

General QR (Mechanical) for Fabrication of Mechanical components/assemblies for Ground Support Equipments (GSEs)

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GENERAL QUALITY REQUIREMENTS (**MECHANICAL**)

for THE FABRICATION of

MECHANICAL COMPONENTS/ASSEMBLIES FOR GSEs

This chapter specifies the general quality requirement / guidelines for the mechanical components of the Electronics Units for Ground Support Equipments. All the mechanical components shall be fabricated following the guidelines given in this document. After the completion of the design review and approval of the packages, a detailed Quality Assurance plan (QAP) shall be prepared in accordance with the guidelines given, which shall also include the acceptance criteria.

1. RAW MATERIAL SPECIFICATIONS AND QA REQUIREMENTS

The QAP shall give the details of all the raw materials required for fabrication of the mechanical components, including the form, dimensions, heat treatment condition, and the applicable standard.

1.1 Inspection and Testing:

Each lot of raw materials shall be subjected to the following tests, and should meet the applicable standard / design requirements.

- 1.1.1 Visual Inspection: All the raw materials shall be visually inspected to ensure that there are no cracks, seams, burrs, excessive scale and rust or any damage that is detrimental to the usage. The dimensions shall be checked with respect to the specifications. The identification numbers shall be checked and recorded.
- 1.1.2 Chemical Analysis: One sample for each heat number of the raw materials shall be tested for their chemical composition, in accordance with the appropriate standard / specification.
- 1.1.3 Mechanical properties: From each production lot of the raw materials, 3 no. of tensile test specimens shall be prepared and tested in accordance with the applicable testing standards. The test results of UTS, 0.2% PS and the percentage of elongation should meet the requirements of the applicable standards / design requirements.
- 1.1.4 NDT Inspection for Internal Defects: All the raw materials which are having more than 12.5mm thickness shall be subjected to NDT inspection like Ultrasonic inspection / Radiography for any internal defects like voids, pores, piping, folds, inclusions, cracks etc. The acceptance criterion shall be decided based on the design requirements, and shall be clearly mentioned in the QAP, for each type of raw material.

- 1.1.5 Testing for specific properties: Special testing like IGC for stainless steel materials, specific gravity, Melting point, di-electric strength etc. for the polymeric materials shall be carried out for some specific materials, based on the design requirements. The acceptance criteria for the same shall be given the QAP.

2. COMPONENTS INSPECTION:

Components shall be machined as per the approved drawings from the respective accepted raw materials. For some special materials like aluminum forgings, care should be taken in the process planning to take care of the dimensional stability problem, by planning the machining in number of stages, leaving in between for natural ageing.

2.1 Inspection and Testing:

After final machining the following inspection shall be carried out on all the components.

- 2.1.1 Visual Inspection: All the surfaces shall be checked visually to ensure that they are free of dents, cracks etc., and for the marking of the identification details.
- 2.1.2 Dimensional Inspection: All the components shall be checked for dimensions as per the drawing. The vendor shall report the deviations, if any, for each component and obtain the acceptance of the Waiver board of ASI. before further processing.
- 2.1.3 D.P. Check: All the components shall be dye-penetrant tested as per ASTM E 165 for detecting the surface defects. No surface defects are permitted.

3. SURFACE PROTECTION:

All the surfaces of the aluminum components which are exposed to the external environment during the service life of the package, shall be anodized. The quality requirements for the anodization are given in Annexure-MA.

The internal surfaces of the components and wherever electrical conductivity is required, shall be conductive Chromate Coated. The quality requirements for the conductive chromate coating are given in Annexure-MB.

All the surfaces of the components manufactured from the stainless steel materials shall be subjected to passivation treatment. The quality requirements for passivation is given in Annexure-MC.

4.0 FASTENERS:

The standard fasteners shall be of Stainless Steel fasteners and should meet the QA requirements given in Annexure -MD.

For the proprietary fasteners the "Certificate of Conformance" mentioning the part no. and lot no. from the manufacturer should be produced.

5.0 ASSEMBLY & INSPECTION:

Components along with the fasteners, which are cleared shall be assembled as per the approved assembly drawing. The dimensional inspection of the assembly shall be carried out as per the assembly drawing. It should be ensured that the gaps between the components are within the specified limits. If required the final assembly shall be carried out by applying sealant (Loctite 510 as per its instructions) for the interfaces between the joining members, to ensure leak-proof assembly. Each assembly shall be marked with the Identification details as given in the assembly drawing.

Annexure -MA

QUALITY REQUIREMENTS FOR ANODIZING OF ALUMINUM ALLOYS

1.0 All the Aluminum components shall be anodized in accordance with AMS-A-8625 with Sulphuric acid process (Type II), non-dyed (Class 1).

2.0 The firm shall submit a detailed process plan for anodization and take the approval from ASL.

3.0 PROCESS QUALIFICATION:

The process shall be qualified by conducting the following tests on 3 test specimens of Al alloy panels of 254 x 76 x 1 (t > 1 mm) processed in accordance with the approved process.

3.1 Visual inspection: The anodic film shall be continuous, smooth, adherent, uniform in appearance, free from powdery areas, loose films, breaks, scratches and other defects detrimental to usage of the component. Differences in anodic coating appearance resulting from inherent base metal differences in a component such as the presence of welds and differences in grain size within a forging shall not be cause to reject the anodic coating. Slight discoloration from dripping or rundown of the sealing solution from designed crevices in a component is allowed.

3.2 Coating weight: Prior to dyeing or sealing, test specimen shall be tested for anodic coating weight in accordance with ASTM B 137 and shall meet the requirement of 1000 mg/ft² minimum.

(Or)

Coating thickness: The thickness of the coating shall be measured in accordance with ASTM B 244 or with appropriate instrument duly calibrated. The thickness shall be the average of not less than 8 measurements and shall be minimum 10 µm. The thickness can also be measured with either Microscopic section method or stripping method in accordance with IS 5523-83.

3.3 Sealing test: The test whether anodised coating has been sealed or made non abortive, a drop of violet dye solution made by dissolving 1 gm of anthraquinone violet in 50 ml of water, should be applied at room temperature to the coated surface of the test specimen, which must not have been contaminated by handling. The solution should be allowed to stand for five minutes and should then be washed off with running water and the test area rubbed with soap water. Satisfactory sealing of the film is indicated by the complete absence of colour after washing.

3.4 Continuity and freedom from porosity:

The anodic film is continuous and free from pores, breaks or scratches, if no brown deposit appears on the sample test piece, when it is immersed 5-10 minutes in an aqueous solution (consisting of copper 20 gm/l. and Hydrochloric acid 20 ml per litre of water).

3.5 Voltage breakdown test: This test shall be carried out on dry sealed anodic coatings. This test is carried out using two electrodes, one pinpoint stationary electrode placed at one end by piercing the coating and other electrode with a spherical end of 1.5 mm diameter for scanning the anodised film. The coating is considered to be satisfactory if the breakdown voltage is not less than 50 V.

3.6 Corrosion resistance: 3 test specimens shall be subjected to a 5% salt spray test in accordance with ASTM B 117, inclined 6 degrees from the vertical, for 336 hours. After exposure to the salt spray test, specimens shall be visually examined to determine that all of the following conditions are met:

- i. The test specimens shall show no more than 10 isolated pits, none larger than 0.8 mm in diameter, in a total of 90 square inches of test area grouped from 3 test specimens.
- ii. The test specimens shall show no more than 5 isolated pits, none larger than 0.8 mm in diameter, in a total of 30 square inches from 1 test specimen.
- iii. The test specimens shall not exhibit patchy dark gray areas (spots, streaks, or marks).

NOTE: Areas within 1.6 mm from identification markings, edges and electrode contact marks remaining after processing shall be excluded.

4.0 Process re-qualification:

Process re-qualification shall be conducted at least once every 6 months. If anodizing is not performed for a period of 6 month or longer, process qualification shall be conducted at the start of anodizing. Moreover, re-qualification of process set-up shall be carried out under any one of the following conditions.

- i. When the composition of the electrolyte is different than approved.
- ii. When thickness variation is found to be more.

5.0 BATCH ACCEPTANCE:

The process qualified as per procedure given in Para 3 shall be used for anodizing the components. For each batch of component anodizing, the details of the components (item description, quantity & identification numbers) and all the process parameters shall be recorded. Two representative coupon as per Para 3.0 shall be anodized along with each batch of components. For batch acceptance, one of the representative coupons should

meet the test requirements mentioned in Para 3.1 to 3.5 and all the components should meet the test requirements mentioned in Para 3.1 & 3.2.

6.0 REPORTS:

The firm shall furnish with each batch of anodization, a report stating that the parts with their identification nos. have been processed, tested and conform to the specified requirements along with the supporting documents.

Annexure -MB

QA PLAN FOR CONDUCTIVE CHROMATE COATING

1. **Degreasing**: Soak the components in Tri-Chloro Ethylene. Remove traces of paint, marking ink and varnish.
2. **Vapour Degreasing**: Keep the components in vapour degreasing plant of TCE for duration of 2 to 5 minutes.
3. **Chemical Cleaning**:
 - 3.1 Immerse the components in 20 to 30 g/l of Sodium Hydroxide at $60 \pm 5^{\circ}\text{C}$ for 20 seconds.
 - 3.2 Rinse the components in clean running water to ensure no traces of acid.
 - 3.3 Desmuting in 5 to 50% of Nitric Acid.
 - 3.4 Rinse thoroughly in clean running water to ensure no traces of acid.
 - 3.5 Jigging: Jig the components with Aluminum Strips.
4. **Chromate Conversion Coating**: Dip the components in standard Chromate solution for appropriate time and temperature. Ensure the pH value of Chromate solution is within 1.5 to 1.7 before dipping.
5. **Rinsing**: These coatings shall receive a final water rinse. If hot water is used as the final rinse after the chromating process, it is essential that the time of rinsing should be kept as short as possible in order to prevent the dissolution of the hexavalent chromium.
6. **Drying**: Drying of the components shall be carried out at a temperature not exceeding 60°C to prevent cracking due to dehydration, which causes loss of adhesion and performance of the chromate coating.
7. **Qualification Test**: Chromate Conversion Coating shall be carried out as per IS 11232 on two test samples (150x100 mm) of the same alloy and **after 24 hours** shall be subjected to the following tests.
 - 7.1 **Visual Inspection**: The coating shall be uniform in appearance, coloured to light iridescent gold. The film shall be continuous, free from powdery areas, breaks, scratches and other damages.
 - 7.2 **Adhesion Test**: The coating shall be adherent and non-powdery. The specimen shall be subjected to Peel test as per ASTM B 571.
 - 7.3 **Electrical Resistance**: When measured at 9V and a 2A current the resistance should be less than 0.1Ω .
 - 7.4 **Corrosion Resistance Test**: Two specimens shall be subjected to corrosion resistance test in neutral salt spray as per ASTM B 117 for duration of 168 hours after which there shall be no evidence, to the unaided eye, of more than a total of eight isolated spots or pits, not larger than 1 mm in diameter. Each individual

specimen shall not have more than five isolated spots or pits, none larger than 1 mm in diameter on the respective surfaces. Spots within 10 mm of the edges of the specimen are not counted.

8. Acceptance Test:

The process qualified as per procedure given in Para 7 shall be used for chromating the components. For each batch of component chromating, the details of the components (item description, quantity & identification numbers) and all the process parameters shall be recorded. Two representative coupons as per Para 7.0 shall be chromated along with each batch of components. For batch acceptance, one of the representative coupons should meet the test requirements mentioned in Para 7.1 to 7.4 and all the components should meet the test requirement mentioned in Para 7.1.

9. Reports:

The firm shall furnish with each batch of conductive chromatisation, a report stating that the parts have been processed, tested and conform to the specified requirements.

Annexure -MC

QUALITY REQUIREMENTS FOR PASSIVATION

- 1.0 All the Corrosion Resistant Steel components shall be passivated in accordance with Method 1 (Nitric acid) SAE AMS 2700.
- 2.0 The firm shall submit a detailed process sheet for passivation and take the approval from ASL before starting the process.
- 3.0 **Process Qualification:**
The process shall be qualified by doing passivation on the sample panels of 50 dia x 10 Thk. Or 100 x 100 x t (t>1 mm) and tested as given below:
- 3.1 **Visual inspection:**
After completion of processing, there shall be no evidence of etching, pitting, smutting, frosting, dimensional changes, or other chemical attack on the parts.
- 3.2 **Corrosion resistance test:**
 - 3.2.1 **Humidity Test:** The sample shall be free from visible red rust after exposure to 95% minimum relative humidity at 35-46 °C for not less than 23 hours.
(Or)
 - 3.2.2 **Water Immersion Test:** The sample shall be free from visible red rust after alternately immersing in de-ionized or distilled water for one hour and allowing it to dry in room temperature air for one hour, until 24 hours (12 cycles) have elapsed.
(Or)
 - 3.2.3 **Salt Spray Test:** The sample shall withstand exposure to 2 hours ± 10 minutes in a salt spray environment operated in accordance with ASTM B 117. The sample shall not show evidence of red rust following completion of the test.
- 4.0 **Process re-qualification:**
Process re-qualification shall be conducted at least once 6 months. If the results of re-qualifications are consistent, then the periodicity may be increased to 1 year. If passivation is not performed for a period of 3 month or longer, process re-qualification shall be conducted at the start of component passivation.

Moreover, re-qualification of process/set-up shall be carried when the composition of the bath is different than approved.

5.0 **BATCH ACCEPTANCE:**

The process qualified as per procedure given in Para 3 shall be used for passivation of the components. For each batch of component passivation, the details of the components (item description, quantity & identification numbers) and all the process parameters shall be recorded. Two representative coupon as per Para 3.0 shall be passivated along with each batch of components. For batch acceptance, one of the representative coupons should meet the test requirements mentioned in Para 3.1.

6.0 **Reports:**

The firm shall furnish with each batch of passivation, along with the above test reports, a separate report, stating that the parts (with identification nos.) have been processed, tested and conform to the specified requirements.

QUALITY REQUIREMENTS FOR STAINLESS STEEL FASTENERS

A. SPECIFICATIONS:

The following information should be specified for each type of fastener being used for the package.

Sl. No.	Description	Material	Property Class	Finish	Applicable Standard

B. QUALITY REQUIREMENTS

The following tests shall be performed at product level on sample basis

1. CHEMICAL COMPOSITION:

One number of random samples from each batch of fasteners shall be checked for chemical composition either by wet chemical method in accordance with ASTM E 353 or by spectroscopic method and shall conform to the specified requirements.

2. VISUAL AND DIMENSIONAL INSPECTIONS:

All the fasteners shall be subjected to 100% visual inspection. Following sampling plan shall be followed for dimensional inspection and Go & No-Go gauge check. If any deviation is observed on any parameter in the samples then the complete lot shall be inspected for that parameter.

Lot Size (Nos.)	Sample Size (Nos.)
Up to 150	13
151 – 280	20
281 – 500	29
501 – 1200	34
1201 – 3200	42
3201 – 10000	50

3. PASSIVATION:

3.1 All the fasteners shall be passivated in accordance with SAE AMS 2700.

3.2 For each batch of fasteners passivation, two samples shall also be passivated and one sample should be subjected to the following tests for batch acceptance.

3.2.1 Visual inspection:

After completion of processing, there shall be no evidence of etching, pitting, smutting, frosting, dimensional changes, or other chemical attack on the fasteners.

3.2.2 Corrosion resistance test:

Humidity Test: The sample shall be free from visible red rust after exposure to 95% minimum relative humidity at 35-46 °C for not less than 23 hours.

(Or)

Water Immersion Test: The sample shall be free from visible red rust after alternately immersing in de-ionized or distilled water for one hour and allowing to dry in room temperature air for one hour, until 24 hours (12 cycles) have elapsed.

(Or)

Salt Spray Test: The sample shall withstand exposure to 2 hours \pm 10 minutes in a salt spray environment operated in accordance with ASTM B 117. The sample shall not show evidence of red rust following completion of the test.

3.3 **Reports:** The firm shall furnish with each batch of passivation, along with the above test reports, a separate report stating that the parts with identification nos. have been processed, tested and conform to the specified requirements.

4. FDP EXAMINATION:

All the fasteners shall be subjected to FDP as per ASTM e 165. No surface & subsurface defects are permissible.

5. BREAKING TORQUE TEST FOR SCREWS/BOLTS:

A minimum of 3 samples for every production lot of screws, shall be subjected to Breaking Torque test in accordance with IS 1367 (Part 14).

6. PROOFING LOAD TEST FOR NUTS:

A minimum of 3 samples for every production lot of nuts shall be subjected to tensile proofing load test. Proof load corresponding to property class 70 specified in IS 1367 -Part 14 shall be applied axially to the nut in a normal tensile testing machine. The full proofing load shall be held for 15 seconds. The nut shall resist the

load without failure by stripping or rupture, and shall be removable by fingers after the load is released. After the removal of the load, the nut should be visually inspected for any micro cracks to ensure the integrity.

7. PACKING:

7.1 Fasteners, which are thoroughly cleaned, shall only be packed. The fasteners shall be packed separately in polythene bags, each bag weighing not more than 5 kg. The bags shall be sealed with a small bag of silica gel kept inside.

- | | |
|------------------------|-------------------------------------|
| i) Manufacturer's name | ii) Description & Property class |
| iii) Quantity | iv) Batch No. & Date of manufacture |

7.2 The polythene bags shall be packed in a cardboard/wooden box. On the box details as mentioned above shall be labeled.

8. CERTIFICATES:

Each batch of fasteners shall be supplied with the applicable test certificates.