 4D	5
Reduction of Area, %	6

.3 Hardness, Rockwell C 32-42

Chemical Composition

.1 Master and remelt heats supplied to this specification shall conform to the following composition (Wt. %):

	MINIMUM	MAXIMUM
Chromium	13.70	14.30
Cobalt	9.00	9.90
Aluminum	2.80	3.20
Titanium	4.70	5.10
Tungsten	3.50	4.10
Molybdenum	1.40	1.70
Tantalum	2.50	3.10
Carbon	0.08	0.12
Zirconium	-	0.040
Boron	0.005	0.020
Iron	-	0.30
Silicon	-	.25
Manganese	-	0.10
Copper	-	0.10
Phosphorus	-	0.015
Sulfur	-	0.005
Columbium		0.15
Oxygen		25 ppm
Nitrogen		50 ppm
Vanadium		0.10
Hafnium		0.15
Platinum		0.30
Rhenium		0.15
Magnesium		50 ppm♦
Nickel	Remainder	Remainder

♦To be reported on re-melt heat only