

RESTRICTED
(DRAFT/PROVISIONAL)
QUALITY ASSURANCE PLAN
FOR
(WORM GEAR)
DRG. NO: 176.23.022CB-1CB
(LF NO: 6206113244)

No. HVF/T-72C/QAP/23/ WORM GEAR/391658-00

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QUALITY ASSURANCE (RIG ASSEMBLY)
HEAVY VEHICLES FACTORY
AVADI, CHENNAI – 600 054


QUALITY ASSURANCE PLAN (QAP)

FOR


WORM GEAR

DRG. NO: 176.23.022CB-1CB

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1. IMPORTANT NOTE:

Note-1

This is only a provisional and will be amended from time to time according to the requirement. No addition, deletion and reproduction will be done without the permission of The General Manager, Heavy Vehicles Factory, Avadi, and Chennai – 54.

Note –2

Any instruction contained in this does not prejudice the terms and conditions of the contract what so ever. In case of any contradiction between the contents of this QAP and the clause in the contract, the latter will prevail.

Note-3

The stores should be manufactured strictly as per the drawings supplied by the Inspection Authority only and not as per the samples, if any received by the manufacturer for guidance purpose.

Note-4

Any amendment issued by the Inspection Authority shall be incorporated in the QAP and the records for the amendments carried out should be maintained as per the Performa at Appendix-"A".

Note-5

In case of any contradiction between the contents of this QAP and drawings issued along with the contract, the latter will prevail.

2. INTRODUCTION:

- a) This quality plan lays down the inspection and testing procedure to be carried out on the **WORM GEAR DRG.NO.176.23.022CB-1CB** being procured indigenously. This is prepared, based on the acceptance standards and inspection parameters laid down in collaborators documents and on the inspection test standards followed in respect of similar indigenous items.
- b) This QAP is the property of Government of India and is liable for amendments as and when required. The General Manager, Heavy Vehicles Factory, Avadi, Chennai – 600 054, is the inspecting Authority for this assembly. Any query / clarification on the content of this QAP shall be referred to this Factory. Any departure from these instructions is allowed only after written approval from the above authority. Notwithstanding the tests indicated in this QAP, the inspecting Officer has the right to carry out any test to check conformance to the paper particulars quoted in the Supply Order, which he may consider necessary to satisfy himself about the stores which he has to accept.

3. AIM:

The QAP is aimed at standardizing the Inspection procedure and acceptance norms for **WORM GEAR DRG.NO.176.23.022CB-1CB**. It also aims at giving adequate information to the manufacturer on the quality requirements so that the required quality control methods are established. This is also meant to guide authorized Inspection Officer in his routine inspection and to set out main points to which his attention must be drawn to ensure that the accepted stores meet the stipulated standards.

4. SCOPE:

This QAP outlines in general terms, the checks and methods to be used during inspection of **WORM GEAR DRG.NO.176.23.022CB-1CB** including the technical requirements of the drawings. The recommended Quality Plan stipulated herein is mandatory and should be strictly adhered to.

Note:

- i. Tender enquiry (TE) and supply order (S.O) will be issued with QAP stating that inspection will be done as per QAP.
- ii. In case of TE, It is responsibility of the vendor to obtain the copy of QAP and give the statement of compliance that vendor will abide by the QAP in case supply order is placed.
- iii. In case of S.O, it is the responsibility of the vendor to obtain copy of QAP and give the statement of compliance that the vendor will follow QAP. However, GM/HVF reserves the right to revise/update the QAP from time to time.

5. DOCUMENTS:

- a) On placement of firm supply order, one set of certified drawings will be forwarded to the Contractor. One set of relevant specification and technical instructions on the subject item can be obtained from AHSP through DDO/HVF.
- b) Any clarification required on these documents should be obtained from the Inspecting Authority i.e. The General Manager, Heavy Vehicles Factory, Avadi, Chennai – 600 054. Equivalent to the collaborators specifications and standards will be decided only by the Inspecting Authority and should not be unilaterally decided.
- c) The process instruction sheets supplied by the collaborators are available with the DDO/HVF, Avadi, Chennai for reference (i.e. Forging, casting, machining, extrusion, forming, manufacturing, heat treatment and plating process etc.) Where ever applicable.
- d) The supplier after scrutiny of the concerned process sheets and connected paper particulars should establish the necessary production and inspection facilities. Particularly the inspection test rigs, stands, fixtures, templates, gauges etc should be provided as recommended in these process sheets.

6. USED ON HIGHER ASSY:

The WORM GEAR to drg.no.176.23.022CB-1CB is used for higher assemblies drawing no's are given below.

- a. 172.23.012CBCB
- b. 176.23CB-3CB

7. BILL OF MATERIAL:

| Sl. No. | DRG. No. | NOMENCLATURE | MATERIAL SPECIFICATIONS | QTY. | REMARKS |
|---------|-------------------------------|--------------|----------------------------|------|-----------------|
| | 176.23.022CB-1CB & ITEM LISTS | WORM GEAR | -- | -- | |
| 1 | 176.23.094 | HUB | STEEL 38XC GOST 4543-71 | 1 | |
| 2 | 176.23.095 | GEAR RING | БРАЖ-9-4L GOST 493-79 | 1 | WITHOUT DRAWING |

Note: Vendor/Contractor may use approved alternate material issued by the tender/ supply order issuing authority in writing (if available).

8. CONDITIONS OF USE/STORAGE INSTRUCTIONS

This assy should be properly packed to protect from transits / handling damage and influence of atmospheric precipitations. In addition, the following parameters should be ensured: -

- a) The threaded parts are to be covered with suitable plastic caps to prevent damages.
- b) Each assy should be placed separately.
- c) The stores are to be suitably covered for preventing ingress of dust and dirty/entry of sunlight and moisture.
- d) The packaging slip shall contains
 - (i) Certificate of testing (NABL)
 - (ii) Pre-inspection report (PIR)
 - (iii) Guarantee/ Warranty Certificate
 - (iv) Delivery Slip with Inspector's Acceptance Mark.
 - (v) Under taking certificate/certificate of conformance.
- e) The stores are not permitted to be stored together with oils. Petrol, acids, alkaline and other substances to avoid damage to the metal / rubber components.

9. SAMPLING PLAN:

| Sl. No. | Sampling Plan | Pilot * | Bulk |
|---------|---|---------|---|
| (i) | Visual Inspection | 100% | 100% |
| (ii) | Dimensional Check | 100% | General Inspection level II, single sampling, Normal Inspection, AQL 1.5 of IS 2500 (Part-I)-2000 |
| (iii) | Material check | 1 No | 1 No for each batch of raw material or Heat treatment lot as required by specification. |
| (iv) | Fitment/Performance test/Trial | 1 No. | 1 No. as and when required. |
| (v) | Interchangeability test | 2 No's | 2 No's Randomly basis, except selective assy. |
| (vi) | Test stands/jigs/ fixtures/ gauges and calibration checks | 100% | 100 % |
| (vii) | Marking/Identification | 100% | 100% |
| (viii) | Packing/preservation | 100% | 100% |

* This clause is applicable if mentioned in supply order or project sanction order in case of Make-II.

Note:- A New supplier should supply bulk only after pilot sample inspection/ evaluation by HVF and obtain bulk production clearance from HVF.

10. VISUAL INSPECTION [Sampling plan as per Para- 9 (i)]

- a) The stores are to be visually examined on 100 % of pilot /bulk and same should be free from any defects and all the finishing requirements shall satisfy as indicated in technical conditions/requirements of the assy / component drawing respectively.
- b) The components shall be checked for the following and should be free from the defects:
 - Defects in construction
 - Fitment of all components
 - Presence of foreign particles
 - Moisture and dust
 - Corrosion of metal parts
 - Mechanical imperfections & distortion
 - Any form of deterioration of material and finishing.
- c) Packing and preservation should be ensured as per drawings/relevant TY specification (To be ensured on receipt at consignee end).

11. DIMENSIONAL CHECKS [Sampling plan as per Para- 9 (ii)]

The dimensions of individual component, sub assy and major assy shall be checked and ensured as per respective drawings. Dimensional checks should be carried out as per sampling plan. However, the inspecting authority/rep. may at his discretion, tighten the inspection level and acceptance quality level on the critical items and adopt check point during manufacture.

11.01) WORM GEAR (176.23.022CB-1CB)

- a) The dimensions and geometrical parameters should be confirmed as per drawing specification. The gear parameters are given below:

| | | | |
|------------------------------------|---|------------|--------------|
| MODULE | | m_s | 4 |
| No. OF TEETH | | Z | 38 |
| MATING WORM | TYPE OF WORM | — | ARCHEMEDIC |
| | No. OF THREADS | Z | 1 |
| | THREAD | — | LEFT HAND |
| CENTRE DISTANCE IN CUTTING | | A_o | 98 ± 0.1 |
| ACCURACY CLASS AS PER GOST 3675-56 | | — | STEEL 8 - X |
| MATING WORM | PROFILE ANGLE | α | 20° |
| | WHOLE DEPTH OF THREAD | h | 7.2 |
| | HELIX LEAD | t_e | 12.564 |
| | TIP CYLINDER DIAMETER | d_{e1} | 50.4 |
| TOOTH CUTTING TOOL | TEETH THICKNESS (IN AXIAL SECTION) | s_a | 6.382 - 0.3 |
| | BOTTOM CLEARANCE IN THE CAVITY OF WHEEL | C_k | 0.8 |
| | FILLET RADIUS | r_{e1} | 0.5 |
| CORRECTION FACTOR | | ϵ | 0 |

| | | |
|--------------------------------------|------------|------------|
| MODULE | m | 1.5 |
| NUMBER OF TEETH | Z | 77 |
| PROFILE ANGLE | α | 30° |
| ADDENDUM MODIFICATION CO - EFFICIENT | ϵ | 0.167 |
| REFERENCE DIAMETER | d_a | 115.5 |
| ADDENDUM | h' | 0.5 |
| DEDENDUM | h'' | 1.3 |

- b) All the technical requirements (T.R) points to be ensured as drawing specification and as given below;

1. ON THE FACES 'B' AND 'B' CAVITIES OF UNGROUPED LOCATION WITH A DIAMETER NOT EXCEEDING 4 mm AND DEPTH NOT EXCEEDING 2 mm AND NOT CROSSING THE TEETH EDGES ARE ALLOWED.
2. NUMBER OF SUCH DEFECTS SHOULD NOT EXCEED 2 ON EACH SURFACE. REQUIREMENTS FOR THE COMPONENT ITEM No.2 ARE AS PER GENERAL PART OF 172 TY 6.
3. SPLINE HOLE SHOULD BE CHECKED WITH A COMBINATION GAUGE WITH STANDARD TEETH THICKNESS ALONG THE ONE OF REFERENCE DIAMETER EQUAL TO 2.645.
4. SURFACES MARKED WITH _____ SHOULD BE HEAT TREATED. INDUCTION HARDENING $\geq 46h = 1 \dots 7$ mm. HARDNESS MAY BE REDUCED IN THE SPACE OF RACE $R4.8 \pm 0.08$ UPTO HRC ≥ 40 .
5. COATING : CHEMICAL OXIDO PHOSPHATIZING OIL FINISH OR CHEMICAL PHOPHATIZING OIL FINISH. SPOTS ON THE BRONZE RING IS NOT CHECKED.
6. UNSPECIFIED ROUNDINGS OFF RADII TO BE 0.5 MAX.
7. OTHER REQUIREMENTS ARE AS PER 520 TY 1.
8. PARTIAL CHIPPING OF BRONZE ALONG THE SURFACE $\phi 132$ B7 FOR NOT MORE THAN THREE GROOVES IS ALLOWED. AFTER MACHINING.

11.02) HUB (176.23.094)

- a) The dimensions and geometrical parameters should be confirmed as per drawing specification.
- b) All the technical requirements (T.R) points to be ensured as drawing specification and as given below;

1. BHN 341 ... 285 (DIA OF INDENTATION 3.3 ... 3.6 mm) MAY BE CHECKED IN THE BLANK.
2. GROOVES MAY BE CUT BY ROLLING-IN AS PER THE ALTERNATE.
3. GROOVES 10 ± 0.5 MAY BE MACHINED ALONG THE DOT-AND-DASH LINE
4. UNSPECIFIED ROUNDING-OFF RADII TO BE 0.5 mm MAX.
5. OTHER TECHNICAL REQUIREMENTS ARE AS PER 520 TY 1.
6. *DIMENSIONS FOR REFERENCE.

11.03) GEAR RING (176.23.095) WITHOUT DRAWING

- a) The dimensions and technical parameters should be confirmed as per higher assembly (176.23.022cb-1cb) specification/requirements.

12) MATERIAL CHECKS [SAMPLING PLAN AS PARA – 9 (iii)]

Material specimen /test bars of the components shall be in conformity as per the material mentioned in the relevant documents/drawings as per the bill of materials (BOM). NABL test reports for all the parameters as per relevant specifications to be submitted. Test samples to be submitted by the vendor to HVF, if required. The material check will be carried out as per sampling plan. However, if the manufacturer proposes any alternative material at the stage of tender enquiry, the same has to be approved and a written concurrence should be obtained from AHSP through DDO/HVF, before usage of such materials.

12.01) HUB (176.23.094)

- a) The component should be manufactured from STEEL 38XC GOST 4543-71.
- b) The chemical composition and mechanical properties of steel grades STEEL 38XC as per GOST 4543-17 is given below, for other requirements refer GOST 4543-71.

CHROME SILICON STEEL OF GOOD QUALITY GRADE 38XC GOST 4543-71.
 (a) CHEMICAL COMPOSITION :-

| CONTENT OF ELEMENTS % | | | | | |
|-----------------------|-----------|-----------|-----------|-------|-------|
| C | Si | Mn | Cr | S | P |
| | | | | M A X | |
| 0.34-0.42 | 1.00-1.40 | 0.30-0.60 | 1.30-1.60 | 0.035 | 0.035 |

RESIDUAL CONTENT OF COPPER AND NICKEL SHOULD NOT EXCEED 0.30% EACH.

(b) MECHANICAL PROPERTIES :-

| TENSILE STRENGTH Kgf/mm ² | YIELD POINT Kgf/mm ² | ELONGATION % | REDUCTION IN AREA % | IMPACT STRENGTH Kgm/cm ² |
|---|------------------------------------|-----------------|------------------------|--|
| M I N I M U M | | | | |
| 95 | 75 | 12 | 50 | 7 |

12.02) GEAR RING (176.23.094) WITHOUT DRAWING

- a) The component should be manufactured from BPAЖ-9-4L GOST 493-79.
- b) Alternate material is given below.

GEAR RING SHOULD BE MADE FROM BRONZE БРАЖ-9-4Л

GOST 493-79. IT MAY BE MANUFACTURED FROM BRONZE

АЖМУ 10-3-1.5 GOST 493-79.

- c) The chemical composition and mechanical properties of BPAЖ-9-4L as per GOST 493-79, for other requirements refer GOST 493-79.

| Grades of Alloy | Chemical composition, % | | | | | | | | | | | | | | | | | | | |
|-----------------|-------------------------|---------|-----------|--------|------|-------------|------|----------|--------|---------|---------------------------|-----|---------|----------|--------|------|-------------|------|------|-----------|
| | Basic Elements | | | | | | | | | | Admixtures, Not More than | | | | | | | | | |
| | Aluminum | Iron | Manganese | Nickel | Lead | Phosphorous | Zinc | Antimony | Copper | Arsenic | Antimony | Tin | Silicon | Aluminum | Nickel | Lead | Phosphorous | Iron | Zinc | Manganese |
| БРАЖЛ | 8.0-10.5 | 2.0-4.0 | - | - | - | - | - | 0.5 | 0.05 | 0.05 | 0.2 | 0.2 | - | 1.0 | 0.1 | 0.1 | - | 1.0 | 0.5 | 2.7 |
| БРАЖМ2 | 9.0-11.0 | 2.0-4.0 | 1.0-3.0 | - | - | - | - | 0.5 | 0.01 | 0.05 | 0.1 | 0.1 | - | 0.5 | 0.3 | 0.01 | - | 0.5 | - | 1.0 |

Mechanical properties and application of tinless bronze

| Grade | Method of Casting | Tensile strength σ_b , MPa (kgf/mm ²) | Relative elongation after rupture 65, % | Brinell hardness HB, MPa (kgf/mm ²) | Application |
|------------|-------------------|--|--|---|-------------------------------------|
| | | Not less than | | | |
| БрА9Ж3Л | к | 490 (50) | 12 | 980 (100) | Steel framework, antifriction parts |
| | п | 392 (40) | 10 | 980 (100) | |
| БрА10Ж3Мц2 | к | 490 (50) | 12 | 1176 (120) | |
| | п | 392 (40) | 10 | 980 (100) | |

13) FITMENT/PERFORMANCE TEST/TRIAL:

- a) Pilot samples should be checked for fitment / Performance test to ascertain the efficacy of the system under different operating conditions by fitting in higher assembly and repeating it for functional checks & performance to be monitored, wherever required.
- b) Bulk supply may be subjected to performance trial in higher assembly in case of repeated failure/defects during exploitation.

14) INTERCHANGEABILITY:

The assemblies should be interchangeable component wise and assembly wise, except the Component are to be supplied as a set and to be assembled selectively.

15) TEST STANDS/JIGS/FIXTURES/GAUGES & CALIBRATION CHECKS:

- a) The supplier / Contractor should manufactured a suitable Test Stand/ jigs/ fixture / mandrels and gauges as per process sheet to carry out quality checks/performance test and to ensure conformance of components/assy as per drawing specification / T.R points.
- b) The supplier/contractor should submit calibration reports for instruments/fixtures/gauges etc., which are used during inspection activities.

16) MARKING/IDENTIFICATION CHECKS:

For traceability, marking of part No., Manufacturer name, supply order No, Serial No/Qty, batch No. and manufacture date & year are to be carried out in all components. Suitable method of marking can be adopted, provided the above details are legible. Inscription if any as called for in the relevant drawing is also to be carried out.

17) PRESERVATION CHECK:

- a) Preservative coatings are to be strictly adhered to as called for in the drawing/T.R points. However, equivalent BIS Standards can also be followed, subject to the thickness of the coating is maintained as per the drawing.

- b) Other preservations as necessary to prevent damages due to moisture and dust during process, storage and transit are to be carried out as per drawing/T.R points. Conventional methods can also be resorted to.

18) PACKING CHECK:

- a) Components / Assemblies are to be packed separately to avoid damages during transit / handling of the same. Part No. and No. of sets are to be marked on the packing.
- b) Packing and preservation should be ensured as per drawings/relevant TY specification (To be ensured on receipt at consignee end).

19) DOCUMENTATION:

- a) Firm has to maintain all the documents as per QAP with respect to the SI.No.to have traceability.
- b) Vendor has to submit Bill of materials, Material test reports, Class 'C' /Endurance test reports (wherever specified in drg/TY specification/QAP) and Complete PIR (pre-inspection report) at the time of offering the item for inspection. HVF will commence the inspection only after scrutiny of these documents.
- c) Pre inspection reports (PIR) of firm like,
 - 1) Chemical analysis, Mechanical properties obtained from NABL as per bill of material (BOM) with respect to material specifications.
 - 2) Pre-forming process report as per process sheets.
 - 3) Coating certificates, hardness reports and heat treatment certificates(Wherever applicable)
 - 4) Calibration reports of instruments and gauges.
 - 5) 100% Dimensional inspection reports (including T.R points) as per bill of material are to be submitted.
- d) The testing/inspection responsibility to test all the parameters as per QAP and drawing specifications as mentioned in Annexure -A (enclosed).

20) REFERENCES:

- a) Refer all the drawings to 176.23.022CB-1CB (Drawing dated 20-01-2004).
- b) Refer all the material specifications like GOST, IS, & TY... etc. Refer to dimensional and material checks clauses in this QAP.

WORM GEAR (176.23.022CB-1CB)

ANNEXURE-A:

| SL. NO | CATEGORY | TESTS/INSPECTION PARAMETERS | STANDARDS TO BE REFERRED | ACCEPTANCE CRITERIA | INSPECTION RESPONSIBILITY | | | REMARKS |
|--------|--------------------------------------|---|--------------------------------------|--|---------------------------|-----|------|---|
| | | | | | Firm | HVF | DGQA | |
| 1. | Pre inspection reports (PIR) of firm | Firm has to produce all the document as per QAP | As per the relevant drawing and QAP. | Conform to drawing and QAP as per bill of material | P | V | R | 100% by firm/ vendor. |
| 2. | Bill of material (BOM) | Firm has to prepare the BOM as per QAP | QAP Para no: 7 or item list. | Conform to QAP | P | V | R | 100% by firm/ vendor. |
| 3. | Dimensional checks | Dimensions as per the drawing | drawing/QAP Para no: 11 | Conform to drawing and QAP Para no: 11 | P | W/P | R | 100% by firm/ vendor, SP followed by HVF. |
| 4. | Material tests | Chemical composition & Mechanical Properties | As per the relevant drawing and QAP | conform with QAP and Drawings | P | W/V | R | Refer note. |
| 5. | Coating checks | Coating | QAP Para no 11 | conform to QAP Para no 11 | P | V | R | 100% by firm/ vendor. |
| 6. | Marking / traceability checks | Marking / traceability | QAP Para no 16 | Conform to QAP Para no 16 | P | V | R | 100% by firm/ vendor |
| 7. | Preservation & packing checks | Preservation & packing | QAP Para no 17 & 18 | Conform to QAP Para no 17 & 18 | P | V | R | 100% by firm/ vendor. |

Note:

- One sample per heat/batch shall be tested under NABL Lab/Govt. Approved lab by firm. In case of non-compliance to standards entire lot will be rejected or not to use in production further.
- For cross conformation, manufacturer has to submit test samples /HVF will draw samples from supplied lot on receipt for Witnessing (W) at HVF premises. In case of non-compliance to standards entire lot will be rejected.

P - Perform W- Witness V-Verify R-Review SP-Sampling Plan

RECORD OF AMENDMENTS

| Sl. No | Amendment No. & date | Amended by | Date of Insertion | Initial |
|---------------|---------------------------------|-------------------|--------------------------|----------------|
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