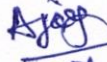
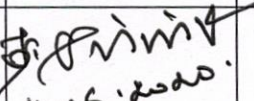


	Bharat Heavy Electricals Ltd. Tiruchirappalli 620014 Advanced Technology Products Operation Planning & Control	OP&C: PROC: RPVB3: 004
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PROCEDURE FOR ELECTRO POLISHING

Revision no and date	No of pages	Description	Prepared by (BHEL)	Reviewed by (BHEL)	Approved by (BARC)
00 07-02-2020	09	Fresh Submission	Ajay Sahu (ATP/OP&C)	K Srinivasan (Plant LAB)	Arun Kumar
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1. INTRODUCTION: REQUIREMENTS OF ELECTRO-POLISHING

- 1.1. This procedure covers technical requirements for electro-polishing of components made of SS321 and SS420 steels. The requirements laid herein are minimum. Additionally, requirements of ISO 15730, ASTM A380, ASTM B912 are applicable.

2. QUALITY REQUIREMENTS

- 2.1. Components shall be processed as per approved OPS (Operation process sheet), which shall be made by the vendor and submitted for approval to BHEL and BARC.
- 2.2. The entire process shall be established through mock-ups and tested on Test Coupons representative of actual job material grade & size.
- 2.3. Once process parameters have been established on mock-Up coupons, job production can be taken up. Test coupons shall be processed concurrently with the job and shall be sufficient to conduct inspection/testing as per paragraph 4.0 of this Annexure. Only when results of testing conducted on Test Coupons are satisfactory, it can be concluded that electro-polishing process is satisfactory. Actual job shall also be subsequently inspected as per paragraph 4.0 of this Annexure.
- 2.4. Pre-electro polishing allowance for each dimension and on threaded areas shall be indicated in manufacturing drawing of every component undergoing electro-polishing.
- 2.5. Mock-up shall be slit open for testing and inspection of all inaccessible surfaces on Job.
- 2.6. Control of material identity shall be maintained by suitable methods to avoid mix-up with other material/ supplies.
- 2.7. Inspection & Certification: Electro-polishing process, Inspection & testing shall be carried out in presence of QC/BHEL and QS/BARC. All

inspection reports & test certificates shall be submitted to BHEL and BARC for approval.

- 2.8. All non-conformances shall be recorded & reported for the approval of BHEL and BARC.
- 2.9. In case of any failure during testing, retesting shall be carried out on double the number of samples.
- 2.10. All surfaces shall be protected from contaminations by injurious and undesirable foreign matter during all stages of manufacture. After cleaning, all surfaces shall pass white cloth swab test.
- 2.11. Details of the chemicals, test methods and the equipment proposed to be used shall be provided by the vendor to BHEL and BARC.
- 2.12. OPS shall include a detailed method of control, with limits for time, temperature, pH values & all other pertinent details that will ensure compliance with requirements of this procedure.
- 2.13. No deviation from the procedure shall be permitted without prior written approval of BHEL and BARC.
- 2.14. As electro-polishing process is likely to alter the dimensions of the components, due allowance will be provided in the machining stage. For threaded surfaces, GO & NOGO gauge checking acceptance shall be done after electro-polishing.
- 2.15. Approval of process, materials and equipment implies no guarantee of acceptance of the results obtained after testing. Acceptance of the test results for Test coupons does not guarantee acceptance of the electro-polishing on components and components will be accepted only after complete inspection of the same.
- 2.16. Test coupons shall be used only once and then preserved only for records.
- 2.17. Where a water rinse is used, to avoid undue accumulation of the treatment chemicals in the rinsed water, the water shall be discarded when its acidity, expressed as ml of N/10 sodium hydroxide solution (4.0

g NaOH per liter) required to neutralize a 50 ml sample, exceeds 1.0 ml.

The sample shall be taken after stirring the water and shall be cooled down before titration in which phenolphthalein shall be used as indicator and the permanent pink colour shall be taken at the end point.

- 2.18. In the OPS, vendor shall indicate those areas on the component where electrical contact shall be made.
- 2.19. Large quantities of hydrogen and oxygen gases are evolved at the electrodes during the electro polishing process. Proper ventilation procedures should be used to ensure their removal.

3. **DESCRIPTION OF WORK**

- 3.1. Consecutive stages shall follow one another without delay.
- 3.2. Electro-polishing shall be carried out after all machining, forming, welding, and stress relieving heat treatment have been completed. All machined components have been already subjected to LPT prior to surface preparation for electro-polishing.
- 3.3. Care shall be taken at all stages to prevent contamination of the surfaces being treated by touching with bare hands, splashing with undesirable liquids or the condensation of moisture on parts after drying.
- 3.4. Major stages along with the associated accessories are listed below: -

Stage	Equipment
I – Surface preparation	Degreasing and descaling tanks
II – Rinsing after cleaning	Cold water tank (with constant water overflow)
III – Electro polishing	Column or Tank containing electro polishing solution
IV – Rinsing	Cold water rinse tank (with constant water overflow)
V – Passivation Rinse	Cold water rinse tank (with constant water overflow)
VI – Testing & Inspection	Passivation testing, surface finish, dimensions, gauge checking etc.

3.5. Stage I - Surface Preparation

- 3.5.1. Before processing, all scale, rust, grease oil & foreign matter shall be removed from surface to be treated by a method, or combination of methods, suitable for meeting the requirement.
- 3.5.2. All surfaces of the article shall be free of clearly visible defects such as pits, roughness, striations or discoloration when examined with 20/20 eyesight at a distance of approximately 0.5 meter
- 3.5.3. Choice of the appropriate process depends upon the type and degree of contamination and the size and shape of the parts. Method of cleaning shall be indicated in OPS covering methods for: -
 - a) Removal of oil, grease, dirt and swarf
 - b) Removal of rust, scale and miscellaneous residues.

3.6. Stage II - Rinsing after cleaning

- 3.6.1. Parts after cleaning and before phosphating shall be given preferably hot water immersion rinse to remove such residues of cleaning materials as might affect the quality of electro polishing.
- 3.6.2. Rinse tanks should be equipped to provide adequate agitation of rinse water to increase rinsing efficiency.
- 3.6.3. Care should be taken to ensure that the water supply itself is sufficiently free from harmful salts with limits specified as given below:
 - a) 70 ppm total chlorides & sulphates (calculated as $\text{Cl}^- + \text{SO}_4^{2-}$)
 - b) 200 ppm total alkalinity (as CaCO_3)
 - c) Maximum of 225 ppm of (a) & (b) together
- 3.6.4. Adequacy and effectiveness of cleaning shall be demonstrated to BHEL and BARC on the mock-up coupons before any further processing.

3.7. Stage III - Electro-polishing

3.7.1. Application method - Immersion only.

3.7.2. Material for tank - SS (preferred) or low-carbon steel. The material of the electro-polishing tank shall be such that they have no adverse effect on the quality of the coating produced. Care should be taken to avoid use of unsuitable material in plant construction, for example, copper or brass heating coils, which can adversely affect the surface of components.

3.7.3. All the process parameters for job production shall be finalized only after obtaining satisfactory results on Trial coupons. Suggested process parameters are given below: -

- Electro-polishing solution consisting of an equal volume mixture of 96% mass fraction sulphuric acid and 85% orthophosphoric acid
- Current density - 5 A/dm² minimum
- Temperature - 75 °C
- Time - 2 to 4 minutes
- Cathodes - SS, Copper, Lead

3.7.4. Process Operating Instructions

- a) The bath materials, chemicals and their concentration, temperature and immersion time for parts shall be such that electro-polished components meet all the requirements of this procedure.
- b) Care should be taken at all stages to prevent contamination of the surfaces being treated by touching with bare hands, splashing with undesirable liquids or the condensation of moisture on components after drying, etc.
- c) Vendor shall maintain a permanent record of the history of electro-polishing bath, showing all additions of chemicals to the bath, and the results of all analyses performed. Log records of bath controls shall be maintained and made available in the form of final documentation.

3.8. Stage IV - Rinsing

3.8.1. After electro-polishing, residues of the electro-polishing solution shall be removed either by: -

- Immersing the article in nitric acid solution of 10% volume fraction to 30% volume fraction (relative density 1.42; 70% mass fraction) at room temperature;
- Using several rinse stages by thorough dip rinsing in water shall be done for a sufficient period to remove any. A continuous overflow shall be maintained by the addition of fresh water.

3.8.2. Care should be taken- to ensure that the water supply itself is sufficiently free from harmful salts, limits for which are listed below:-

- a) 70 ppm max as total chlorides (calculated as Cl^-),
- b) 200 ppm max as total alkalinity (calculated as CaCO_3)
- c) Total of (a) & (b) above as 225 ppm max.

3.8.3. Neutralization procedures such as immersion in alkaline solutions shall not be used as they have a tendency to "set" the residual surface film and detract from appearance and performance.

3.8.4. After rinsing is completed, components shall be handled only by clean white gloves for rest all operations & inspection and stored on clean white cloth.

3.9. Stage V - Passivation rinse

3.9.1. Final passivation rinse shall be done to remove all traces of acidified water for a sufficient period by thorough dip rinsing in DM water.

4. INSPECTION & TESTING

Material Sampling & Testing Plan and Acceptance:

4.1 Passivation Testing:

The Material after post –treatment and rinsing shall be tested / Inspected in the presence of BHEL/BARC engineers for the tests mentioned in Table 1. One tube from Each size will be taken at random and will be cut into required length to do all Tests. For passivation testing we can do either SL no 1&2 or 1&3 or 2 &4. 

TABLE -1

SL.NO	TEST	DESCRIPTION	ACCEPTANCE CRITERIA
1	Water immersion Test	The article(s) shall be alternately immersed in distilled water for 1 hr. then allowed to dry for 2 hrs. for eight wet dry cycles(24 hrs. total)	No Evidence on the article of red rust or other visible products resulting from the test
2	Copper Sulphate test	<u>Principle: -</u> The article is swabbed with an acidified solution of copper sulfate and inspected for evidence of a copper- colored spots indicating the presence of free iron <u>Reagents: -</u> A fresh copper sulfate test solution, prepared by dissolving 1.6 g of analytical reagent grade copper sulfate ($\text{CuSo}_4.5\text{H}_2\text{O}$) in 100ml of distilled water and 0.4 ml of sulfuric acid of 96% mass fraction <u>Procedure: -</u> Using a cotton swab, apply the test solution to a clean area of the passivated surface to be tested, ensuring that the surface is kept wait for 6 min. inspect the surface for the formation of a copper – colored deposit and/or copper- colored spots. Discard or reprocess parts used for testing	No Evidence of a copper colored deposit and /or copper colored spots
3	Modified ‘ferroxyl’ test	<u>Principle:</u> The article is swabbed with a solution of potassium ferricyanide and inspected for the formation of a dark blue colour indicating the presence of free iron	No evidence of the formation of a dark blue colour within 30 sec when tested

		<u>Reagents:</u> A fresh potassium ferricyanide test solution, prepared by dissolving 1.0 g of analytical grade potassium ferricyanide [K ₃ Fe(CN) ₆] IN 70 ML OF DISTILLED WATER AND 30 ml of reagent grade nitric acid of (70±1) % mass fraction and relative density of 1.415 to 1.420. <u>Procedure:</u> Using cotton swab, apply the test solution to a clean area of the passivated surface to be tested. Note the time taken for a dark blue colour to form. discard or reprocess parts used for testing.	
4	Neutral Salt Spray test (5% NaCl)	Test coupon shall show no evidence of red rust or any visible products resulting from the test, when tested for a minimum of 2 hours in accordance with ASTM B117.	No evidence of red rust

5. **PACKING**

Electro-polished products shall be individually packed so as to avoid any damage during handling or shipping. Parts/articles cleared for shipment but found damaged after receipt shall be accounted as "Rejected".

6. **DOCUMENTATION**

The following completed documents for mock-up coupons & actual job shall be supplied to BHEL along with the job: -

- a) OPS
- b) Process parameters and electro-polishing log records
- c) Inspection and Testing records