OUTER SHEET

# TECHNICAL SPECIFICATION
# FOR
# THREE-PHASE ASYNCHRONOUS TRACTION MOTOR
# (WITH SCHEME-I TYPE ROTOR)

## TYPE : 6FRA-6068 FOR WAG – 9 /WAP-7 LOCOMOTIVES

**Total no. of sheets – 23**

| **Alt No.** | 01 | 02 | 03 | 04 | 05 | |
|---|---|---|---|---|---|---|
| **Date** | 21/04/2023 | 11/10/2023 | 25/05/2024 | 04/11/2024 | As signed | |
| **Sheet No.** | 10 | 10 to 13 | 13 & 17-23 | 10 | 10-13, 16 & 17-23 | |

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|---|---|
| | |
| Recommended by CEE/TM | Approved by PCEE |

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|---|---|
| **3-Ph Asynchronous Traction Motor (with Scheme-I type Rotor) Type 6FRA-6068 for 3 ph Electric Locomotives.** | **CHITTARANJAN LOCOMOTIVE WORKS (W.B.)**<br>**No. 4TMS.096.080 Rev-1 Alt-5**<br>Initial Issue Date : 12.07.2022 |

| Prepared & Checked by | | Reviewed by | |
|---|---|---|---|
| SSE/TMDO | | Dy.CEE/TMD | |

## Alteration Sheet:

| Alt. No | Description of Alteration | Issuing Authority | Date |
|---|---|---|---|
| 01 | Routine test schedule at clause number 7.5.2 modified, BOM updated at clause number 13 and specification digitized. | Dy.CEE/TMD | 21/04/2023 |
| 02 | "Frequency in percentage for lot to be inspected by inspecting agency" revised in clause No. 7.5.2 vide Note No. CLW/TM/Sample QAP approved on 26/06/2023 | Dy.CEE/TMD | 11/10/2023 |
| 03 | Para No. 7.5.2, Routine Test Schedule and Para No. 13, Bill of Material modified vide Note No. CLW/TM/17280 Vol-IV dated 10/05/2024. | Dy.CEE/TMD | 25/05/2024 |
| 04 | Inductance measurement between phases incorporated in para 7.5.2 Routine Test Schedule vide Note No. CLW/TM/17280 Vol-IV approved on 23/10/2024. | Dy.CEE/TMD | 04/11/2024 |
| 05 | Para No. 7.5.2, Routine Test Schedule, Para No. 11 Inspection Criteria, Para 13 Bill of Material modified & Para 14 Warranty added. | Dy.CEE/TMD | As signed |
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**Three Phase Asynchronous Traction Motor Type 6 FRA 6068 with Scheme-I type Rotor for 3 Ph Electric Locomotive.**


| SN | Description |
|---|---|
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**SUBJECT :-**

Short description : Three-phase asynchronous traction motor, type: 6FRA 6068
Number : Six (06) traction motors per locomotive

## 1. FUNCTION/PRINCIPLE :-

### 2.1 Scheme :-

For general information see the following documents please:

| | |
|---|---|
| Main Current scheme | 3EHP 281141 |
| TE-speed-diagram | HBTB 490727 |
| TE/BE-speed-diagram | HBTB 490731 |
| Cooling system | BEHT 3056 |

### 2.2 Principle :-

Due to the converter technology it is possible to use asynchronous brushless motor, which have the advantage of being maintenance-free with smaller dimensions and a very favorable power-to-weight ratio. The freight loco for Indian Railways has two bogies, each with three axles. Three traction motors per bogie are connected in parallel to a motor converter (ASC).

The control of the motors is executed by the motor converter (ASC), which generates a voltage proportional to frequency-rate. Up to the rated point the frequency is approx. proportional to the voltage rate from the rated point to max. speed the voltage remains constant. Wheel slip and torque are accordingly defined by comparing the frequency of the rotating field and the motor speed. A positive slip generates traction forces, a negative one brake forces.

## 3. TECHNICAL DATA :-

### 3.1 Vehicle data:-

| | |
|---|---|
| Vehicle mass | : 123 ton ± 1% (Without ballast) |
| Gauge | : 1676 mm |
| Ground clearance above rail level, wheel fully worn | : 102 mm between bottom of gear case and |
| Diameter of the traction wheels | |
| New | : 1092 mm |
| Half-worn | : 1054 mm |
| Fully-worn | : 1016 mm |

### 3.2 Vehicle characteristics:-

All information refers to half-worn wheels.

| | |
|---|---|
| Operational condition | : according to IEC 563-1976, clause 2.2 (a) |
| Initial traction force | : 460 kN |



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| | |
|---|---|
| Continuous traction force | : 325 KN, range 0-50 km/h |
| Continuous power | **:** 4500 KW, range 80-100 km/h |
| Test Speed | **:** 110 km/h |
| TE-speed-diagram | : HBTB 490727 |
| TE/BE-speed-diagram | : HBTB 490731 |

**3.3 Electrical data :-**

| | | Rated point | Maximum data |
|---|---|---|---|
| Stator frequency | : | 65 Hz | 132 Hz |
| Motor voltage (phase to phase) | : | 2180 V | 2180V |
| Stator current | : | 270 A | 393 A |
| Power factor | : | 0.88 | -- |
| Torque | : | 6330 Nm | 9200 Nm |
| Power | : | 850 kW | 850 kW |
| Motor Speed at shaft | : | 1283 / min | 2584 / min |

For additional information see:

| | | |
|---|---|---|
| - Data sheet traction motor | : | 3 EHM 426603 |
| - Characteristics traction motor | : | 3 EHM 426606 |

**3.4 Design :-**

| | |
|---|---|
| Type | : 6FRA 6068 |
| Outline Drawing | : 3 EHM 211699 |
| Weight | : 2100 kg / ± 5% / average |
| Transmission | : axle suspension |
| Gear ratio | : 21: 107 (WAG-9) & 20:72 (WAP-7) |
| Painting | : RAL 7021 (anthrazite silky surface finish) |

Remarks: In case of an earth fault, the propulsion system must stay in service. For fault-finding the vehicle should be put out of service in the evening of the day the failure happened. Drainage holes for condensing water have to be cut in.

**Cooling :-**

| | | |
|---|---|---|
| Coolant | : | Air |
| Ventilation type | : | by independent fan |
| Flow rate | : | 4.05 $m^3/s$ at 1900 Pa. |
| Pressure drop | : | 1600 Pa |
| Air intake | : | The cooling air for the traction motor has to be passed through a zyclon-filter at the locos side panels. |
| Air escape | : | at the under side of the Loco's floor. |



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**Electrical connection :**

| | | |
|---|---|---|
| Supply cable | : | Cables are constructed with M 12-fasteners within the terminal box. |
| Design | : | according to chapter 6.1 and waterproof |
| Insulation material | : | GRP (glass reinforced polyester) Pre-preg |
| Creep age distance | : | min. 45mm. |

**Protection system:**

The traction motor meets the protection system IP 22M with the exception of the air inlet and air escape at the bearing end frame. The clamp case meets IP-55.

**Fixed electrical connections:** Preferably pressed-on or bolt-on.

**Shocks and vibration: -**
suitable for Rly. stock according to IEC-77.

**Inflammability and toxicity of materials.**
-Non-inflammable and non-toxic materials to be used.

**3.5 Insulation system:-**

| | |
|---|---|
| Insulation class | : Class 200 |
| Insulation system | : Veridur (R) |
| Diff Hot-Spot & average temp. | : ≤30º C during 1 h, short time and continuous rating. |
| Max. heating | : The max. heating of the winding under nominal load must never exceed temperature Index of Class 200 minus 95º C (Δv ≤ 253ºC- 95º C = 158). |
| Evaluation or the Insulation System | : Thermal properties, ageing according to IEEE 309 and IEC 505<br>- Resistance against humidity according to IEEE 429. |

**3.6 Auxiliary devices at the motor :-**

| | |
|---|---|
| Speed sensing System :- | : Active Speed Sensor to spec No. 4TMS.096.079 (not to be supplied) |
| Temperature measuring :- | |
| System | : 2 Sensors PT 100 |
| Completely Assembled Temperature Sensor | : 4TMS.096.085 Rev-2 |
| Rated data | : 0˚C/100 Ohm |
| Plugable connection | : None at the motor. |
| Cable length | : 2200 mm. |



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**4.0 ADDITIONAL CLAUSE** :- The successful tenderers shall submit design details and drawings to RDSO/CLW for approval before the manufacturing of proto type.

## 5. STANDARDS/QUALITY

**5.1** Standards (Revised no from IEC handbook should be followed)

| | |
|---|---|
| IEC 77/2 | : Electrical Traction devices (components) |
| IEC 349/2 | : Electrical Traction devices (rotating machines) |
| IEC 34-14 | : Mechanical vibrations (rotating machines) |
| IEC 563 | : Allowed temperatures for electrical devices |
| IEC 505 | : Insulation system for electrical devices |
| IEC 505 | : Draft supplement |
| IEEE 429 | : Standard test procedure for the evaluation of sealed insulation for AC electric machinery |
| IEEE 304 | : Test procedure for evaluation and classification of insulation systems machines. |
| IEC 349-2 | : Electrical Traction rotation electrical machines for rail and road vehicles. Part 2 electronic converter fed ac motors. |

### 5.2 Quality assurance

An **ISO 9001** compatible quality assurance system has to be used.

## 6. ENVIRONMENTAL CONDITIONS

### 6.1 Environmental conditions

| | | |
|---|---|---|
| Country | | : India |
| Location of the traction motor | | : bogie |
| Environmental air | | : salty |
| Cooling air temperature | | : 0 ……. + 47°C |
| Expose to sunshine max. | | : 70°C |
| at shadow | | : 50°C |
| Air humidity | nom. | : 60% |
| | Max. | : 100% during rainy season (monsoon) |
| Operational heights | nom. | : 160 m above sea level |
| | Range | : 0…1000/800 m above sea level. |

Rainfalls : In some area heavy rainfalls have to be taken into account. Running at 10 km/h must be possible under flood condition. (102 mm above rail level).

Hot season : Extremely dusty, in some areas deserts.

Locomotive and equipment should be designed for operation in coastal region (wet and salty air) as well as in arid or semi arid areas (extremely dry and dusty air).



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**6.2 Lifetime :-**

Operational time - Daily approx. : 16 hours (approx. 330 days per year).
Environmental conditions
Rated values for environmental temperature and air humidity according to chapter 6.1.

Traction motor : 40 years from initial operation of the locomotive onwards.
Bearings : 1.6 Mio. Km (L-10 Lifetime);

**6.3. Reliability**

Operational condition : according to chapter 5.2
Availability rate : 98%
Life time of the locos : min. 30 years (Maintenance, spare parts lifetime)

**6.3.1 Assurance of reliability**

Components, modules, groups and so on, according to ABB-rules (CHVEK-IEC) & DIN-standards.

**6.3.2 Failure rate**

Failure classification : The following MIBF should be achieved 37-67 years.
Category 3 Failure with impact on operation (bogie-failure) MTBF: 12.5 years.
Calculation see document 3EHM 620757 "Reliability Estimation".

**6.4 Security**
As per client's requirements.

**7.0 TEST CONDITIONS :-**

**7.A Type Tests :-**

According to IEC 349 (latest), IEC 349-2 (latest) and test specification Indian Railways prescribes a type test for every component. Exception are only made, if the concerned component has been tested earlier, used as a strictly identical item (down to the smallest screw) and run under identical condition (e.g. leading the cooling airflow). Therefore, a type test is required. The type test planning shall be submitted to the technical project management and the Indian Railway representatives for approval.

The acceptance test place in the presence of the Inspecting Officer from Indian Railways for client's information, a definite timetable must be submitted to the project management at least 7 weeks before start of the test.

**7. B Routine tests:-**

According to IEC 349 (latest), IEC 349-2 (latest) and test specification, they have to be submitted to the technical project management for approval.

**7.1.0 SITUATION & PURPOSE**

Traction motor is to be tested according to the standard IEC 349-2. Type test to be done on first 06 (Six) Nos. Traction Motors as per Type Test Schedule issued by design office. Type test on converter supply [(i) Temperature Rise test, (ii) Short time thermal test / Heat Run test & (iii) Motor Characteristics tests] to be done on one of first 06 TMs or any other subsequent TM.

**7.2.0 ASSIGNMENT**

Type tests on one motor with two point converter supply (except the over speed test and the cooling air measurement which can be carried out on sinusoidal voltage supply).
-Routine tests on all motors on sinusoidal voltage supply. 50 Hz.
- Evaluate or compile the type tests result in the form of a type test report, which also must contain the routine test report of the type tested motor.

**7.3.0 INFORMATION AVAILABLE :-**

-Standard instructions IEC 349 (latest) and IEC 349-2 (latest)
-working instructions HTAT 620467 (test thermocouples)

**7.4.0 DATA OF TEST OBJECT :-**

Three phase asynchronous traction motor, type 6FRA6068 (Curve sheet 3EHM 426606)

| | | | **Nominal working point** | **Maximum values** |
|---|---|---|---|---|
| Voltage ( phase /phase ) | $U_1$ | V | 2180(F) | 2180(F) |
| Current( phase ) | $I_1$ | A | 270(F) | 393(F) |
| Power ( shaft ) | $P_1$ | KW | 850 | 850 |
| Torque ( shaft ) | T | Nm | 6330 | 9200 |
| Speed | N | 1/min | 1283 | 2584 |
| Stator frequency | $f_1$ | Hz | 65 | 132 |
| Forced ventilation | 1.35 $m^3/s$ | Test Voltage | | 8300V |
| Over speed tests | 3250 $min^{-1}$ | Insulation Class | | 200 |

(F) = Fundamental value



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**7.5.1** Firm must keep ready in advance before placing call for inspection and shall be made available to inspecting engineer on arrival for physical inspection.

Inspection engineer properly check acceptability of above mentioned documents before commencement of inspection.

a) Copy of PO With latest Amendments.
b) Copy of applicable latest specification, Drgs., MS/SMIs.
c) Copy of latest QAP (Quality Assurance plan/test protocol etc.
d) Sr. Nos. of equipment being offered (with Declaration about latest applicable Drg./Spec./QAP etc.)
e) Details of compliance of MS/SMIs.
f) Details of compliance of any special instruction as issued by CLW/RDSO/Consignee.
g) Details of compliance of any special condition as mentioned in PO/Amendments.
h) Details of material procurement from sub vendor (Test certificates, Invoice/material receipt details), lot wise material utilization/consumption records).
i) Internal test/measurement reports as per QAP/test protocol.
j) Stage inspection report if any earlier stage inspection done by RDSO/external inspector.)
k) Details Investigation/rectification Report if previously failed/rejected equipment is being re-offered for inspection.

The above is list of standard required documents, any other details /records like shop diary/register/or any relevant documents as required for cross verification by inspecting engineer should also be made available promptly , so that inspecting engineer may satisfy about acceptable quality standards followed by firm in manufacturing.

**7.5.2 Routine Test Schedule:** Routine tests (on sinusoidal supply 50Hz) (only one direction of rotation) Test to be done according to test as per IEC 349 -2/1993 & 3EHM 620794 & 3EHM 420347 Alt-1

| SN | Nature of Tests | Specified Limit | Frequency in percentage for Lot | |
|---|---|---|---|---|
| | | | To be tested by firm | To be inspected by inspecting agency |
| **Final Inspection:** | | | | |
| 1 | Resistance measurement on all windings. | 93.28 to 103.10 mili ohm at 30°C | 100% | i) 10% for lot of ≥ 20 TMs (Minimum quantity 04 numbers or next whole number whichever is higher to be taken). & |
| Alt-4 | Inductance measurement between phases | Inductance variation should be ≤0.015 mH (15 µH) | 100% | |
| 2 | No-load characteristic and winding tests: | | | |
| 2.1 | No-load characteristic and winding tests Measured phase current $I_0$ | $U_0$ phase / phase = 2360V, 1817 V, 545V | 100% | |
| | Measurement of current symmetry at $U_{0\ n}$ | 1817 $U_0$ [V] Current balance ±2% | | |



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| SN | Nature of Tests | Specified Limit | Frequency in percentage for Lot | |
|---|---|---|---|---|
| | | | To be tested by firm | To be inspected by inspecting agency |
| 2.2 | Test of stator winding:<br>The first two motors:<br>The motor is to be run at $U_1$ (phase/phase) = 2180 V on no-load without ventilation and with the air inlet closed. The duration of the test shall be 30 minutes (stop the run by switching over the terminals $U_1$ and $V_1$)<br>Stator winding temperature 150°C -180°C<br>After the run, measure:<br>--Winding temperature (resistance method)<br>--Housing (frame) temperature<br>-- Bearing temperature DE/nDE<br>--Thermo-feeler readings 1 /2<br>--Ambient temperature<br>The stator winding temperature (by resistance measurement) shall be 150 … 180°C. If this is not the case, than the run must be repeated with another $U_1$ value.<br>Repeat the test with a second motor.<br>Determination of the $U_1$-value for the following motors from the results of these two motors.<br>The condition:<br>After the 30min. run at this $U_1$-value, the winding temperature shall be at least 150°C. | U1 [V]<br>2180 V<br>U1-V1 [°C]<br>150 - 180 °C | 100% | ii) 20% for lot of < 20 TMs (Minimum quantity 02 numbers or next whole number whichever is higher to be taken).<br>Alt-2 |
| 2.3 | The following motors-<br>The (cold) motor is to be run on no-load without ventilation and with the air inlet closed during 30 min. at the $U_1$-value attained from the test above (Test 2.2).<br>Measurements after the run like test 2.2 | Temperature rise of stator winding 121 - 141 °C<br>Temperature rise of bearing DE -- 40°C max and nDE 40°C max. | 100% | |
| 2.4 | Short circuit characteristic: first motor<br>Set value :phase current $I_0$<br>Measured value; phase to phase voltage $U_0$<br>Rotor blocked up<br>Measurement of current symmetry at 270A, 50 Hz , blocked rotor<br>Declared value of the short circuit current at this $U_1$-value is the average value from the first 4 motors. | $I_1$=390, 270, 80A<br>$I_1$ [A]<br>270 A<br>Current symmetry ± 2% | 100% | i) 10% for lot of ≥ 20 TMs (Minimum quantity 04 numbers or next whole number whichever is higher to be taken).<br>& |



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| SN | Nature of Tests | Specified Limit | Frequency in percentage for Lot | |
|---|---|---|---|---|
| | | | To be tested by firm | To be inspected by inspecting agency |
| 3 | Test of the isolation<br>Winding against iron<br>Measure isolation resistance of the winding against iron with 1000V DC. | 8300 V, 1 min.<br><br>I.R. > 500 MΩ | 100% | ii) 20% for lot of < 20 TMs (Minimum quantity 02 numbers or next whole number whichever is higher to be taken).<br>Alt-2 |
| 4 | Check direction of rotation<br>$L_1$-$L_2$-$L_3$ to $U_1$-$V_1$-$W_1$:<br>Rotation clock wise as seen from DE. | Rotation clock wise as seen from DE. | 100% | |
| 5 | General data | | | |
| | A. Statement of rotor diameter, stator bore diameter, air gap, type of bearings, on the test report. | As per tendered drawings & specification | 100% | |
| Alt-5 | B. Axial Play<br>Radial Clearance DE (measured)<br>Radial Clearance DE (effective: 0.86 x measured) | 200-400 µm<br>130-220 µm<br>110-190 µm | 100% | 100% |
| 6 | Check of temperature sensor assly<br>As per 4TMS.096.085 Rev-2 measure the resistance of temperature probes with multi meter & calculate the temperature which should not vary more than 2 °C | IR with 500 V megger > 50 MΩ<br>-- Resistance of the element 107.6Ω ± 2% at temp 20 °C | 100% | i) 10% for lot of ≥ 20 TMs (Minimum quantity 04 numbers or next whole number whichever is higher to be taken). &<br>ii) 20% for lot of < 20 TMs (Minimum quantity 02 numbers or next whole number whichever is higher to be taken).<br>Alt-2 |
| 7 | Wheeling test of TM | To check temperature rise , abnormal sound, backlash range: WAG-9: 0.290 - 0.490 mm. WAP-7: 0.254 - 0.458 mm | 100% | 20% (Minimum quantity 02 numbers or next whole number to be taken.) & test report of remaining qty to be verified. |
| Alt-5 | **Note**: Check sheet for assembly/overhauling of TM type 6FRA 6068 issued vide RDSO's letter number EL/3.2.182/comments/3 Ph dtd. 02/12/2024 to be filled up and jointly signed by OEM and inspection agency during routine inspection. | | | |



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| SN | Nature of Tests | Specified Limit | Frequency in percentage for Lot | |
|---|---|---|---|---|
| | | | To be tested by firm | To be inspected by inspecting agency |
| **Stage Inspection:** | | | | |
| 8 | Verification of purchase documents | - | 100% | 100% |
| 9<br>Alt-3 | Inspection (by 3D CMM) of Associated Components of Machined Stator i.e. 11 components in kit form.<br>Alt-5 | Dimensions. (As per respective drawings with latest alt) | **To be inspected by inspecting agency**<br>100 % at firm premises (i.e. TM manufacturer) / sub vendors premises. Place of inspection to be decided by railway inspection agency in consultation with TM manufacturer. | |
| 10 | Inspection (by 3D CMM) of Machined Stator Assembly | | (i) 100 % CMM record verification if procured from CLW approved source **OR** (ii) 100% Internal CMM check if manufactured in-house. | 20% of offered Lot at firm premises (i.e. TM manufacturer) / sub vendors premises. Place of inspection to be decided by railway inspection agency in consultation with TM manufacturer. 100 % Record Review of CMM dimensional report. |
| 11<br>Alt-5 | Taper draw of Rotor Shaft (finished machined) | Distance between gauge face & shaft outer face should be 1± 0.3 mm | **To be inspected by inspecting agency**<br>100% at firm premises (i.e. TM manufacturer) / sub vendors premises. Place of inspection to be decided by railway inspection agency in consultation with TM manufacturer. | |
| | UT and Dimension Measurement of Rotor Shaft (finished machined) | As per respective specification and drawing with latest alt | 100 % | 100 % Record Review |

**Note:**

i. Tests Mentioned at Sr. No. 8 to 11 are independent from each other, thus tests at Sr. No. 8 to 11 can be done in single (01) stage/step or independently in 02 stages/steps may be opted by firm.

ii. If firm opts 02 stages, firm shall be independent to select any inspection from Sr. No. 8 to 11 for either stage (Stage-1 or Stage-2) or interchange, as per its convenience.

**Note:** This is bare minimum requirement. However, if the inspection authority desires to inspect /test more quantity or any other test not mentioned, they can do so with intimation to the manufacturer.

**ROTOR:**

Rotors are to be manufactured as per RDSO specification No.: RDSO/2007/EL/SPEC/0060 Rev-0 (Latest Alt. & Rev. to be followed)

**7.6.1** All the supplier should have at least one set of motor suspension unit with wheel assly. with arrangement of wheeling test (e.g. podium, power supply etc.).

**7.6.2** Supplier should carry out fitment & wheeling test of motor with motor suspension unit with wheel assly. on 100% TM. Temperature rise, abnormal sound to be recorded .Test results/records shall be shown to the inspecting authority.

**7.7 Meaning of the symbols**

| | | | |
|---|---|---|---|
| ΔpLe | [Pa] | = | pressure at motor inlet |
| Δ Ref | [Pa] | = | Pressure at reference point (The ref. point is a fixed point at the end shield nDE. The opening below can for instance be used for it.) |
| cosØ (cosphi) | [1] | = | power factor (fundamental value) |
| DE | | = | Drive end |
| (F) | | = | Fundamental value |
| F1 | [Hz] | = | Stator frequency |
| I1 | [A] | = | Stator current per phase (r.m.s value) |
| n | [1/min] | = | Motor speed |
| ns | [1/min] | = | Synchronous speed |
| nDE | | = | Non drive end |
| P1 | [kW] | = | Input power at the motor terminals |
| P2 | [kW] | = | Output power at the motor shaft |
| Pf | [1] | = | Power factor |
| S | [1] | = | slip = 1-n/ns |
| T | [Nm] | = | Torque at the motor shaft |
| U1 | [V] | = | Stator voltage (phase to phase) r.m.s value, at the motor terminals |
| V | [$m^3/s$] | = | Cooling air flow rate (cooling air quantity) |



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## 8. DOCUMENTATION :-

### 8.1 Drawings, tracings and descriptions :-

All drawings, specifications and work instructions which are necessary for design, assembly and commissioning of the traction motor, all parts list to each drawing has to be given. Within the individual lists all parts of the corresponding drawing have to be mentioned, including consumable items.

A family-tree has to be given, including all drawings, parts list and other relevant documents which are part of the documentation. Also, a complete list of all documents and all components ("Bill of Materials") has to be submitted as part of the documentation.

### 8.2 Manual :-

The manual includes all necessary information for correct, maintenance, fault finding and repair of the traction motor, including spare parts catalogue and instruction for assembly, dismantling and replacement of the individual components.

### 8.3 Structure :-

#### 8.3.1 Drawings, tracing and descriptions

The documentation shall be structured by the following order:

1. Family tree (sorted by Ident-no.)
2. List of drawing (sorted by Ident-no.)
3. Bill of Materials (sorted by Ident-no.)
4. Drawings etc. (sorted by sub assembly components, corresponding to the family tree).

All documents have to be given in proper folders; loose documents will not be accepted.

**Manual :-**

An overview of function and work order has to be given. The chapter of the manual must belong to the individual subassembly components. All drawings and documents, which are used as reference documents, have to be given as annexure to the manual.

### 8.4 No. of documents

#### 8.4.1. Drawing, tracing and descriptions

2 sets of prints (according to chapter 7.1.).
1 set of soft copy (only drawings; sorted by Ident- no.)

**8.5 Type-/Routine- Test documentation/Special documents :-**

| Document | Made by |
|---|---|
| Technical data and information | |
| Design/test | |
| Description of function | |
| Program of type test/routine test | |
| Records of type test/routine test | |

**8.6 Quality proof :-**

| Document | Made by |
|---|---|
| Standard test plan | |

**9. DELIVERY REQUIREMENTS :-**

(a) Developmental orders will be given after ensuring compliance with STR.
(b) Proto type traction motor should be delivered within 6 months.
(c) Proto type traction motor to be in satisfactory service on loco for at least six months after which joint clearance of RDSO & CLW shall be mandatory for supply of balance TM.
(d) Payment for proto type TM to be released only after above clearance.
(e) In case of failure, even after improvements, order to be cancelled.

**10. REFERENCE DOCUMENTS**

| *Sl. No* | *Title* | *Ident.- No.* |
|---|---|---|
| *1.* | *TE-speed-diagram* | *HBTB 490727.* |
| *2.* | *TE/BE-speed-diagram* | *HBTB 490731.* |
| *3.* | *General scheme main power circuit* | *3EHP 281141* |
| *4.* | *Data sheet traction motor* | *3EHM 426603* |
| *5.* | *Characteristics traction motor* | *3EHM 426606* |
| *6.* | *Cooling* | *BEHT 3056* |
| *7.* | *Reliability estimation* | *3EHM 620* |
| *8.* | *Outline drawing* | *3EHM 211699* |
| *9.* | *Bogie arrangement* | *IB011-00065* |

**11. INSPECTION CRITERIA**

a. Prototype and routine inspection will be carried out by the authorized representative of Dy.CEE/TMD & RDSO representatives or as mentioned in the P.O. at firm's premises. All the cost to be borne by the supplier.
b. Quality audit and consistency type test of TM manufacturers to be done every 05 years for ensuring reliability of Traction Motor.
c. All type test and routine test will be carried out as per the tender specification & approved test schedule.
d. Tenderer should submit detailed drawings and technical source of sub suppliers for approval before manufacturing of prototype sample.

## 12.0 SOURCES OF RAW MATERIALS :-

Firms shall make bulk procurement of individual items required for sub assemblies or complete equipment from Approved sources of CLW/RDSO source only. Procurement from vendors/ suppliers whose capacity cum capability assessment & prototype testing has been successfully done and final inspection certificate is issued by CLW, can be made up to 20% of total procurable qty in a given procurement case. Firm shall keep all such procurement records and will submit the same to inspecting agency at the time of inspection to ensure that above procurement procedure is strictly adhered to.

## 13.0 SCOPES OF SUPPLY & BILL OF MATERIAL FOR MANUFACTURING OF 3 PH TRACTION MOTOR WITH SCHEME-I TYPE ROTOR:-

Alt-5 Alt-3 Alt-1

(Note: For all specification & drawings latest alteration /revision /modification to be verified from Dy.CEE/TMD's office after placement of valid purchase order)

Each Traction motor consists of the following items.

| SN | C&D NO | DESCRIPTION OF ITEM | DRG. NO. & SPECN. NO. (latest Alt/Rev to be followed) | UNIT | QTY / TM (Indicative) |
|---|---|---|---|---|---|
| 1 | 5712/322 | Mica Glass Fabric Tape Mi/Gl-Gwb 18, size. 0.12x15 mm (in roll of 30 m) | 4TMS.096.098 (or latest) | Mtr. | 2840 |
| 2 | 5712/324 | Auto Adhesive tape (KAPTON) Selbst Kl F11, size 0.07x9.5 mm (in roll of 33m ) | 4TMS.096.097 Alt-1 (or latest) | Mtr. | 90 |
| 3 | 5712/325 | Auto Adhesive tape (KAPTON) Selbst Kl F11, size 0.07x19.1 mm (in roll of 33m ) | 4TMS.096.097 Alt-1 (or latest) | Mtr. | 280 |
| 4 | 5712/326 | Auto Adhesive tape (KAPTON) Selbst Kl F11,size 0.076x50 mm (in roll of 33m ) | 4TMS.096.097 Alt-1 (or latest) | Mtr. | 90 |
| 5 | 5712/327 | Polyimide Foil (KAPTON) PI F01 size 0.125x510mm (in continuous roll of 50m) | 4TMS.096.092 Rev-1 (or latest) | Mtr. | 10 |
| 6 | 5716/023 | Polyamide Paper (Nomex), PAP1, size 0.38x914 mm (in continuous roll of 10m) | 4TMS.096.091 Rev-1 Alt-1 (or latest) | Mtr. | 0.075 |
| 7 | 5716/015 | Polyamide (NOMEX) PA Vlies 1 Size 2.5x1000 (in continuous roll of 10 m) | 4TMS.096.028 Rev-1 (or latest) | Mtr. | 2.75 |



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| SN | C&D NO | DESCRIPTION OF ITEM | DRG. NO. & SPECN. NO. (latest Alt/Rev to be followed) | UNIT | QTY / TM (Indicative) |
|---|---|---|---|---|---|
| 8 | 5716/005 | Glass Fibre cord-1 Ø 7 | 4TMS.096.100 (or latest) | Mtr. | 25.25 |
| 9 | 5716/006 | Glass Fibre card-1 Ø 11 | 4TMS.096.100 (or latest) | Mtr. | 5 |
| 10 | 5716/051 | Flat Hose Gl Gefl-7 Size 1.6x17 mm | 4TMS.096.102 (or latest) | Mtr. | 125 |
| 11 | 5716/024 | Hose Gl Gefl 3(flat hose) Size 4x22 m | 4TMS.096.101 (or latest) | Mtr. | 1.8 |
| 12 | 5716/052 | Polyester Glass Silk Tape size 0.09±0.01 x20 mm | 4TMS.096.088 Rev-1 (or latest) | Mtr. | 687 |
| 13 | 5716/010 | Silicon Impregnating Resin | 4TMS.096.093 Alt-1 (or latest) | Kg. | 14.30 |
| 14 | 5716/012 | Auxiliary material 38 | 4TMS.096.093 Alt-1 (or latest) | Kg. | 0.26 |
| 15 | 5716/019 | Basic Resin SI 32 | 4TMS.096.094 Alt-1 (or latest) | Kg | 0.37 |
| 16 | 5716/020 | Accelerator 27 | 4TMS.096.016 Rev-1 (or latest) & 4TMS.096.094 Alt-1 (or latest) | Kg | 0.004 |
| 17 | 5716/045 | Silicone Rubber components Elastosil RT 622 A& B and Primer G-790 of Wacker Metroark chemicals or equivalent | Primer G-790 Spec: 4TMS.096.095 Alt-1 (or latest) | Kg | 5.25 |
| 18 | 5760/650 | Completely Assembled Temperature Sensor for 3ph Traction Motors | 4TMS.096.085 Rev-2 (or latest) | No. | 01 |
| 19 | 5780/052 | Lubricating Grease | SERVOPLEX SHC-120 (IOC) | Kg | 1.5 |
| 20 | 5716/034 | Thinner for Stator washing | 4TMS.096.030 Rev-1 (or latest) | Kg | 10 |
| 21 | 5716/053 | Non- Adhesive polyimide film tape size:- 2 mil thk. X20 mm Wide (in continuous roll of 50 m) | 4TMS.096.029 Rev-1 (or latest) | Mtr. | 390 |
| 22 | 5716/060 | Polyamide ( Nomex type-410) Strip Size 0.25mm thk x9 $^{+0.02/-0.4}$ mm width x 507± 0.2 mm long | 4TWD.096.169 Ref-3, Alt-2 (or latest) & 4TMS.096.091 Rev-1 Alt-1 (or latest) | Pcs. | 152 |
| 23 | 5780/073 | Set of Roller Bearing each set consisting of 01 no roller bearing NU2236E/C4; 01No roller bearing NJ 320E/C4 and 01 no. Thrust coller HJ 320E | 4TMS.096.065 Rev-1 Alt-3 (or latest) | Set | 1 |

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| **3-Ph Asynchronous Traction Motor (with Scheme-I type Rotor) Type 6FRA-6068 for 3 ph Electric Locomotives.** | **CHITTARANJAN LOCOMOTIVE WORKS (W.B.)**<br>**No. 4TMS.096.080 Rev-1 Alt-5**<br>Initial Issue Date : 12.07.2022 |

| Prepared & Checked by | | Reviewed by | |
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| SN | C&D NO | DESCRIPTION OF ITEM | DRG. NO. & SPECN. NO. (latest Alt/Rev to be followed) | UNIT | QTY / TM (Indicative) |
|---|---|---|---|---|---|
| 24 | 5716/055 | Glass Tape (EGT) size 0.18x25 mm | 4TMS.095.016 Rev-1 (or latest) | Mtr. | 36 |
| 25 | 5711/301 | Stator main stampings | 1TWD.096.015 Alt-7 (or latest) & 4TMS.096.053 Rev-2, Alt-11 (or latest) | Nos. | 940 |
| | 5711/340 | Stator end plate assly | SKEL-4889 (or latest) | Nos. | 02 |
| | 5721/325 | Rotor main stampings | 1TWD.096.010 Ref-1, Alt-10 (or latest) & 4TMS.096.053 Rev-2, Alt-11 (or latest) | Nos. | 924 |
| | 5721/326 | Rotor mid stampings | 1TWD. 096.010 Ref-2, Alt-10 (or latest) & 4TMS.096.053 Rev-2, Alt-11 (or latest) | Nos. | 16 |
| | 5721/350 | Rotor end plate assly | SKEL-4890 (or latest) | Nos. | 02 |
| 26 | 5721/321 | Rotor shaft (Finished machined ) | 1TWD. 096.009 Alt-1 (or latest) & 4TMS.096.071 Rev-1 Alt-2 (or latest) | No. | 1 |
| 27 | 5714/501 | Neutral conductor ring Assay. (Without insulation) | 4TWD.096.061 Ref-1, Alt-4 (or latest) & 4TMS.096.062 Alt-5 (or latest) | No. | 1 |
| 28 | 5721/403 | End Ring Plate for Scheme-I Rotor | SKEL-4739 Alt-3 (or latest) & 4TMS.096.068 Rev-2 Alt-2 (or latest) | Nos. | 2 |
| 29 | 5716/004 | Stator Slot wedge | 4TWD.096.050 Alt-3 (or latest) & 4TMS.096.103 (or latest) | Nos. | 144 |
| 30 | 5715/600 | Terminal Board Assly Complete | 2TWD.096. 019 Alt-1 (or latest) & 4TMS.096.025 Rev-1 (or latest) | No | 1 |
| 31 | 5712/321 | Winding wire, Flat Fl Cu FO 13 CR bare size: 4.00x2.00 mm & Insulated:4.23x2.23mm | 4TMS.096.099 Alt-2 (or latest) | Kg. | 160 |
| 32 | 5721/402 | Rotor Bar For Scheme-I rotor | SKEL-4740, Alt-3 (or latest) & RDSO/2008/EL/Spec/0063 Rev-4 (or latest) | Nos. | 88 |
| 33 | 5721/401 | Zr-Cu Stamping type Resistance Ring For Scheme-I rotor | SKEL-4738 Alt-3 (or latest) & RDSO/2008/EL /Spec./0062 Rev-3 (or latest) | Nos. | 26 |
| 34 | 5713/400 | Connections complete with clamping plate (Without insulation) | 1TWD.096.014 Alt-5 (or latest) & 4TMS.096.062 Alt-5 (or latest) | Set | 1 |

| 3-Ph Asynchronous Traction Motor (with Scheme-I type Rotor) Type 6FRA-6068 for 3 ph Electric Locomotives. | CHITTARANJAN LOCOMOTIVE WORKS (W.B.)<br>No. 4TMS.096.080 Rev-1 Alt-5<br>Initial Issue Date : 12.07.2022 |
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| SN | C&D NO | DESCRIPTION OF ITEM | DRG. NO. & SPECN. NO. (latest Alt/Rev to be followed) | UNIT | QTY / TM (Indicative) |
|---|---|---|---|---|---|
| 35 | 5780/018 | Name plate for rating | 4TWD.096.039 Alt-4 (or latest) | No. | 1 |
| 36 | 5780/068 | Name plate | 4TWD.096.090 Alt-3 (or latest) | Nos. | 2 |
| 37 | 5711/313 | Tension bar (modified) | 3TWD.096.092 Alt-4 (or latest) & 4TMS.096.055 Rev-1 (or latest) | Nos. | 2 |
| 38 | 5711/314 | Tension bar (modified) | 3TWD.096.093 Alt-4 (or latest) & 4TMS.096.055 Rev-1 (or latest) | Nos. | 2 |
| 39 | 5711/315 | Stator Rib (Modified) | 4TWD.096.095 Alt-3 (or latest) & 4TMS.096.055 Rev-1 (or latest) | Nos. | 4 |
| 40 | 5711/316 | Cross piece (machined) | 3TWD.096.094 Alt-4 (or latest) & 4TMS.096.055 Rev-1 (or latest) | Nos. | 2 |
| 41 | 5711/317 | Accessory Bar | 3TWD.096.096 Alt-4 (or latest) & 4TMS.096.055 Rev-1 (or latest) | Nos. | 2 |
| 42 | 5711/318 | Accessory Bar | 3TWD.096.097 Alt-4 (or latest) & 4TMS.096.055 Rev-1 (or latest) | Nos. | 2 |
| 43 | 5721/322 | Key | 4TWD.096.048 Alt-2 (or latest) & 4TMS.096.055 Rev-1 (or latest) | No. | 1 |
| 44 | 5721/324 | Half ring | 4TWD.096.049 Alt-3 (or latest) & 4TMS.096.055 Rev-1 (or latest) | Nos. | 2 |
| 45 | 5720/210 | Balance weight Kit for Scheme –I Rotor | 4TWD.096.044 Alt 8 (or latest) 4TWD.096.101 Alt 4 (or latest) 4TMS.096.084 Rev-1 (or latest) | Set | 1 |
| 46 | 5711/308 | Flange | 4TWD.096.067 Alt-6 (or latest) & 4TMS.096.055 Rev-1 (or latest) | No. | 1 |
| 47 | 5711/360 | Machined Terminal Box Assay. | 3TWD.096.059 Alt-4 (or latest) & 4TMS.096.055 Rev-1 (or latest) | No. | 1 |
| 48 | 5780/013 | Thrust carrying piece | 3TWD.096.037 Alt-5 (or latest) & IS : 10192 (latest) | No. | 1 |
| 49 | 5780/016 | Hose clamp | 4TWD.096.070 Alt-3 (or latest) | No. | 1 |
| 50 | 5711/310 | Welding plate | 4TWD.096.068 Alt-4 (or latest) | No. | 1 |

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| SN | C&D NO | DESCRIPTION OF ITEM | DRG. NO. & SPECN. NO. (latest Alt/Rev to be followed) | UNIT | QTY / TM (Indicative) |
|---|---|---|---|---|---|
| 51 | 5730/308 | End Frame / DE Assly (CNC MACHD) | 1TWD.096.005 Alt-11 (or latest) & 4TMS.096.068 Rev-2 Alt-2 (or latest) | No. | 1 |
| 52 | 5740/408 | End frame / NDE assly (CNC MACHD) | 0TWD.096.003 Alt-13 (or latest) & 4TMS.096.068 Rev-2 Alt-2 (or latest) | No. | 1 |
| 53 | 5711/319 | Stator Chamber / DE (CNC MACHD) | 1TWD.096.017 Alt-8 (or latest) & 4TMS.096.059 Rev-1 (or latest) | No. | 1 |
| 54 | 5711/320 | Stator chamber / NDE (CNC MACHD) | 1TWD.096.016 Alt-9 (or latest) & 4TMS.096.059 Rev-1 (or latest) | No. | 1 |
| 55 | 5780/001 | Inner labyrinth / DE (CNC MACHD) | 4TWD.096.028 Alt-6 (or latest) & 4TMS.096.068 Rev-2 Alt-2 (or latest) | No. | 1 |
| 56 | 5780/056 | Outer bearing cap /DE (CNC MACHD) | 1TWD.096.006 Alt-8 (or latest) & 4TMS.096.068 Rev-2 Alt-2 (or latest) | No. | 1 |
| 57 | 5720/202 | Inner labyrinth / DE (CNC MACHD) ROTOR | 4TWD.096.043 Alt-7 (or latest) & 4TMS.096.068 Rev-2 Alt-2 (or latest) | No. | 1 |
| 58 | 5780/069 | Outer labyrinth / DE (CNC MACHD) | 4TWD.096.029 Alt-8 (or latest) & 4TMS.096.068 Rev-2 Alt-2 (or latest) | No. | 1 |
| 59 | 5720/201 | Inner labyrinth / NDE (CNC MACHD) | 4TWD.096.042 Alt-7 (or latest) & 4TMS.096.068 Rev-2 Alt-2 (or latest) | No. | 1 |
| 60 | 5780/005 | Inner labyrinth / NDE (CNC MACHD) | 4TWD.096.031 Alt-6 (or latest) & 4TMS.096.068 Rev-2 Alt-2 (or latest) | No. | 1 |
| 61 | 5780/058 | Bearing cap / NDE (CNC MACHD) | 3TWD.096.032 Alt-9 (or latest) & 4TMS.096.068 Rev-2 Alt-2 (or latest) | No. | 1 |
| 62 | 5780/057 | Clamp plate / NDE (CNC MACHD) | 2TWD.096.033 Alt-9 (or latest) & 4TMS.096.068 Rev-2 Alt-2 (or latest) | No. | 1 |
| 63 | 5780/079 | Speed probe housing | 1TWD.096.077 Alt-5 (or latest) & 4TMS.096.068 Rev-2 Alt-2 (or latest) | No. | 1 |
| 64 | 5711/309 | Earthing stud | 4TWD.096.066 Alt-3 (or latest) | No. | 1 |

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| SN | C&D NO | DESCRIPTION OF ITEM | DRG. NO. & SPECN. NO. (latest Alt/Rev to be followed) | UNIT | QTY / TM (Indicative) |
|---|---|---|---|---|---|
| 65 | 5770/700 | Terminal Box cover Assay | 4TWD.096.027 Alt-3 (or latest) | No. | 1 |
| 66 | 5780/094 | Rubber bush | 4TWD.096.171 Alt-1 (or latest) | Nos. | 3 |
| 67 | 5780/004, 007 | Sealing Rings | 4TWD.096.030, Ref- 1 & 2, Alt-5 (or latest) & 4TMS.096.086 Rev-1 Alt-1 (or latest) | No. | 1 |
| 68 | 5780/015 | Corrugated Hose Coflex | 3TWD.096.072 Alt-7 (or latest) | Set | 1 |
| 69 | 5780/053 | Cable binder | 4TWD.096.079 Alt-5 (or latest) & 4TMS.096.067 Rev-1 (or latest) | Nos. | 5 |
| 70 | 5780/061 | Clip Assly.(without welding plate ) | 4TWD.096.082 Alt-2(or latest) | Set | 2 |
| 71 | 5720/207 | Primer paint | 4TMS.096.019 Rev-1 (or latest) 4TMS.096.020 Rev-1 Alt-1 (or latest) | Kg | 1 |
| | 5780/065 | Top coating paint | | Kg | 1.6 |
| | 5780/066 | Hardener for top coating paint | | Kg | 0.14 |
| | 5780/067 | Thinner for top coating paint | | Kg | 0.75 |
| 72 | 5716/041 | Adhesive glass cloth tape 0.14x19 mm wide (in continuous roll of 30m) | 4TMS.096.026 Rev-1 (or latest) | Mtr. | 15 |
| 73 | 5716/042 | Adhesive glass cloth tape 0.14x50 mm wide (in continuous roll of 30m) | 4TMS.096.026 Rev-1 (or latest) | Mtr. | 10 |
| 74 | 5716/044 | Polyester Film(Y-P) 2 mil size 100 +2/+0 x500 +3/+0 mm | 4TMS.096.104 Alt-1 (or latest) | Nos. | 150 |
| 75 | 5780/054 | Anaerobic Adhesive and sealant for threaded locking similar to three bond screw lock super 1303 of M/s Three bond Co. Ltd. /Japan | 4TMS.095.018 Rev-1 (or latest) | Kg | 0.11 |
| 76 | 5716/043 | High temperature non-asbestos fabric mat. Size 0.762x914 mm wide | 4TMS.096.027 Rev-2 (or latest) | Mtr. | 0.35 |
| 77 | 5713/434 | Silver Brazing alloy rod Ø 2x500 ± 6 mm long | IS:2927'75 Gr: Ba-Cu-Ag 16A (latest) | Kg | 0.16 |
| 78 | 5713/437 | Brazing flux suitable for silver Brazing alloy rod & Silver Brazing alloy foil. | 4TMS.096.096 Rev-1 (or latest) | Kg | 0.04 |
| 79 | 5780/080 | Cylindrical Pin Kit | 4TMS.096.072 Rev-1 (or latest) | Set | 01 |
| 80 | 5780/090 | Machined Washer Kit | 4TMS.096.073 Rev-1 (or latest) | Set | 01 |
| 81 | 5780/091 | Spring Washer Kit | 4TMS.096.074 Rev-1 (or latest) | Set | 01 |



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| SN | C&D NO | DESCRIPTION OF ITEM | DRG. NO. & SPECN. NO. (latest Alt/Rev to be followed) | UNIT | QTY / TM (Indicative) |
|---|---|---|---|---|---|
| 82 | 5780/092 | Standard Hardware Kit | 4TMS.096.075 Rev-1 Alt-1 (or latest) | Set | 01 |
| 83 | 5780/093 | Thread Insert Kit | 4TMS.096.076 Rev-1 (or latest) | Set | 01 |
| 84 | 5780/089 | Non Standard Hardware Kit | 4TMS.096.077 Rev-1 Alt-1 (or latest) | Set | 01 |
| 85 | 5721/317 | Brazing Flux | EN 1045-FH 10 (latest) | Kg | 0.20 |
| 86 | 5780/074 | Liquid Gasket | 4TMS.095.017 Rev-1(or latest) | Kg | 0.1 |
| 87 | 5721/333 | Molycote (R) GN plus of Dow Corning or High Temperature EP Grease MK IMPEX Canada | - | Kg | 0.025 |
| 88 | 5716/056 | Methyl Alcohol or Industrial Solvent | IS: 517 (latest) | Kg | 0.75 |
| 89 | 5712/331 | Polyamide ( Nomex Type -410) strip size: 0.13mm Thk x 8.4±0.05 mm width x 90mm ± 0.1 long | 4TWD.096.169 Ref.1 Alt-2 (or latest) & 4TMS.096.091 Rev-1 Alt-1 (or latest) | Pcs. | 1134 |
| 90 | 5716/054 | Polyamide ( Nomex Type -410) strip 5mil thick x 25 mm x140 mm | 4TWD.096.172 Alt-1 (or latest) | Pcs. | 152 |
| 91 | 5721/407 | Silver Brazing alloy rod Ø 2x600 ± 6 mm long | DIN EN1044; AG,203 (latest) | Kg | 1.03 |
| 92 | 5711/203 | Accessories of 3-Phase Stator Chamber | 3TWD.096.167, Alt-5 (or latest) | Set | 1 |
| 93 | T201/088 | Pinion | SKDP 3847 Alt-1 (or latest), 3473 Alt-4 (or latest) RDSO.MP.0.2800.19 (Rev-0) (or latest) | Nos. | 1 |
| 94 | - | Irreversible Temperature Strips | 4TMS.096.106 (or latest) | Nos. | 2 |

## 14.0 WARRANTY

Alt-5

Warranty period for Traction Motor shall be-

(i) 54 months from date of commissioning of locomotive or 60 months from date of supply, whichever is earlier for TM of WAP-7 Locomotive.

(ii) 72 months from date of commissioning of locomotive or 78 months from date of supply, whichever is earlier for TM of WAG-9 Locomotive.

The contractors shall warrant that the motors supplied under the contract shall be free from defects and faults in material, workmanship and manufacturing. In case of any failures/defects noticed within warranty period, the motors shall be repaired/ replaced by the contractor free of cost.

**SHEET END**

| 3-Ph Asynchronous Traction Motor (with Scheme-I type Rotor) Type 6FRA-6068 for 3 ph Electric Locomotives. | CHITTARANJAN LOCOMOTIVE WORKS (W.B.)<br>No. 4TMS.096.080 Rev-1 Alt-5<br>Initial Issue Date : 12.07.2022 |
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