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GOVERNMENT OF INDIA

MINISTRY OF DEFENCE

DIRECTORATE GENERAL OF QUALITY ASSURANCE

QUALITY ASSURANCE INSTRUCTIONS

No CQA (ICV)/QAI/001A

[SUPERSEEDS CI (ICV)/QAI/001A Issue 1 29 Feb 1988]

WATER RADIATOR

Drng No 765-03-Sb 178



CONTROLLERATE OF QUALITY ASSURANCE

(INFANTRY COMBAT VEHICLES)

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QUALITY ASSURANCE INSTRUCTIONS

No. CQA(ICV)/QAI/001A

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WATER RADIATORS

DRG. NO. 765-03-Sb 178

Prepared By

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SIGNATURE



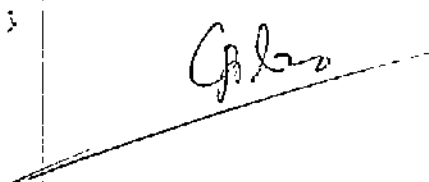
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Secunderabad-3

Dt. 25 Nov 1990

MINISTRY OF DEFENCE

DGQA

CONTROLLERATE OF QUALITY ASSURANCE
(INFANTRY COMBAT VEHICLES)

QUALITY ASSURANCE INSTRUCTIONS
NO.CQA(ICV)/QAI/001A

(Supersedes CI(ICV)/QAI/001A Issue 1, 29 Feb 1988)

WATER RADIATOR

DRG.NO. 765-03-Sb178

QUALITY ASSURANCE INSTRUCTIONS FOR
WATER RADIATORS
DRG.NO.765-03-Sb 178

INTRODUCTION/SCOPE

This Quality Assurance Instruction is the property of Government of India. This is based on the acceptance standards and the methods generally in vogue and has been compiled for guidance of Inspector during inspection of Water Radiator to drawing No.765-03-Sb 178, its relevant part drawings and process sheets used in the cooling system of Article 675 to ensure that the stores accepted are qualitatively comparable to original in meeting the service requirements, pilot and bulk inspection requirements for determining the quality and performance of water radiator assembly.

This QAI also includes certain tests not covered in the original drawings and specifications. In such cases the test parameters and acceptance standards will jointly be considered.

This QAI is liable to be amended as and when required by the Controller, CQA(ICV). During inspection, if the inspector finds any points which could be included in the QAI, he should refer such points to the Controller, CQA(ICV) and finalised after matter is jointly considered with the supplier. Before commencing the inspection, the inspector will make himself fully conversant with the terms and conditions of the contract including specifications, drawings and other literature.

II. DESCRIPTION/CONSTRUCTION

The power unit which sets the vehicle in motion is a six cylinder engine. 'V' type, four stroke, high speed airless injection, liquid cooled, diesel engine with jet atomisation of fuel.

Contd... 2

The gross hose power of the engine at 2600 rpm is 210 to 211 Kw (285 to 300 hp) and specific fuel consumption at 2200 rpm is not more than 10.9 gr/kwh (8 grams/hp H).

The cooling system is designed to dissipate the heat from the engine parts and to maintain the temperature of these parts within the tolerable range. The coolant is a liquid with closed circulation. The total quantity of the coolant in the system is 50 to 52 litres. In summer water with three component additive is used for cooling the engine and in winter low freezing liquid grade 40 or 65 is used. The cooling system consists of water pump of the engine, radiator, expansion tank, vacuum- and pressure relief valves, ejector, heater's cock, louvers and shutters of the ejector and pipes.

Flow of cooling air through the radiator fins is caused by partial vacuum created in the ejector casing due to the flow of the engine exhaust gases and therefore, the conventional fan is eliminated. Radiator has a fin and tube type core. It is designed to cool the coolant coming from the engine and is mounted in the top of the ejector casing along with the air coolers. The radiator consists of packs of brass tubes having oval cross section cooling fins that are fitted into the tubes, tube plates and headers. The operating pressure of pressure and vacuum relief valves are $1.8/2.2 \text{ kg/cm}^2$ and $0.06/0.1 \text{ kg/cm}^2$ respectively.

III. QUALITY ASSURANCE PROVISIONS

Inspection Responsibility : The supplier is responsible for satisfactory performance of the item during usage and for the performance of all inspection requirements specified herein. Inspection and test records shall be kept complete and made available for perusal of the Inspector.

2. Quantity 4 Nos. are required to be submitted as pilot samples before commencing the bulk production. Clearance for the bulk production will be accorded only

after evaluation/approval of pilot samples. Inspection of pilot samples and bulk supplies of water radiator assemblies will be carried out in accordance with these quality assurance instructions, relevant drawings and material specifications. The following method of inspection will be adhered.

| S.No. | Description of test to be carried out | Sampling Size | |
|-------|--|---------------|--------------------------------------|
| | | Pilot | Bulk |
| 1. | Visual Inspection | 100% | 100% |
| 2. | Dimensions | 100% | 10% |
| 3. | Materials | 1 No. | 1 in 300 & 1 in any case |
| 4. | Water capacity check | 100% | 10% or 2 Nos. max. per lot |
| 5. | Weightment | 100% | -do- |
| 6. | Leakage Test | 100% | 100% |
| 7. | Flow rate test | 100% | 10% or 2 nos. per lot. |
| 8. | Vibration test on jolt table | 100% | 5% subject to minimum of 1 no. /lot. |
| 9. | Endurance test on high frequency vibration table | 1 No. | 1 No. against each order |
| 10. | Heat transfer test | 1 No. | 1 No. against each order |
| 11. | Fitment/Performance on vehicle | 1 No. | 1 qualifying test for supplier |
| 12. | Preservation | 100% | 100% |

IV METHODS OF TEST TO BE CARRIED OUT

1. Visual Inspection : The radiator assembly shall be inspected visually that workmanship is satisfactory.

Edge bonding of fin shall be uniform and distortion limited to tolerance shown in the drawing. Ensure adequate contact between fin and tube in the core to meet the heat dissipation within the tolerance specified. Ensure building up of core is as per the relevant drawings. Care should be taken on quality of soldering and trimming and presence of plugs and seals. There shall be no signs of corrosion or any visible damage.

2. Dimensions : All the dimensions shall be strictly conform to relevant component drawings 765-03-Sb 178. During inspection of pilot sample, before assembling the radiator, detailed dimensions of all the components shall be checked as per the relevant drawings. Bulk supplies shall be checked for all over all dimensions and reference dimension. Number of fins and tubes of Radiator shall be within specified limits.

3. Materials : The radiator assembly shall be manufactured using the materials conforming to the material specifications mentioned in the relevant drawing. Material test specimens/ test bars may be drawn for chemical analysis and mechanical properties as per the relevant specifications. The results shall conform to the specification. The solder material and brazing material used in the fabrication of radiator assembly shall also be analysed for chemical composition as per specifications. The representative samples for the above tests may be drawn from the production line of the components. In case any disputes on the test results the supplier shall arrange testing at standard laboratories where the samples will be tested in the presence of the Inspector.

4. Water Capacity Check : The aim of this is to check the amount of water that can be held by the radiator. The water holding capacity of the radiator shall be within the limits of 27.0 ± 1.5 litres.

5. Weightment : Individual weight of each radiator shall be within the limits of 110.5 kg max. The supplier will record weight of all the radiators. Inspector will verify the records and check the weight of random samples.

6. Leakage Test : a) Pressurise the radiator with compressed air upto 3 kg/cm^2 and immerse in hot water maintained at 75° to 85°C for 1 minute minimum. No leakage shall be permitted.

b) Alternatively pressurise the radiator with hot water maintained at 75° to 85°C upto 3 kg/cm^2 for one minute minimum. No leakage of water or sweating shall be permitted.

c) The radiator shall be further tested with compressed air upto 3 kg/cm^2 for one minute to check for leaks in water at room temperature if so required by the inspector.

NOTE : Rectification of leaks by solder/brazing at all stages of testing shall be permitted. After rectification leak test shall be repeated.

7. Flow rate test : Pressure drop between inlet and outlet of radiator shall be 9.5 PSI max. at a water flow rate of 340 lt/min at room temperature.

8. Vibration Test on Jolt Table : Before commencing the test the radiator shall be subjected to leak test as per clause (6) above. The radiator is mounted and securely held on the table with rubber sheets (as installed in vehicle radiator compartment). The radiator is pressurised upto 1 kg/cm^2 with water at room temperature and subjected to vibration as follows.

(i) Amplitude : 50 mm simulating free fall of radiator with the table on timber blocks placed on felt or rubber mats.

- ii) Frequency : 80 \pm 10 cycles/min.
iii) Duration : 2 min. minimum - No leakage shall be permitted.

All 4 Nos. of the pilot lot will be subjected to the above test. 5% of the bulk or minimum one number from each lot will be tested. In case the sample fails the entire batch will be tested. Leakage can be rectified by soldering/brazing and retested as 6(c) only.

9.

9. Endurance Test on High Frequency Vibration Table : To ensure that the fabrication process and material specification meet operational requirements, the pilot lot must be tested on a vibration rig hydraulically or otherwise similarly actuated. The radiator will be mounted on the table of the rig resting on rubber pads and held securely in position. The radiator will be filled with water at room temperature and maintained at a pressure of 1 kg/cm². The following parameters will be selected for test:

| | | |
|---------------|----|------------------------------|
| Acceleration | -- | 4 g in up and down direction |
| Amplitude | -- | 3 to 5 mm |
| Test duration | -- | 10 hours |

No leak is permitted when tested with compressed air at 1 kg/cm² in water at room temperature.

10. Heat Transfer Test : The aim of test is to find out the quantum of heat dissipated by radiator core, at various air flows for stipulated water flow. To keep the heat input requirement of test within practical limit sealed model of core not less than 250 mm x 250 mm frontal area is prepared with necessary tanks and plumbings.

The specimen core is fitted in a wind tunnel with arrangement to measure (1) air and water flow, (2) air pressure drop (3) air and water temperature at inlet and outlet conditions.

The following parameters are to be selected for the test:

- i) Inlet water temperature $85^{\circ} \pm 2^{\circ}\text{C}$
- ii) Water flow rate 300 l/min.
- iii) Air velocity to be varied 10 to 40 km/hr at room temperature.

The heat dissipation is carried out on the scaled model of Core at specified coolant flow rate and the heat dissipation in K.Cal per hour per degree of temperature gradient per dm^2 of core area is computed. Based on this the heat dissipation for the total core of the radiator for 50° of temperature gradient is computed. The specified values (as obtained by testing imported sample) are given at appendix-'A'. The observed values shall be within $\pm 10\%$ of the specified values.

11. Fitment/Performance on Vehicle : Quantity one pilot samples and random sample from the bulk shall be fitted on the vehicle. Then the vehicle may be subjected to rigorous cross country test, gradient climbing and maximum speed running test for a total duration of 500 km. The coolant temperature so recorded must be compared with original radiator subjected to similar test. The radiator performance must be expressed as 'Cooling Constant' in $^{\circ}\text{C}$ which is the temperature difference between radiator inlet water and temperature of air in $^{\circ}\text{C}$ at the core inlet face standard and calibrated thermometer and temperature gauges must be used for temperature measurement.

12. Preservation : After testing, each radiator shall be washed and flushed free from traces of flux, zinc salts and other chemicals. Drying the radiator with jet of hot air to ensure that no traces of water are left inside the tubes. Traces of zinc or chloride salts more than 0.025 g/litre of radiator volume shall not be permitted. Each radiator

Contd... 8

shall be flushed with passivating solution for corrosion resistance. All openings in each radiator shall be plugged firmly using wooden or plastic plugs painted red in colour and tied in position with wire and sealed.

V. PAINTING :

External surface of headers including beading of tubes boards shall be given a coat of primer and painted enamel green of IS:2933-75 semiglossy olive green scamic 314 JSS:8010-1. The fin surface and flange threads shall be protected.

VI. MARKING :

The following identification marks shall be stenciled or rubber stamped on each radiator at location shown on the header

- a) Manufacturer's symbol
- b) Supply order No. and date
- b) Code and part No.
- d) Serial No. and date of manufacture.

VII. PACKING :

Each radiator shall be individually packed in wooden case firmly supported at the joints of headers with the tube boards and the core surfaces protected suitably. Each case shall bear the following marks :

- a) Manufacturer's name or symbol
- b) Supply order No. and date
- c) Part No. and date of manufacture
- d) Part description.

HEAT DISSIPATION VALUES FOR WATER RADIATOR 765-03-0008

APPENDIX-'A'

| COOLANT - WATER | | | | | | COOLING MEDIUM - AIR | | | | | | | | | | | | |
|-----------------|-------|--------|-------|---------------|-------|-------------------------|-------|----------------------|-------------|-------|--------------------------|----------------------|---------------------------------|--------------|----------------|--------------|-----------------------------------|--|
| Sl. No. | IN °C | OUT °C | Δt °C | Flow mm of Hg | l/hr | Heat dissipated KCal/hr | IN °C | OUT °C | OUT (AV) °C | t °C | ΔP across orifice mm W.S | P across core mm W.S | Volume flow m ³ /sec | Velocity M/B | Velocity km/hr | Temp grad °C | "q" K Cal / hr °C dm ² | Corrected for full size core & 50°C gradient KCal/hr |
| 1. | 85.4 | 84.7 | 0.7 | 172 | 17980 | 12586 | 32.5 | 75.5 77.0 75.0 | 75.83 | 43.33 | 4 | 7 | 0.171 | 2.736 | 9.85 | 52.9 | 38.06 | 129686 |
| 2. | 85.5 | 84.5 | 1.0 | 172 | 17980 | 17980 | 31.5 | 71.0 71.5 72.5 | 71.66 | 40.16 | 17 | 26.3 | 0.3525 | 5.64 | 20.3 | 54.0 | 53.27 | 181512 |
| 3. | 85.35 | 84.0 | 1.35 | 172 | 17980 | 24273 | 31.5 | 67.5 69.0 69.0 | 68.5 | 37.0 | 39.5 | 54.5 | 0.5374 | 8.598 | 30.9 | 53.85 | 72.12 | 245742 |
| 4. | 85.55 | 83.9 | 1.45 | 172 | 17980 | 26071 | 31.5 | 65.5 67.5 67.5 | 66.83 | 35.33 | 57.5 | 75.0 | 0.64837 | 10.37 | 37.3 | 53.85 | 77.46 | 263937 |
| 5. | 86.05 | 84.4 | 1.65 | 172 | 17980 | 29667 | 31.5 | 65.0 67.0 67.0 | 66.33 | 34.8 | 79.0 | 98.0 | 0.75998 | 12.16 | 43.7 | 54.55 | 87.0 | 296444 |

Indigenous Radiators shall be tested under similar test conditions and the values should be within 10%.