

ICF

SPECIFICATION NO: ICF/ELEC/ 021
REV 'A'NO: OF PAGES: 56 + 1 + 2
(CS.NO:1)(CSNO:2)SPECIFICATION FOR
CONVERTERS FOR B.G. AC EMU'S MOTOR COACHESISSUED BY

INTEGRAL COACH FACTORY, MADRAS-38

E-16/12

CORRECTION SLIP NO:	—	1	2						
REVISION:	A								
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1. SCOPE AND DEFINITIONS:1.1. SCOPE

1.1.1. The specification covers the design, manufacture, testing and supply of silicon converter equipment for 25 KV, BG, AC, EMUs motor coaches to be built at ICF and shall be suitable for working with traction equipment indicated in clause 3.0 (data of existing equipment). The converter shall consist of Main Power Converter and Auxiliary L.T. supply converter housed in a single sheet steel cubicle.

1.1.2. The converter is to be complete with the following associated components/units:-

- i) Sheet steel cubicle interchangeable with the existing cubicles in service, therefore, mountings dimensions must be as per ICF drawing No. ICF/SK 7-1-068 (Alt.g).
- ii) Diodes complete with heat sinks and diode damping net-work against internal switching voltage surges.
- iii) AC and dc bus-bars for main traction and auxiliary LT supply for compressor.
- iv) Earthing capacitor units for main traction converter and auxiliary converter.
- v) R.C damping units to be provided at input and output converter.
- vi) Semi-conductor fuses and over current protection.
- vii) Signalling circuit complete with diodes, relays, wiring, micro switches, trip fuses, lamp etc.

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viii) Cooling system complete with blower motor, blower, cooling duct protection against ventilation failure.

ix) Voltage limiter for Auxiliary convertor.

x) Lugs, bus-bar insulators, flexible connections, insulation sheets, nuts, bolts, washers, door locking arrangement etc. to meet the actual requirements of convertor assembly.

1.1.3. The Schedule of items to be supplied for the complete convertor are indicated in various categories mentioned in the standard form on tender. This is intended only for itemising the equipment for tendering purposes and it is upto the tenderer to give the details specification and a list of accessories to make the convertor assembly offered complete and suitable for installation and commissioning. If any other items/equipment which have not been included in the list, are considered necessary by the tenderer the tenderer shall make a special mention of this in the offer and details specification advised in the offer.

TECHNICAL SPECIFICATION

2.0. GENERAL REQUIREMENTS:

The tender shall take into consideration the following factors in developing a suitable design to meet the specification requirements:

2.1. The equipment being mounted on the Railway coach shall withstand the vibration and shock incidental to Railway Transportation Service and specified in Clause 3.1.3 of IS:7788.

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2.2. The offered equipment shall be suitable for the climatic Environmental and Service Conditions as given below:

Maximum	Under Sun	70 deg. C
temperature	Under Shade	50 deg. C
(atmospheric)	Inside HT	55 deg. C

Minimum		0 deg. C
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Humidity	95 to 100% during raining season
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Reference	Ambient	47 deg. C
site conditions	Inside HT	55 deg. C
	Compartment	

Humidity	Upto 90%
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Altitude	160 m above mean sea level
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Rainfall	Very Heavy in certain areas.
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Atmosphere	Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach a high level of 1.6 mg/M3.
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Coastal area	The equipment shall be designed to work in coastal area in humidity and salt laden and corrosive atmosphere. The maximum values of the condition will be as under:
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RMSHAW

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1. Maximum pH value 8.5
2. Sulphate 7 mg/litre
3. Maximum concentration of Chlorine. 6mg/litre
4. Maximum conductivity 130 micro Siemens/GM

Vibration & Shocks : As per IEC 411 or IS: 7788

2.3 The basic features of 25.0 KV, ac, single phase, 50 Hz system are as follows:

General : 25.0 KV, is the nominal voltage of the system

Supply Voltage : 19.0 kv to 27.5 kv 30.0kv(rms)
variation. with occasional max.
instantaneous
minimum 17.5kv(rms)

Variation in frequency: +/- 3% (48.5 to 51.5 Hz)

The voltage is subjected to wide fluctuation which are inherent in any traction system. The traction substations are provided with 12.5 MVA/20 MVA, 132 KV/25 KV single phase transformers. As per supply condition, average power factor is not to be less than 90%, failing which heavy penalties are imposed. Indian Railways are also considering the 2 x 25 KV HT system for traction power supply.

2.4. The modular construction of convertor shall be simple in construction for easy alteration/replacement in service.

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2.5 As the equipment is to be mounted on under-frame of Motor Coach of BG, AC EMUs, it shall be made Hose proof conforming to IP-55 (except for louvers for air outlet) to withstand rain and heavy brake block dust. Under no circumstances water shall reach Semi-conductor devices or any part electrically energised.

2.6. The discharge of preheated cooling air inside the cubicle after cooling semi-conductor devices is not acceptable, since, lot of dust will collect inside the cubicle.

2.7 The equipment will be exposed to flying ballast from the track on the run and hence shall be suitability guarded to prevent damage.

2.8. The equipment shall be designed to be safe for bolting on the underframe any accidental loosening of working out of the bolts or falling out of the bolts or

falling of the component of the equipment. It shall also be ensured that fitting or dismantling of the equipment from the coach underframe shall be at the same time be made easy and not made cumbersome between racks and cubicle as well as cubicle and coach body.

2.9 SPECIAL REQUIREMENT

The offered rectifier cubicle must be interchangeable with the existing cubicles in service therefore, mounting dimensions must be as per ICF drawing No. ICF/SK 7-1-068 alteration latest. In case the offered equipment is smaller in size necessary frame work shall be provided to meet this requirement. The mounting arrangement of rectifier cubicle is shown in ICF drawing No. EMU/M/9-0-001 for information.

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3.0 DATA OF EXISTING EQUIPMENT

3.1 The relevant ratings/operating parameters of some of the important associated equipment which are not included in the scope of supply are given below:-

3.1.1. SURGE ARRESTOR ON THE PRIMARY WINDING-LA

Nominal system voltage	25 KV rms, 50 hz +/- 3%
Continuous operating voltage capability	33 KV rms
Normal discharge current	10 KA (8/10 micro wave)
Maximum discharge voltage at nominal discharge current	85 KV (peak)
Power frequency voltage withstand for arrester insulation.	105 KV (rms)
Standard lightening impulse voltage withstand for arrester insulation.	250 KV (peak)

3.1.2. AIR BLAST CIRCUIT BREAKER:

Make	Brown Boveri
Type	DBTF Air Blast
Operating time	80 m.sec.
Recommended tripping time for rectifier design	100 milli secs.

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3.1.5 MAIN SMOOTHING REACTORS.

The output of convertor is fed to main smoothing reactor which consists of two windings. Each winding is rated for 640 A to feed two traction motors. The tech. data of smoothing reactor is given below:-

Make	M/s. BHEL
Reactance at 65A, 50 Hz	0.546
Total inductance at 1280A (640 per coil, 2 coils in para parallel)	1.5mH
dc resistance at 75 deg. C with two windings in	0.004 ohm.

Under saturated condition the value of inductance may be assumed as 25% of value at rated current.

3.1.6 ADDITIONAL SMOOTHING REACTOR

In addition to main smoothing reactor each traction motor has been provided with additional smoothing reactor of ~ 0.65 mH, 0.0023 ohm value in service to reduce current ripple content to traction motor. Under saturated condition 25% inductance may be assumed.

3.1.7. TRACTION MOTOR.

At present M/s. BHEL traction motors type 253 BX has been provided on motor coaches. Some of the motor coaches are provided with M/s. Hitachi, Fuji make traction motors. The reduced current setting of accelerating relay for all the type of motor coaches is the same at present. The technical data of traction motors are given below:-

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Make	M/s. BHEL	M/s. Hitachi	Fiuji
Type	(253 BX/4601 AZ	EF20 - H60	66R 125 ZY
Motors in parallel	4	4	4
Continuous rating	535 V, 340A 1260 rpm	570V, 305A, 1140 rpm.	535V, 425A 1170 rpm.
One hour rating	535V, 380A, 1182 rpm	570V, 380A, 1040 rpm.	535V, 465A, 1120 rpm.
Motor Resistance at 110 deg. C			
Armature	0.0247 ohm	0.0276 ohm	0.0161 ohm
Main field	0.137 ohm	0.0292 ohm	0.0177 ohm
Commutator field	0.132 ohm	0.0197 ohm	0.0115 ohm

3.1.8 AUXILIARY SUPPLY.

The rectifier blower motor set is supplied from 240 V +/- 22.5%, 50Hz +/- 3% single phase, ac, from aux. Winding of the transformer.

3.1.9. Control circuit supply.

The nominal voltage for control circuit is 110 V dc. with the voltage range of variation from 68 to 130 V dc.

4.0: Parameters of equipment to be supplied:

The performance specification and operating requirements for the equipment to be supplied are detailed under:-

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4.1. Surge arrestor across rectifier input:-

The provision of surge arrestor across rectifier input is not recommended and the rectifier voltage rating shall therefore be so designed to meet the voltage rating of surge arrestor provided on the primary winding of transformer. In case the surge arrestor is not available a spark gap electrodes with 75 mm air gap within provided in place of surge arrestor till the arrestor is procured and provided.

The effective voltage rating of rectifier below, 3000 V (PIV) is not acceptable. The voltage rating of auxiliary rectifier bridge feeding compressor motor shall not be less than 2000 V (PIV).

4.2 Earthing Capacitors Units:

The earthing capacitor units consisting of capacitors the series and mid point earthed shall be provided across traction winding terminals M1-M8 and also across auxiliary winding feeding auxiliary rectifier. The recommended values are given below:-

WindingEffectived valueMain rectifier input
at M1-M8 terminals0.1 mfd. 2000 Vrms between
earth point and M1. 0.1 mfd.
2000 Vrms between earth point
and M8 terminal.Auxiliary winding
feeding auxiliary
rectifier0.1 mfd. 1000 V rms between
A22 and Earth. 0.1 mfd. 1000V
rms between A 26 and Earth.

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The earthing capacitor unit for main traction convertor shall be assembled separately since it is to be provided inside rectifier unit across M1-M8 terminals of power circuit.

The earthing capacitor unit for auxiliary rectifier shall be provided in rectifier cubicle.

The capacitor used must be approved type non-trusting and suitable for + 85 deg.C case temperature.

4.3. R-C Damping Units.

The R.C. damping units across ac input and dc output of both main traction convertor and auxiliary convertor shall be provided. The capacitors selected shall be of approved type, non-busting, suitable for traction duty metalised paper and suitable for +85 deg.C case temperature. The resistor selected shall be silicon coated.

It is proposed that all the manufacturers shall use the same value as recommended below:-

AC Damping Units:

- Across main traction convertor : 8 ohms, 500 watts in series 15 mfd not less than 1000V rms.
- Across auxiliary convertor : 10 ohms, 100W in series 8 mfd not less than 500 V rms.

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DC damping Unit:

- Across main traction convertors. : 2 ohms, 200W in series
10 mfd. 1000V rms with
capacitor discharge
resistor at 50 K ohm,
50 W resistor.
- Across Auxiliary rectifier. : 2 ohms, 100 W in series
5 mfd voltage not less
than 500 v rms with
discharge resistor of
50 K ohms, 20 W.

Diode RC Damping Unit:

- Traction convertor : Not less than 0.47 mfd.
2000 V rms.
- Auxiliary convertor : Not less than 0.47 mfd.
640 V rms.

In case the offered values are different or different arrangement proposed detailed calculation, service experience based on which these values are obtained are to be submitted.

4.4 Voltage Limiter for Auxiliary convertor:

In addition to R-C damping unit and earthing capacitors across auxiliary rectifier input suitable voltage limiting device at the ac input or dc side of auxiliary rectifier bridge shall be provided to limit the surge voltage.

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✓ The voltage damping units provided across traction convertor are not effective under EMU at stationary condition and sudden interruption in power supply (OHE) will result in heavy voltage surges across auxiliary rectifier.

The use of avalanche protector or metal oxide varistor (MOV) may be considered for the is purpose and detailed calculation, data of the offered unit submitted.

4.5. Rectifier over current relay:

The current transformer and over current relay matching with rectifier rating shall be provided. The over current relay shall have minimum 2 NO and 2 NC contacts for control circuit and flag indication under tripped condition. The relay must be instantaneous type (DI) for effective protection (Not applicable for EMU Converter)

4.6. Design data for rectifier assembly:

	Main traction rectifier	Auxiliary rectifier
	(I)	(II)
System of connection	Bridge	Bridge
Connected load	4 traction motors in parallel	Compressor Motor set.
Rated dc voltage for steady state	535V	136V

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No load input voltage corresponding to 27.5 KV line voltage.	860V	165V
Peak input voltage at 30 KV line	1326.8 V	239.13 V
200% switching surge voltage (Peak)	2653.6 V	478 V
10% over voltage sheet due to non-avalanche R-C damping limits.	2919 V	526 V
PIV rating of rectifier not less than	3000 V	2000V
Starting current peaks	3000 A for 1. Sec.	
Average accelerating current.	2640 A	
Continuous current of transformer	1250A	
Current rating requirement with (M-1) parallel paths of converters:		
- Pre loading	1250 A cont. 1700A - 10 min. N.A.	
- Off loading	0A - 30 Sec.	

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- Followed by

3000 A - 1 Sec.

2640 A - 20 Sec.

1700 A - 180 sec.

After cont. loading at 1700A

repeat duty cycle for

6 times with 0 A for 30 secs.

3000A for 1 Sec. 2640 A

for 20 Secs. and 1700 A for

180 Secs.

Designed dc rating for
semi-conductor device with
all parallel paths in
healthy condition.

2640A cont.

500A cont.

- Peak short circuit
cal)

16 KA (Asymmetri-

current with smoothing
reactor in circuit
for both conditions
of N and (N-1) parallel
paths.The asymmetrical condition will
be assumed as 300 deg. conduc-
tion and peak to rms factor
as 1.7. Duration for such
fault current shall be taken
as 100m sec. (tripping time of
main circuit-breaker) for
design purpose.Protections:

-Voltage

*Earthing capacitor
unit*R-C damping unit
across input to
converter*Snubber across
diode*R-C damping unit
across dc output
of converter* Earthing capacitor
unit* R-C damping unit
across input to
converter*Snubber across
diode* R-C damping unit
across dc output of
converter*Avalanche or MOV
voltage limiter.

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GMSr

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-Current	*Over current relay	*Convertor line fuses
	*Semi-conductor fuses of convertor	
	*Main circuit breaker under traction motor flash over.	
-Ventila- tion	*Air flow relay common for both convertors.	
-Number of devices per con- verter	*Not more than 12.	* 4.
Indica- tion/Tri- pping of load.	*One parallel path out-indication only More than one para- llel path out - Tripping of main circuit breaker.	*Indication through trip fuse.
Convertor assy. testing.	*As per IS:7788.	
Diode FVD Groups	*Three consecutive FVD groups for entire	*N.A.
	*Not more than one group in a cubicle.	
FVD Group band width.	*Based on 50 mV(peak) difference at full diode rated current.	

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✓ Diode
testing

As per IS.7788

Cooling
air tem-
perature

* 55 deg.C (rise in
cooling duct)

* 70 deg.C (since
placed after main
rectifier)

Cooling
air
velocity

* Not less than m/sec.

* Not less than
6m/Sec.

- Bus-bar
temp.
after
correc-
tion for
55 deg.C
ambient
and closed
doors.

* 100 deg.C

* 100deg.C

- Duty
cycle for
bus-bar
temp. rise.

* (n-1) parallel
path & duty cycles
specified above.

* 300A (cont)

- Genl
conductor
fuses.

* Matching to diode
rating

* 10mSI2t value
less than diode
10m/sec. I2t value
not less than
300A (cont).

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4.7 Design Features:

4.7.1. The complete rectifier assembly including all surge suppression ~~not~~ work units, protections, fault diagnostic unit, cooling equipment etc. for main and auxiliary rectifier, shall be housed in a cubicle and it shall not exceed the overall dimensions indicated in ICF drawing ICF/SK 7-1-068 alt.'g'. The mounting arrangement holes must be as per ICF drawing No. ICF/SK 7-1-068 alt.'g' to meet interchangeability requirements.

4.7.2. The temperature of inlet cooling air shall be taken as 55 deg.C and a further temperature rise of 15 deg.C in cooling duct will be assumed for calculation purpose. A temperature rise of 5 deg.C will be added to actual cooling air temp. rise recorded on prototype to meet variation in power losses, air conductivity being different at site conditions and test conditions, air delivery etc. In case, it is more than 15 deg.C, this temp. rise will be considered while calculating junction temperature at 55 deg.C ambient.

4.7.3. The current unbalance between the parallel connected bridges shall not exceed 10%. This current unbalance will be taken as 20% for design purpose since the contact resistance of heatsinks, bus-bar joints changes in service.

4.7.4. While calculating short circuit capacity of the rectifier under (n-1) parallel paths the following conditions shall be considered:

- The semi-conductor devices junction temperature at rated permissible junction temp. or calculated for 6 duty cycles as given above under clause 4.6.
- The surge current rating of the device considered for calculation is with 50% reverse voltage applied between current pulses.

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- Due to presence of smoothing reactor in the circuit, dc traction motor flash over current will gradually increase in magnitude and conduction angle. For the purpose of calculation, five cycles of 300 degree conduction angle and 16 KA shall be taken. To convert the peak value of fault-current to rms a factor of 1.7 and a factor of 2.0 for diode shall be taken.
- The current unbalance factor 1.2(20%) shall be considered.
- The fuses/devices feeding fault current must withstand this 16KA fault current for 100 m sec. without any deterioration to rectifier under both conditions on 'n' and (n-1) parallel paths of convertor.

4.7.5. The fuse protection provided for semiconductor devices shall meet the following requirements:-

- i) I_2t value for 10m sec. of diode must be more than 10m sec. I_2t value of fuse.
- ii) Under normal operation with (n-1) parallel paths and duty cycle as per Clause 4.6 and traction motor flash over current of 16KA (Asymmetrical) for 100m sec., no fuse shall blow.
- iii) The fuse blade/body temp. shall not exceed this permissible limit after applying correction for 55 deg.C ambient and temperature inside the cubicle.

It is preferable to have diode forward protection i.e. diode over current rating is more than fuse upto 10 sec.

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4.7.6. The layout/construction of rectifier cubicle shall be modular for easy replacement/maintenance.

4.7.7. The semiconductor devices racks are so designed that they are interchangeable and bus-bar connections are identical.

5.0. CONSTRUCTIONAL REQUIREMENTS: (MECHANICAL)

5.1 The converter cubicle shall be of cold rolled metal sheet construction with a strong frame work to withstand normal vibrations and shocks of vehicle in service and as indicated in IS:7788 specification. The minimum thickness of sheet steel shall be 1.6mm. The thickness may be increased as indicated below with the panel width increase above 500mm.

Maximum Panel Width

750 mm
1500 mm
2000 mm

Minimum Thickness of Steel Sheet

2.0 mm
2.5 mm
3.15 mm

5.2 Easily removable covers/doors shall be provided for easy accessibility of AC input, main rectifier, Aux. rectifier and DC output. The rectifier inspection covers shall be provided with the provision for locking. The lock shall be suitable for the keys shown in the ICF drawing ICF/SK 7-1-068. Indication plate showing lock/open position in anodised aluminium plates shall be provided by riveting. The doors also shall be made interchangeable from one unit to another unit.

5.2.1 Anodised aluminium plates with 15 mm size letters shall be provided by riveting outside the front door indicating locations of i) AC input ii) Main rectifier, iii) Auxiliary rectifier and DC output.

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5.2.2 The rectifier shall also be provided with rating plate as per IS 7788 on the front main door of (outside) the Main Rectifier. The unit Sl.No. shall be as per the IRS code, Is two digits year and 2nd two digits month of manufacture. The third 3 digits bearing the serial number of the unit.

5.2.3 Suitable ventilating openings with louvres shall be provided for the cubicle air outlet.

5.2.4 The layout of equipment in the cubicle shall provide easy accessibility of equipment for maintenance/ replacement without having to remove associated equipment.

5.2.5 Withdrawable racks consisting two diodes and associated components shall be guided on rails. the devices with Heat sink shall be mounted on FRP (SMC) or glass epoxy panels of not less than 10 mm thickness and they shall form the sides of the air duct such that they snug-fit on their supporting brackets in such a way as to form a reasonably square ducting. The panels shall be provided with hand holds to facilitate easy insertion of this device stack.

5.2.6 Blower motor shall be mounted as an independent unit inside the main cubicle frame and suitably connected to cooling duct. It shall be possible to remove the blower cubicle or other equipment inside the vehicle. Adequate set resilience shall be provided between blower and duct to reduce vibrations and allow for manufacturing tolerance of the blower and rectifier duct assembly.

5.2.7 Rectifier shall be forced ventilated such as to comparatively dust free air from inside the (equipment) compartment and provide uniform flow over all cooling fins.

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5.2.8 As the rectifier is mounted from the vehicle underframe adequate precaution shall be taken to prevent any accidental loosening or falling out of rectifier or any of its aux. equipment. This shall also be suitably protected against damage due to flying ballast, the design shall be dust proof and water proof with suitable filters.

5.2.9 The rectifier cubicle shall be provided with two numbers of earthing boss one on each side (wall). The earthing boss shall be 50 mm wide X 25 mm thick mild steel block welded to frame one side on the other side it shall be brazed with 5 mm thick copper/ brass plate. the contact surface shall be provided for securing earth cable. Suitable indication plate in anodised aluminium shall be riveted on the side of the earthing boss for identification. It shall be provided with electrogalvanised M12 X 25 Hex. head screw with one plain and spring washer and one copper crimping terminal suitable for 35 Sq.mm copper cable.

5.2.10 Bulk welding shall be used for fabrication of frame work. Fillet welding shall be avoided as far as possible. If unavoidable it shall be ensured that there exists no undercuts in fillet weld.

5.2.11 The slags around the welding shall be cleaned ground and made to smooth finish.

5.2.12 The unit shall be painted with two coats of redoxide primer followed by two coats of white stove enamel paint inside and with two coatings of air craft gray on outside to IS 5-1961.

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5.12.13 FASTENERS

5.12.13.1 Plated hexagonal screw and nuts of metric size only shall be used. Socket headed screw shall be used only at locations where any of hexagonal nut is not feasible. All the nuts shall be suitable to tight with spanner. The bolts or screw heads shall be locked against rotation while working.

5.12.13.2 The minimum size of screw or bolts shall not be less than M6 bolts and screws of M10 size and shall be of high tensile steel preferably clause 8.8 and as per IS 1367.

5.12.13.3 All the nuts which are normally required to be opened for repair or maintenance shall be locked. locking may be done in case of small nuts whether with a drop of araldite or locktite compound. Nylock nuts are not acceptable.

5.12.13.4 All bolted connections/screws shall be provided with plated plain and spring washers.

5.12.13.5 Tightening of nuts shall be done to maximum extent with recommended torque wrenches to avoid fatigue failures.

5.12.13.6 The fasteners used for electrical connections shall be nickel plated or cadmium passivated.

5.12.13.7 the copper bus bars must be plated after drilling required holes etc. Bare copper surface at any place is not accepted.

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6.0 CONSTRUCTIONAL REQUIREMENTS (Electrical)

6.1 SILICON DIODES

6.1.1. Diodes with soldered junction and soldered external seal are not acceptable.

6.1.2 The use of Capsule type diodes or flat base diodes are acceptable. In case of flat base devices a suitable cover either silicon rubber or PTFE shall be provided over the device and flexible lead to avoid occurrence of external flash over by foreign matters.

6.1.3 The minimum surface finish and flatness of the surface of the device in contact with heat sink shall be

- | | |
|----------------------|---|
| i) Surface finish | - Less than 1.524 microns. |
| ii) Surface flatness | - Total indicator reading (TIR) to be held from 0.0005 to 0.001 mm. |

6.1.4 Quality assurance testing and end line screening of devices shall be governed by Quality Assurance Testing of silicon diodes to RDSO specn.No: IRS E 16/13.

6.2 HEAT SINKS

6.2.1 Heat sink shall be extruded constructions. Sand casted/gravity die casted heat sinks are not acceptable. The type of heat sink used shall have specific approval of RDSO/ICF.

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6.2.2 The area of device seat on the heat sink shall have proper surface finish and flatness as indicated in clause 6.1.3 of this specification to minimise the mounting resistance due to surface problems.

6.2.3 Current collection through the heat sink is to be avoided. In case it is not possible then the heat sink device mounting surface and current collection contact area shall be suitably treated to prevent electro corrosion and bimetallic action.

6.2.4 To improve radiation heat transfer and give corrosion protection the heat sink surface shall preferably be treated in black color by anodizing or any other similar process.

6.2.5 Device seat and power connection area on the heat sink shall be free from treatment, foreign material oxides and film etc.,

6.3 RESISTANCES

6.3.1 Silicon coated non inductive wire wound resistor shall be used. Vitreous enameled resistors are not acceptable.

6.3.2 The resistances shall be stud mounting type and provided with lug terminals.

6.3.3 The declared wattage ratings of the resistors at the specified ambient temperature shall be at least 3 times the calculated maximum wattage in the circuit of application under the worst loading conditions and higher temperature at the place where these are mounted.

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6.3.4 The resistors shall be mounted vertically, if two resistors are mounted close to each other the distance between resistors (edge to edge) shall be at least two times the diameter of the bigger resistance.

6.4 CAPACITORS

6.4.1 Capacitors of reputed and RDSO approved sources only shall be used. The type of capacitor selected out of standard range of reputed manufacturer shall be suitable for particular circuit application.

6.4.2 MP capacitors with self healing and non-bursting features only shall be used in snubber circuit. Full technical details and calculations for selecting a particular capacitor shall be furnished for technical scrutiny of tender. All capacitors shall have non-bursting property.

6.4.3 Capacitors with main terminals mounted on porcelain insulation are preferable.

The clearance and creepage distance between the terminals shall comply with Table 5 of IS:7788.

6.4.4 The connections to the capacitors shall be provided by insulated type slip on connectors or soldered. The capacitor terminals must be suitable for both type of connections.

6.4.5 The max. working voltage across any capacitor shall not exceed 50% of the rated repetitive voltage. In case of hole shortage capacitor the voltage rating shall be same as PIV rating of semi-conductor device.

6.4.6 The capacitors shall be suitable for case temperature from 20°C to +85°C. The case temperature rise shall not exceed 10°C under the designed current and voltage ratings.

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6.5 FUSES:

6.5.1 Semi conductor fast acting fuses matching to semi-conductor devices used, shall be provided. The semi-conductor (bridge) to protect against failure of diode strings to fuses shall be type tested as per IEC-769(1-n) and approval of RDSO/ICF.

6.5.2 The selection/fuse shall be supported by fuse co-ordination calculations and fuse characteristic curves translated to English language which shall be submitted during technical evaluation of the tender and approval stage.

6.6 ASSEMBLY OF HEAT SINK AND DEVICES:

6.6.1 In case of disc type devices the design of the clamping system shall be such that the required clamping force must be applied perpendicular to disc surface. The clamp shall be provided with a mechanical force gauge to indicate the amount of force applied to the device with inscriptions of recommended force for that particular device. Individual clamp arrangement shall be provided to each assembly and not a common clamp for whole of the stack.

6.6.2 In case of flat base devices pressure plate or mounting spring with safety bracket shall be provided between the base and the mounting studs, so that the spring pressure plate becomes flat where proper mounting pressure is applied.

6.6.3 Mounting arrangement of the device shall be such that the pressure is uniformly distributed over a total contact area. The pressure shall be applied in a staggered fashion such as tightening of opposite corners to one half of the recommended torque and then finally apply the necessary remaining torque in the same staggered fashion.

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6.6.4 Recommended optimum mounting pressure for the offered device shall be determined by suitable tests and full details of the same be furnished to RDSO/ICF.

6.6.5 In order to optimise the contacts between the mating surface of the device and heat sink suitable thermal compound shall be used to fill up the voids between mating surfaces before assembly. The thermal compound shall have very low thermal resistance and shall seal the joint against moisture. The type, make and quantity shall be advised during tech. scrutiny.

6.7 BUS BARS:

6.7.1 The bus-bars used shall be of high conductivity electrolytic copper as per IS.613 and current density shall not exceed 4.0A/sq.mm and max. temp. shall not exceed 100°C under any working conditions at 55°C inlet air temperature. Due correction for temperature inside temperature. Due correction for temperature inside cubicle at the testing time and 55°C shall be supplied.

6.7.2 The bus-bars shall be tin plated. The tin plating shall be done after bending, drilling holes etc. and bare copper shall not be used anywhere. The pure tin plating shall be as per IS 1356 and thickness of plating shall not be less than 8 microns.

6.7.3 Joints in busbars shall be avoided as far as possible. In case joints are to be provided the joints shall be away from the bent portion.

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6.7.4 Sharp bends in the bus bars must be avoided. The inner radius of cold bend shall be as large as possible but not less than the following:-

Minimum radius 'R' = $2 \times T$ (in annealed electrolytic copper)

-do = $3 \times T$ (in Hard drawn -do-)

Where 'T' is the thickness or dia of the flat or rod. Bus bars after bending must be annealed to remove mechanical stress and should be free from cracks.

6.7.5 The above limits of bend radius shall apply to all busbars inclusive of wiring.

6.7.6 The busbars shall be provided with following color code to identify AC, DC, positive and negative connections:-

AC = Yellow

DC = Positive = Red

DC = Negative = Black

6.7.7 All power connections to the busbars and busbar joints shall be directly made without any insulating supports.

6.7.8 Bus bar supports be made with insulators and not by insulating members of the assembly.

6.7.9 Bus bars shall be identified by punching the respective circuit numbers and applying with contrast paint.

6.8 CABLE WIRE TERMINATIONS

6.8.1 Soldered Joints

6.8.1.1 Soldered cable terminations and connections shall be avoided. In case soldered connections are unavoidable full details of solder joints shall be furnished to RDSO/ICF for approval.

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6.8.1.2 Soldered joints shall be made by trained staff with 100% tin solder with suitable soldering equipment which shall maintain a constant bit temperature.

6.8.1.3 Only pure resin is to be used as flux. Use of acidic/corrosive flux is prohibited.

6.8.1.4 Visual inspection of each soldered joint shall be carried out by trained inspected for checking the soundness of the joint and proper wetting of the surfaces being joined.

6.9 CRIMPING SOCKETS:

6.9.1 All the cable/wire ends shall be terminated with suitable crimping sockets of approved make.

6.9.2 Pre-insulated sockets with bell mouth only shall be used for control cables. This crimping shall be done in such a way that the insulation of the cable gets crimped, with the insulated sleeves to prevent failures due to fluxing action of the un-supported length.

6.9.3 Proper tools and dies shall be used for crimping and frequent checks shall be carried out by the examination of cut samples and voltage drop test to ensure quality of crimping is satisfactory.

6.9.4 Pull out tests shall be made on 1% sample to check quality of crimping tools and dies. The pull out force shall not be less than 80% of the U.T.S of the wire.

6.10. TERMINAL BOARDS

6.10.1 The design of the terminal board shall have the approval of RDSD/ICF. The design shall generally comply with the following:-

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i) The size of connecting studs shall have adequate current rating and the minimum size shall not be less than M6 Maximum size shall not be greater than M12.

ii) The studs shall be provided with plated two plain washers and one spring washer.

iii) The studs shall be cadmium plated steel as per BS 3382 - '61 part (1) in metric size only'.

iv) Provision of insulation barriers between terminals shall be provided.

v) Method of making electrical connections shall be such that the current shall not pass through studs and contact tightening force shall not pass through insulating board.

vi) The insulating boards shall be made up of the Fire retardant FRP sheet moulding type and shall pass fire retardant test as per specification IS 2046 and ICF/spec/MD/D/014 Clause 3.1.

6.10.2 Not more than two terminations shall be made at any stud. In case more connections are required the terminals may be extended by providing tinned copper connection strips. Tinned copper strips shall be used for interconnections in terminal boards instead of small cable loops.

6.10.3 Separate terminal boards shall be provided for each voltage grade like 110V DC, 230V AC.

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6.10.4 All the studs shall be identified by the circuit numbers by marking indelibly.

6.10.5 Positive and negative terminals shall be separately located. Adequate spare terminals (minimum four) shall be provided in each terminal board for emergency use.

6.10.6 Terminal boards shall be installed in the vertical position to avoid dust collection and accidental short circuits. Suitable baffles may be provided, if necessary.

6.11 CABLE/WIRES

6.11.1 Single strand solid wires shall not be used for inter-connections between components/sub-assemblies. All inter-connections shall be with multi-strand flexible insulated cables conforming to RDSO spec. IRS.E/14/01 Pts. I, II & III.

6.11.2 The use of carbon bus bars, multi-strand cable insulated with fibre-glass/rubber sleeving etc. is not acceptable.

6.11.3 PTFE (Poly Tetra Fluoro Ethylene) insulated cables only shall be used for all inter-connection to the snubber circuits and signalling fuses.

6.11.4 The voltage rating, voltage grade of PTFE wires used shall be 3.0 KV AC for damping and snubber circuits and 750V for ventilation and other auxiliary circuits. The cross section of core shall not be less than 2.5 sq.mm.

6.12 CABLES MARKERS

All the wires shall be numbered and provided with cable ferrules of approved design/style and provided either end of cable termination. The marking shall be indelible and un-alterable.

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6.13 WIRING LAYOUT

6.13.1 The quality of workmanship and layout of the wiring shall be of high standard so as to ensure long life for wiring as well as to prevent deterioration/damage of insulation in service. For layout of wiring the following guidelines shall be kept in view in addition to IRS spec. IRS/E/12/01.

i) Complete separation of low, minimum and High voltage shall be ensured. Only wired on same potential shall be bunched together. Cables of different voltage grade shall be bunched separately.

ii) Similarly cables that are temporarily energised/permanently energised shall be bunched separately.

iii) Sharp bends shall be avoided. The closed installed minimum radius of the bend shall be at least 10 times the OD of the cable.

iv) Wherever the cables are passes through holes/orifices, cutaway etc. suitable rubber grommets shall be provided so that they shall not dislodge during vibration, shocks and tampering normally encountered in Rolling Stocks.

v) All the cable bunches shall be suitably supported by insulated stiffeners of minimum 8 10 or laid in cable ducting.

vi) The cable bunches shall be neatly tied with cable ties at 100mm interval. In order to have neatness and easy maintenance. The number of wires in each bunch shall not exceed ten.

6.13.2 The use of more PTEF wires/cables is recommended.

7.0 TESTS:

All the type/routine tests on silicon diodes and complete rectifier assembly shall be conducted at the manufacturer's works. Tests after erection shall be conducted at site. The contractor may depute his engineer at site where the EMU is under commissioning test at his own cost.

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7.1 INSPECTION AND TESTING

7.1.1 MATERIALS:- All equipments, materials, fittings and components will be subject to inspection and tests by the Purchaser or his engineers at the manufacturer's works before dispatch and no materials shall be dispatched from the manufacturer's works until these are inspected by the Purchaser or his representatives again at sit. The purchaser or his representative shall have the right to present during all stages of manufacture, and shall be offered, free of charge all reasonable facilities for inspection and testing so as to satisfy himself that the materials are in accordance with specification, approved drawings and designs, Any unreasonable delay in inspection will be reasonable ground for extension of time for completion of the work.

7.1.2 All the expenses of the purchaser's representatives shall be borne by the purchaser.

7.1.3 The decision of the purchaser shall be final in respect of acceptability or otherwise of any material, fittings, component or equivalent required for the work.

7.2 TYPE TESTS ON SILICON DIODES

Atleast 10 diodes shall be subjected to type tests as per IS-7788 in the presence of RDSO/ICF Inspecting Officer. Type test shall be arranged atleast two months before assembly of convertor to avoid delay of prototype assembled cubicle testing.

7.3 ROUTINE TESTS AND ACCEPTANCE TESS

7.3.1 Routine tests on each diode shall be conducted as IS-7788 and record maintained by the manufacturers.

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7.3.2 10% diodes selected at random from the load or two diodes per cubicle shall be subjected to routine tests in the presence of nominated Inspector testing the convertor cubicles.

7.4 TYPE TEST ON RECTIFIER ASSEMBLY

7.4.1 Temperature Rise Test: With normal ventilation (when the blower motor is running at 240V a.c 50 c/s input) the rectifier shall be subjected to continuous rated d.c current of 2640 amps for a period until steady state temperature is obtained. The temperature stabilisation can be deemed when the temperature measured in three consecutive 15 minutes intervals does not vary by more than 0.5°C. The temperature shall be increased at the base of heat sink of all diodes/capsules by suitably placed thermo-couples and the temperature rise corrected to 55°C ambient and with 20% current imbalance between parallel paths. The maximum diode junction temperature thus calculated shall be less than the maximum permissible, junction temperature declared by the diode manufacturer. The test may be conducted at a low voltage by shorting the DC output through an adequate rated shunt for measuring the current. The temperature rise shall be conducted for both (n) & (n-1) bridge conditions following the corresponding duty cycles :

The test under n-1 bridge conditions shall be conducted with any one of the paralleled bridges disconnected as chosen by the inspector.

During the above test full rated current of 500amps shall also be passed through the auxiliary rectifier continuously.

The testing may be conducted at low voltage with blower 'ON'.

Air inlet and air outlet temperature also shall be recorded during the above test.

The computed values of junction temperature and case temperatures of the hottest diode of both main rectifier and auxiliary rectifiers for 55°C inlet air temperature, shall not exceed the permissible limits of the temperature indicated by the manufacturer of diodes.

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During the temperature rise tests the cubicle doors and inspections covers shall be closed.

Calibrated CT-2 with accuracy clause of 0.5 or arms of the bridges and leads brought out for current unbalance in different arm to the average shall not be more than 1.0% in cold and hot conditions.

7.4.1.1 Heat run test with (n-1) parallel path will be conducted on 1st of prototypes and afterwards the test may be conducted corresponding to simplified equipment duty cycle as routine tests.

7.4.1.2 The fust blade temperature and bus-bar temperature shall not exceed 100°C with duty cycle indicated for (n-1) parallel paths under clause 4.6. The temperature limit is to be applied after applying correction for 55°C inlet air temperature.

All doors shall remain in closed condition as in service. The use of digital channel temperature indicator measuring instrument is recommended.

7.4.1.3 The instruments used for type testing shall be 0.5 clause accuracy and shall be calibrated within 6 months from a reputed test range.

7.4.2 All type and Routine tests shall be conducted as per IS-7788 measured power losses shall not exceed +10% value of declared value.

7.4.3 Verification of Cell check device and ventilation tests:

Different fault conditions in the rectifier shall be simulated to check the proper functioning of the cell check device.

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7.4.4 Running Test:- EMUs shall be run first with half load and then full load and subjected to three consecutive starts to stimulate starting duty cycle given by RDSO.


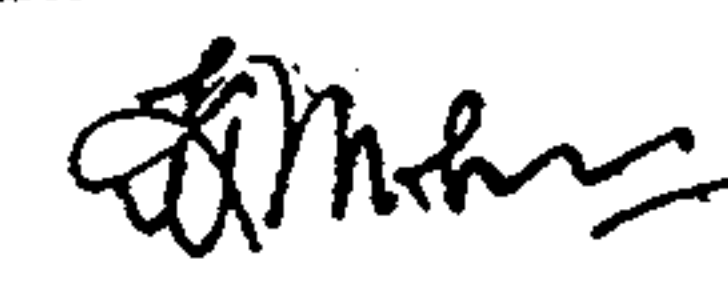

7.5 Tenderer shall express comments on the test programme and indicate their full acceptability for conducting tests.

7.6 INSPECTION:

7.6.1 The successful tenderer shall be required to furnish a programme of inspection allowing a minimum of 15 days time for arranging inspection in the manufacturer's works of the various equipment.

7.6.2 All kinds of materials and workmanship shall be tested and/or approved by the Inspectors nominated by the purchaser. The Inspector shall be able to witness the construction work during the period of manufacturing. Without the certificate nothing will be accepted. The Inspectors shall have free access to the manufacturer's works at all times while the work on the equipment is progressing. They shall be at liberty to inspect the manufacture at any stage to the terms of this specification and the foregoing as work progresses and stamp the important parts inspected, as they may deem necessary. The inspection made at the Manufacturer's workshop shall be regarded as a preliminary inspection for acceptance. There shall be a installed on the Coaches and tested. If anything does not pass the further inspection, the maker shall correct the fault before inspection for acceptance. The makers shall bear all the expenses for each corrections under Warranty.

7.6.3 The tenderer shall indicate the place of manufacture and the place where routine tests and type tests are proposed to be conducted.

		
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8.0 WARRANTY

8.1 Any part of the equipment failing or proving unsatisfactory in service due to defective design, material or workmanship within 60 months from the date the equipment is placed in service shall be replaced by the period for which the equipment was out of commission.

9.0 TECHNICAL PARTICULARS

9.1 The tenderer shall give along with the tender detailed technical literature of the equipment offered including the constructional features, instructions for installation, proper maintenance and repairs.

9.1.1 The maintenance manuals shall be supplied one number for each rectifier and ten copies additionally for each order without any additional charges.

10.0 CONDITIONS OF CONTRACT

10.1 The standard IRS conditions of contract will be applicable for the development and supply of the equipment in so far that any of the provisions of this specification are not contradictory.

11.0 TEST REPORTS:

11.1 The contractor shall supply copies of Test Reports as follows:-

- a) Type Test report for entire order - 4 copies.
- b) Routine Test report (along with each set of rectifier equipment) - 4 copies.

<i>M. K. N. S.</i>	<i>S. M. K.</i>	<i>V. D. S. R. S. R. S.</i>
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12.0 CONTRACTORS RESPONSIBILITY

12.1 The contractor shall be responsible for and shall bear and pay the costs for any alterations arising from any discrepancies, errors or omissions in the designs and drawings supplied by him, whether such designs and drawings have been approved by the Purchaser or not. After completion of supply, all drawings and schedules submitted by the Contractor and approved by the Purchaser, shall be made upto-date incorporating actual supply and erection particulars, such drawings and schedules shall then be verified and corrected if necessary by the Contractor, jointly with the Purchaser's representatives.

12.2 All designs and drawings submitted by the contractor shall be based on a thorough study and shall be such that the contractor is satisfied about their suitability. The purchaser's approval will be based on these considerations. Notwithstanding approval communicated by the purchaser, during the progress of the contract, for designs and drawings, proto-type samples of components, materials and equipments, after inspection of materials, after installation and adjustment, the ultimate responsibility for correct design and execution of work shall rest with Contractor.

12.3 In case the tender offer is accepted for supply of components only:-

12.3.1 Contractor shall depute one Engineer to ICF at his own expense to supervise the assembly of the equipment and advise at site. Supervisory, skilled and unskilled staff will be provided by Purchaser. The quotation shall be as per Schedules 1,2,3 & 4 Part IV.

<i>M2kms37</i>	<i>AMCh</i>	<i>KV Suresh Kumar</i>
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12.3.2 The supplier shall make available one proto-type of the equipment proposed to be supplied by him for inspection and test at his works and advise the Dy.CEE, ICF, Madras, and Controller of Stores/ICF, Madras as and when he is ready with the proto-type and provide necessary testing and measuring apparatus and facilities for carrying out the tests. The proto-type shall be approved by the Dy.Chief Elec.Engineer/ICF, in conjunction with Director General RDSO/Lucknow.

12.3.3 After the above tests, if it is considered necessary by the Dy.Chief Elec.Engineer/ICF, Madras or Director General/RDSO, Lucknow to carry out any further tests or trials of the proto type at ICF the supplier shall arrange for the same. Dy.Chief Elec.Engineer/ICF and Director General RDSO/Lucknow imply their authorised representatives also.

12.3.4 Any short-comings or defects in the design and workmanship of the equipment shall be pointed out after the tests, to enable the manufacturer to incorporate and necessary improvement before bulk manufacture is commenced.

13.0 FACILITIES:

13.1 Cranes or Hoists will be provided free of all charges, including cost of operation, at site. All Electrical energy for installation and testing will be given free of charge to the Contractor, at site.

14.0 USE OF REJECTED EQUIPMENT:

14.1 In the event of rejection of equipment supplied, the Purchaser shall without prejudice to his other rights and remedies be entitled to the use of the rejected equipment for a time reasonably sufficient to enable him to obtain other replacement equipment.

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During such period, if the rejected equipment is used commercially the Contractor shall not be entitled to payment or provisional acceptance until such rejected equipment is rectified and/or replaced, but the Purchaser shall not be entitled to claim any damages arising out of rejected equipment in respect of such period.

15.0 SPARE PARTS CATALOGUE:

15.1 Ten copies of the spare parts list with catalogue numbers shall be supplied at the time of commissioning of the first EMU with silicon rectifiers at no extra cost to the purchaser.

16.0 CONTRACTORS'S DESIGN & DRAWINGS

16.1 Any calculations, designs, drawings, schedules, information, data, progress charts etc. required by the purchaser's Engineers in connection with the contract shall be furnished by the contractor at his own expense.

16.1.1 The contractor shall submit to the purchaser's Engineers (RDSO/ICF) for approval, initially two copies of all detailed designs and drawings relating to supply and installation of the equipment covered by the work. The RDSO/ICF will scrutinise such designs and drawings and return one copy of the drawings either with its approval or with remarks for modifications or amendments, if any. On receipt, the Contractor shall submit six copies of such designs and drawings duly amended, if necessary for formal approval. RDSO/ICF will return one copy of the drawing duly stamped and signed in token of approval. The contractor shall as far as possible avoid correspondence on comments furnished and shall endeavor to settle any difference of opinion on the comments by discussions with RDSO/ICF.

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16.2 SUB CONTRACTORS

16.2.1 The contractor may sublet a part of the works under this contract and enter into contract with suppliers for supply of materials.

16.2.2 The names of all sub-contractors proposed to be employed on execution of work or any part thereof including manufacture of components and fittings shall be submitted by the contractor enters into an agreement with the sub-contractor for the purpose.

16.2.3 The contractor shall arrange for effective supervision of sub-contractor's work and remain solely responsible for materials supplied and for works carried out on his behalf by the sub-contractor.

OFFICE LETTER

From : M/s.

To: The President of India,
Acting thro' the GM/Elec./ICF,
Integral Coach Factory, Madras-38.

Dear Sir,

SUB : Tender for

I/We, the undersigned hereby offer to execute the work relating to design, manufacture, supply, installation testing and commissioning of -

Within the time specified below and in strict compliance with the provisions detailed in the tender papers appended hereto, and as modified by this tender at such rates as are specified in schedules appended hereto.

M2k m37

[Signature]

K. V. Srinivasan

PREPARED BY

VERIFIED BY

APPROVED BY

INTEGRAL COACH FACTORY, MADRAS-38.

ICF/ELEC/021

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Period of completion
Supply of complete rectifier Supply of components

- i) Date of issue of letter of acceptance of tender D D
- ii) Complete finalisation of design and drgs. with the approval of the purchaser. D plus months D plus months
- iii) Complete supply of the proto type Silicon Rectifier/components for the first EMU, will be completed within. D plus months D plus months
- iv) Supply of silicon rectifiers/components for 2nd EMU onwards within... D plus months D plus months
- v) Supply of silicon rectifier/components for the remaining EMU. D plus months D plus months

2. A list of imported materials considered necessary for the execution of the contract is attached.

Mzk u37

Amu

KV Gnan Arun

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MEMORANDUM OF THE TENDERER

M2km37

[Signature]

L.V. Srinivas Rao

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ALTERNATIVE PROPOSALS OF THE TENDERER2. Para No. of
the Tender
PapersAlternative
proposalsTechnical advantages
and/or final impli-
cation of the propo-
sals (savings/excess)

M2kust

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L.V. Subbarao

PREPARED BY

VERIFIED BY

APPROVED BY

ICF/ELEC/021

REV. NO. 4

DATE 2-9-96

RECOMMENDED

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DEVIATION FROM THE TENDER PAPERS

Section - E

1.1 Instructions to Tenderers and Conditions of Tendering
Deviations required : Reason/s for the deviation

Para No. of the Tender

Papers.

1.1

Section - II

1.2 Conditions of contract

1.2...

Section - III

1.3 Specifications.

1.3...

3. I/We agree that this Tender shall not be restricted on withdrawn and shall remain open for acceptance for and during the period of four months from the date fixed for opening the same and I/We shall be bound by a communication of acceptance.

4. I/We fully understand the terms, conditions and other provisions as contained in the Tender-papers and I/We agree that same shall apply to my/our Tender as modified by my/our Tender and I/We shall be bound by them.

Johnson

Levenson, Ann

VERIFIED BY

APPROVED BY

INTEGRAL COACH FACTORY, MADRAS-3B.	ICF/ELEC/021 REV.NO. A DATE : 2-9-96 (REVALIDATED)
SUBJECT: SPECIFICATION FOR CONVERTERS OF BG, AC EMUs MOTOR COACHES.	PAGE : 47 OF 56

5. I/We have been licensed by the Government of India, for the manufacture of the components/complete assembly of rectifiers offered herein and the licensed capacity is adequate to meet the present offer.

6. I/We have deposited with the Chief Cashier, Integral Coach Factory, Madras the required Earnest Money of Rupees

@ in respect of this
Tender for which Receipt No. Dt. has been granted.

I/We enclose a bank guarantee from Bank Ltd. for rupees towards earnest money in respect of this Tender.

7. I/We enclose the Income Tax clearance Certificate or a declaration to that effect as required under para of the Tender Papers pertaining to me/us for the year.

8. I/We have no retired engineer or retired gazetted officer of the Engineering Department of any of the Railways owned and administered by the President of India.

or

The list of retired engineers or retired gazetted officers of the Engineering Department of any of the Railways owned and administered by the President of India who are associated with me/us, is included as an enclosure to this offer letter.

Seal of the tender :

Yours faithfully,

Place :

Date :

1. Witness by:

Signature of Tenderer/s
1. Signature : Name in Block letters:
Address :

2. Signature : Name in Block letters :
Address :

<i>M2K up 57-</i>	<i>[Signature]</i>	<i>[Signature]</i>
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INTEGRAL COACH FACTORY, MADRAS-38.	ICF/ELEC/021
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SCHEDULE - I
SCHEDULE OF PRICES
Section . 1
(complete Rectifier Assembly)

Description	Price per EMU Set	Price for 15 EMU Sets
Design, manufacture, supply, testing and commissioning of Silicon Rectifier equipment complete with blowers and protective equipment etc. for 25KV, single phase, 50 cycles, AC/EMU in accordance with specification contained in Tender-Papers ICF/EN/8/		

Note : Give herein breakup prices of major items of rectifier assembly as in Schedule 1 Sec.2

Important : 1) Any other material or equipment considered necessary by tenderer for completely assembling of the rectifier set and its proper functioning, may be indicated here. List here items not included in the supply of the tenderer but required for the assembly of the complete rectifier and to be arranged by Purchaser in order to enquire its proper functioning.

Maxamist,	Ambar	LV Suman
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SCHEDULE - I
SCHEDULE OF PRICES
Section . 2

Value of major components and assemblies for on-account payment on delivery at site.

Sl.No.	Description	Unit	Qty.per EMU	Quantity for 15 units unit	Value per 15 EMU Col.5 x Col.6	Total value of materials for 15 EMU Col.5 x Col.6	90% of Col.7
1	2	3	4	5	6	7	8

Col.4 x 15

- 1) Silicon diodes with cooling fins and flexible connections.
- 2) Reinforced fibre glass other insulating material trays with runner guides fixed to the tray, handles with bolts and screws but without the steel cubicle.
- 3) Steel cubicle complete with inspection cover and locking arrangements.
- 4) Bus and other connections with support insulators or bushes, complete set of terminals, terminal blocks,. insulated where necessary with nuts, bolts required for connections internal as well as external for rectifier set as a whole (Insulated flexible wire for internal connection will be supplied by Purchaser) 1 set.
- 5) Resistors - One lot required for assembling one complete rectifier set.
- 6) Capacitances - -do-
- 7) Protective relays required for each rectifier equipment.
 - a) Description
 - b) Description
 - c) Description
 - d) Description

0 Col.4 x 15

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SCHEDULE - I
SCHEDULE OF PRICES
Section . 2

Value of major components and assemblies for on-account payment on delivery at site.

Sl.No.	Description	Unit	Qty.per EMU	Quantity for 15 units unit	Value per 15 EMU Col.5 x Col.6	Total value of materials for 15 EMU Col.5 x Col.6	90% of Col.7
1	2	3	4	5	6	7	8

8) Blower with motor (capacitor start and type) (AC single phase 50 c/s to latest Indian Standards and IEC publication 101 latest, with correction for operation at 550C, supplied from 266V (Nominal) Auxiliary winding of the transformer. Ordinary wire mesh guard type of filter will be supplied by purchaser.

9) Surge Absorber : (a)
(b)

- 10) Fuses
11) Special materials required for each rectifier set during assembly like :-
a) Solder
b) Paste
c) Any other item.

Prepared by	Checked by	Approved by
VERIFIED BY		APPROVED BY

INTEGRAL COACH FACTORY, MADRAS-38.	ICF/ELEC/O21 REV.NO. A
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SCHEDULE - I
SCHEDULE OF PRICES

Section . 3

Foreign Exchange Requirement

Sl.No.	Description of item to be imported	Unit of supply	Unit* price Rs.	No. of Units reqd. per EMU	No. reqd. for 15 EMUs.	Total price C.I.F.
--------	------------------------------------	----------------	-----------------	----------------------------	------------------------	--------------------

- I)
1.
2.
3.
4.
5.
etc.

II) Add 10% loss and damages in transit and erection and other contingencies.

III) Foreign exchange requirement of spares included in Schedule.3

IV) Foreign exchange requirements of special imported tools, etc. included in Schedule 2 & 4.

Total : ..

Grand Total: ..

(In words)

* C.I.F Unit Price less Indian Agent's commission payable in Rupees.

PREPARED BY	VERIFIED BY	APPROVED BY
M. K. S. S.	S. S. S.	L. V. S. S.

INTEGRAL COACH FACTORY, MADRAS-38.	ICF/ELEC/021
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SCHEDULE - 2
SCHEDULE OF PRICES OF SPARES

Sl.No. (1)	Description of Item (2)	Quantity required (3)	Unit price free at site (4)	Total price (3 x 4) (5)
---------------	----------------------------	--------------------------	--------------------------------	----------------------------

Grand Total (in figures) _____
(In words)

Note : The spares are to be recommended on the basis of requirement
for first two years.

Makur...
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SCHEDULE - 4
INSTRUMENTS AND GAUGES etc. FOR OPERATION/MAINTENANCE
SCHEDULE OF PRICES OF TOOLS,

<u>SCHEDULE OF PRICES OF LOGS</u>			
Description	Quantity-required 2	Price for each EMU free 3	Total price for 15 units 4
1			
			Rs. P.

SECTION. 1

Tools on EMU's :

Total of Section-1.

SECTION. 2

Tools on for Sheds :

Total of Section-2.

GRAND TOTAL (in figures)

(in words)

<p>Maxwell</p>	<p>Johnson</p>	<p>LLV Simon and</p>
<p>PREPARED BY</p>	<p>VERIFIED BY</p>	<p>APPROVED BY</p>

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SCHEDULE - IList of imported special tools, plant, instrument, gauges,
jigs fixtures etc. required for installation.

(To be procured by the Contractor at his own cost)

Item No.	Description of item	Quantity required	Unit price* CIF	Total CIF price
(1)	(2)	(3)	(4)	(5)
			Rs. P	Rs. P

Grand Total : _____

* Exclusive of Indian Agent's Commission payable in rupees.

<i>M. K. N. S. T.</i>	<i>[Signature]</i>	<i>K. V. S. R. S. R.</i>
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NAMES OF MANUFACTURERS, PLACES OF MANUFACTURE, TESTING AND INSPECTION AT WORKS

Item No.	Description of item	Name and address of Manufacture	Place of Manufacture	Place of Manu.
(1)	(2)	(3)	(4)	(5)

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TENDERER'S CREDENTIALS

Please fill in the Questionnaire below :

1. Give details of your previous experience on installation of similar equipment/s.

2. Have you any consultants to assist you in this work ? If so, give full particulars.

3. Give details of technical personnel you would employ for execution of this Contract and a brief note about their qualifications and experience.

4. Give the names of your Bankers and their reference.

5. Give details of the licensed capacity was granted by the GOI for manufacture supply of components/full rectifier assembly offered herein.

NOTE: This form shall be filled precisely and will full details.

Encl: Drg.No. EMU/M-9-0-001.

ICF/SK.7-1-068, alt 'g'.

M2KwST

M2KwST

M2KwST

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CORRECTION SLIP NO. 1 DT. 14.2.93.

Clause 4.4

The last para shall be read as follows :

In the Auxiliary rectifier, metal oxide varistor (MOV) shall be provided in AC input side. RDSO approved type number of MOV is V 240 or 251 CA 32. of M/s I.G.E.(INDIA) Ltd., Bombay. Detail calculations and Technical Data of MOV shall be submitted for approval.

Clause 4.5

Deleted. This over current relay is not applicable for EMU Main Rectifier.

(Clause 4.4 correction is based on item 16 of V MSG Meeting at Bhopal, 21/22 June '91 and RDSO letter EL/2.3.7/J10 dated 15.1.92)

<i>Mekn37</i>	<i>[Signature]</i>	<i>[Signature]</i>
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DATE : 2.9.96

C. REVISED 4.7.97

SUBJECT: SPECIFICATION FOR
CONVERTERS OF BG, AC EMUs
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CORRECTION SLIP NO. 2 DT. 16.10.95

1. Clause 7.2

The para shall be read as follows :-

The type and routing test on diodes, converter Assy. and after installation of the Rolling Stock shall be in accordance with IS.7788-75 as shown below. Atleast 10 diodes shall be subjected to type tests as per IS.7788-75 and record maintained by the manufacturers. The type test shall be arranged atleast 2 months before assembly of converter.

1.1 Test on Diodes

Sl.No	Nature of Tests	IS.7788-75 Clause No.	
		Type tests	Routine
1.	Forward voltage	10.1.2.1	10.1.2.2
2.	Reverse characteristic	10.1.3	-
3.	Reverse current	10.1.4	-*
4.	Reverse voltage	10.1.5	-*
5.	Reverse recovery change	10.1.6	-
6.	Thermal Resistance	10.1.7.1	-*
7.	Transient Thermal impedance	10.1.7.2	-
8.	Thermal cycling	10.1.8	-
9.	Surge forward limit current	10.1.9.1	10.1.9.2
10.	Surge forward current	10.1.10	-
11.	Load	10.1.11	-
12.	Deterioration	10.1.12	-*
13.	Encapsulation	10.1.13	-

* its applicable

M2K m57-

E. M. M.

L. V. S. R. S.

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REV.NO. A

DATE 2.9.96

C.A.E.V.I.D.4782

SUBJECT: SPECIFICATION FOR
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1.2 Tests on Converter Assembly

IS-7788-75

Clause Number

Type Routine

1. Ventilation	10.2.2	-
2. Mechanical vibrations and shock	10.2.3	-
3. Voltage sharing	10.2.4	-*
4. Forward current sharing	10.2.5	-*
5. Continuous duty temp. rise	10.2.6	-*
6. Starting duty cycle temp. rise	10.2.7	-
7. Impulse voltage	10.2.8	-
8. Insulation	10.2.9	-*
9. Tests on Converter Assembly	10.2.10	-*
10. Tests on indicating and functional units of converter assemblies.	10.2.11	-*
11. Power loss, measurement	10.2.12	-
12. Check of diode characteristic	10.2.13	-
13. Temperature rise test	Clause 7.4.01 to ICF/ELEC/7.4.1.2. 021 Rev.A	

1.3 Tests on Converter Assembly after installation.

	Type	Routine
1. After installation on Rolling Stock	10.2.14	-*
2. A.C circuit breaker testing	10.2.16	-

* denotes 'Applicable'.

2. In addition to the tests indicated for converter assembly, the Hose proof test as per IS.4691 - (latest) shall be conducted as Routine test for all the converter assemblies offered for inspection, to meet the requirements, indicated in the clause 2.5 of ICF/Elec./021 (Rev. 'A')

<i>M. K. N. S.</i>	<i>J. M. S.</i>	<i>L. V. S.</i>
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