



BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

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TYPE OF DOC.	TECHNICAL SPECIFICATION			NAME	BA	VK	RS
TITLE	400kV CURRENT TRANSFORMER			SIGN	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>
				DATE	17.09.13	17.09.13	17.09.13
				GROUP	TBEM	W.O.	80012
CUSTOMER	APGENCO, VIDYUT SOUDA, HYDERABAD						
CONSULTANT	DESEIN ENGINEERS PRIVATE LIMITED, HYDERABAD						
PROJECT	400/220 KV SWITCHYARD, RAYALSEEMA, 1*600 MW, STAGE-IV, UNIT-6						

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SECTION 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES

1.0 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of Current transformers complete with accessories as listed in clause 1.2 & 1.3 below.

This section covers the specific technical requirements of 400kV Current Transformers. **In case of any discrepancies between the requirements mentioned in this section and those specified in the following sections of this specification, the specifications given herein shall prevail and shall be treated as binding requirements.**

1.1 The equipment is required for the following project.

Name of customer: **APGENCO**

Name of the project: **400/220 KV SWITCHYARD, RAYALSEEMA, 1*600 MW, STAGE-IV, UNIT-6**

Refer Section - 3 for Project Details and General Specifications.

Note: The terms used in this specification namely, “Employer/Purchaser” refers to APGENCO, “Contractor” refers to BHEL & “Sub-contractor” refers to successful bidder.

1.2 SPECIFIC TECHNICAL PARTICULARS:

a. System Parameters:

S. No.	Description of parameters	400kV System
1.	Maximum system voltage Um (kV)	420
2.	Impulse withstand voltage (dry & wet) (kVp)	1425
3.	Power frequency withstand voltage (dry and wet) (kV rms)	630
4.	Total creepage distance (min) (mm)	10500
5.	Rated Frequency	50
6.	No. of Poles	1
7.	Design ambient Temperature (°C)	50
8.	Rated Insulation Levels: a. Full wave impulse withstand Volt (1.2/5µs). - between line terminals and	1425KVp

	ground. b. One minute power frequency dry and wet withstand voltage - Between line terminals and ground.	630 kV rms.
9.	Seismic acceleration	0.3g
10.	Partial Discharge level [pC max]	10
11.	Phase to space spacing (mm)	4000

b. Core Parameters of 400 KV CT:

1. (For all bays except Line Bays)

Rated Primary Current: 2000A (with 120% extended current rating)

- Core 1 - 2000 - 1000 / 1Amp
 $V_k \geq 2000V / 1000V$
 $I_e \leq 30 \text{ mA} / 60 \text{ mA at } V_k$
 $R_{ct} = 10 / 5 \text{ ohms}$
 Class PS
- Core 2 - 2000 - 1000 / 1Amp
 $V_k \geq 2000V / 1000V$
 $I_e \leq 30 \text{ mA} / 60 \text{ mA at } V_k$
 $R_{ct} = 10 / 5 \text{ ohms}$
 Class PS
- Core 3 - 2000 - 1000 - 500 / 1Amp
 Burden- 20VA / 20VA / 20VA
 Accuracy Class- 0.2S on all taps
- Core 4 - 2000 - 1000 - 500 / 1Amp
 $V_k \geq 4000V / 2000V / 1000V$
 $I_e \leq 30 \text{ mA} / 60 \text{ mA} / 120 \text{ mA at } V_k$
 $R_{ct} = 15 / 10 / 5 \text{ ohms}$
 Class PS
- Core 5 - 2000 - 1000 - 500 / 1Amp
 $V_k \geq 4000V / 2000V / 1000V$
 $I_e \leq 30 \text{ mA} / 60 \text{ mA} / 120 \text{ mA at } V_k$
 $R_{ct} = 15 / 10 / 5 \text{ ohms}$
 Class PS

2. (For Line Bays)

Rated Primary Current: 2000A (with 120% extended current rating)

- Core 1 - 2000 - 1000 / 1Amp
 Vk ≥ 2000V / 1000V
 Ie ≤ 30 mA / 60 mA at Vk
 Rct = 10 / 5 ohms
 Class PS
- Core 2 - 2000 - 1000 / 1Amp
 Vk ≥ 2000V / 1000V
 Ie ≤ 30 mA / 60 mA at Vk
 Rct = 10 / 5 ohms
 Class PS
- Core 3 - 2000 – 1000 - 500 / 1Amp
 Burden- 20VA / 20VA / 20VA
 Accuracy Class- 0.2S on all taps
- Core 4 - 2000 – 1000 - 500 / 1Amp
 Burden- 20VA / 20VA / 20VA
 Accuracy Class- 0.2S on all taps
- Core 5 - 2000 – 1000 – 500 / 1Amp
 Vk ≥ 4000V / 2000V / 1000V
 Ie ≤ 30 mA / 60 mA / 120 mA at Vk
 Rct = 15 / 10 / 5 ohms
 Class PS
- Core 6 - 2000 – 1000 – 500 / 1Amp
 Vk ≥ 4000V / 2000V / 1000V
 Ie ≤ 30 mA / 60 mA / 120 mA at Vk
 Rct = 15 / 10 / 5 ohms
 Class PS

1.3 BILL OF QUANTITIES

S. No.	Description	Main Equipment	Spares	Total Quantity (Nos.)
1.	400kV, 40kA for 1sec, 2000Amps, 5 core, single phase Current Transformer with extended current 120% along with mounting hardware	24 Nos.	NIL	24
2.	400kV, 40kA for 1sec, 2000Amps, 6 core, single phase Current Transformer with extended current 120% along with mounting hardware.	6 Nos.	NIL	6

1.4 MOUNTING STRUCTURE

The steel structures shall not be in scope of CT supplier. These shall be supplied by TBG/BHEL. However equipment fixing hardware shall be included in scope of supply.

1.5 TERMINAL CONNECTORS

The HV terminal connectors shall not be in scope of CT supplier. These shall be supplied by TBG/BHEL.

1.6 MOUNTING HARDWARE

Each CT shall be offered with set of mounting hardware viz., Nuts, Bolts, washers etc. Price of the same is deemed to be included in the offered CT price.

1.7 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

All current transformers should have been type tested as per IEC/ IS and shall be subjected to routine tests in accordance with IEC60044-1/ IS 2705. Only type-tested equipments only shall be offered. Manufacturer shall submit valid reports of type tests carried out within five years of bid opening date. These reports should have been conducted on identical / similar equipment to those offered, in case less than five years old type test reports OR valid type tests are not furnished, the tests shall be conducted free of charge. No separate type test charges shall be paid.

Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out without any additional cost implication to the Purchaser.

1.8 DEVIATIONS

The bidder shall list all the deviation from the specification separately. Offers without specific deviation will be deemed to be totally in compliance with the specification and NO DEVIATION on any account will be entertained at a later date.

1.9 MANUFACTURING QUALITY PLAN

Bidder has to follow APGENCO/BHEL approved Manufacturing Quality Plan at contract stage.

1.10 TECHNICAL REQUIREMENT

The manufacturer whose current transformers are offered, should have manufactured & type tested as per IS/IEC or equivalent standard and supplied the same for the specified system voltage for CT and 25kA fault level or above (fault level applicable for current transformer only).

These equipment should be in operation for at least 2 (two) years as on the date of bid opening. In addition to the above the offered Current transformer should have been manufactured and type tested to specified fault level as on the date of bid opening.

SECTION 2

Equipment Specification

1.0 GENERAL

This section covers this design, manufacture, assembly, testing at manufacturer's works supply and delivery of outdoor, **dead tank type, oil impregnated paper**, single phase, 50 Hz, oil immersed, self cooled, current transformer suitable for operation in the climate conditions specified. The current transformers shall be complete in all respects.

STANDARDS FOR CURRENT TRANSFORMERS:

S. No.	STANDARD NO.	TITLE
1	IS:2165	Insulation co-ordination for equipment of 100 KV and above
2	IS: 105 (I to IV)	Instrument Transformers
3	IS:2099	High voltage porcelain bushings
4	IS:3347	Dimensions of porcelain transformer bushings
5	IS:2071	Method of high voltage testing
6	IS:335	Insulating oil for transformers and switchgears
7	IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control.
8	IS:60044-1	Instrument Transformers
9	IEC-270	Partial discharge measurement
10	IEC-44(4)	Instrument transformer measurement of PDs
11	IEC-171	Insulation co-ordination
12	IEC-60	High voltage testing techniques
13	IEC-8263	Method for RIV test on high voltage insulators
14	----	Indian Electricity Rules 1956

- a) The current transformers and accessories shall conform to the latest versions of the standards IEC-60044-1/IS: 2705 or latest applicable standard of IEC/IS except to the extent explicitly modified in the modified in the specification.
- b) The current transformer shall be complete with its terminal box.
- c) The tank along with top metallics shall be painted as per IS-5 shade or hot dip galvanizing shall be specified by the customer during detailed engineering.
- d) The impregnation details alongwith tests/ checks to ensure successful completion of impregnation cycle shall be furnished for approval
- e) The current transformers shall be designed for use in geographical and meteorological condition as specified in section-3.
- f) The equipment will be installed outdoor in a hot, humid and tropical atmosphere with heavy chemical pollution.
- g) All equipment accessories and wiring shall have tropical protection, involving special treatment of metal and insulation against fungus, insects and corrosion.
- h) The maximum temperature in any part of the equipment at specified rating shall not exceed the permissible limits as stipulated in the relevant standards.
- i) The equipment shall be capable of withstanding the dynamic and thermal stresses of listed short circuit current without any damage or deterioration.
- j) The safety clearance of all live parts of the equipment shall be as per relevant standards.

2.0 CONSTRUCTION FEATURES

The features and constructional details of instrument transformers shall be in accordance with requirements stipulated hereunder:

2.1 Bushing/Insulators:

- a) Instrument transformers shall be of 420 kV class, oil filled, with shedded porcelain bushings/ Insulators suitable for outdoor service and upright mounting on steel structures.
- b) Bushings/Insulators shall conform to requirements stipulated in relevant IS/IEC. The bushing/insulator for CT shall be one piece without any metallic flange joint.

- c) Bushings shall be provided with oil filling and drain plugs, oil sight glass of CT. The bushing/insulator of instrument transformer shall have a cantilever strength of not less than 500 kg for 420kV Instrument transformers respectively.
- d) Instruments transformers shall be hermetically sealed units. Manufacturer shall furnish details of the arrangements made for the sealing of instrument transformers alongwith the bid.

Manufacturer shall also furnish the details of site tests to check the effectiveness of hermetic sealing for approval.
- e) Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.
- f) Insulator shall be of wet process porcelain, brown glazed and free from imperfections. All metal parts and hardware shall be hot dip galvanized.
- g) The creepage distance shall correspond to heavily polluted atmosphere. Grading ring, if required, shall be furnished to maintain voltage gradient with permissible limit.

2.2 Terminal box/Marshalling box:

The terminal box shall be provided with a removable cable gland plate at the bottom for mounting. It shall conform to the requirements furnished separately in section-3 of specification.

2.3 Insulating Oil:

Insulating oil to be used for instrument transformers shall be of EHV grade and shall conform to IS: 335 (required for first filling).

2.4 Name Plate:

Nameplate shall conform to the requirements of IEC incorporating the year of manufacture. The rated current, extended current rating in case of current transformers shall be clearly indicated on the nameplate. The rated thermal current of CT shall also be marked on the name plate.

3.0 SPECIFIC TECHNICAL REQUIREMENT

- a) Current transformers shall have single primary either ring type, or hair pin type and suitably designed for bringing out the secondary terminals in a weather proof (IP 55) terminal box at the bottom. These secondary terminals shall be terminated to stud type non disconnecting terminal blocks inside the terminal box. In case "Bar primary"

invented type current transformers are offered, the manufacturer will meet following additional requirements:

- (i) The secondaries shall be totally encased in metallic shielding providing a uniform equipotential surface for even electric field distribution.
 - (ii) The lowest part of the insulation assembly shall be properly secured to avoid any risk of damage due to transportation stresses.
 - (iii) The upper part of insulation assembly resting on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly & top dome.
 - (iv) Nitrogen if used for hermetic sealing (in case of live tank design) should not come in direct contact with oil.
 - (v) Manufacturer shall recommend whether any special storage facility is required for spare CT.
- b) Different ratios specified shall be achieved by secondary taps only and primary reconnection shall not be accepted.
 - c) Core lamination shall be of cold rolled grain oriented silicon steel or other equivalent alloy. The cores used for protection shall produce undistorted secondary current under transient conditions at all ratios with specified CT parameters.
 - d) The expansion chamber at the top of the porcelain insulators should be suitable for expansion of oil.
 - e) Facilities shall be provided at terminal blocks in the marshalling box for star delta formation, short-circuiting and grounding of CT secondary terminals.
 - f) Current transformer's guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.
 - g) For 420 kV class CTs, the rated extended primary current of the CTs shall be 200% of rated primary on all except 2000/1 tap ratio. On 2000/1 tap ratio the rated extended primary current shall be 120%. However, at 2000/1, ratio the CT shall be thermally rated for 200% for 15 minutes and 120% continuous.
 - h) For current transformer, characteristics shall be such as to provide satisfactory performance of burdens ranging from 25% to 100% of rated burden over a range of 5% to 120% of rated current in case of metering CTs and up to the accuracy limit factor/knee point voltage in case of relaying CTs.
 - i) The current transformer shall be suitable for horizontal transportation. It shall be ensured that the CT is able to withstand all the stresses imposed on it while transporting and there shall be no damage in transit. The manufacturer shall submit the details of packing design to the Purchaser for review.
 - j) For CTs the instrument security factor at ratios shall be less than five (5) for metering core. If any auxiliary CTs/reactor are used in the current transformers then all parameters

specified shall have to be met treating auxiliary CTs as an integral part of the current transformer. The auxiliary CTs/reactor shall preferably be inbuilt construction of the CTs. In case these are to be mounted separately these shall be mounted in the central marshalling box suitably wired upto the terminal blocks.

- k) The current transformers should be suitable for mounting on lattice support structure to be provided by the contractor.
- l) The CT shall be designed as to achieve the minimum risks of explosion in service. Manufacturer shall bring out the measures taken to achieve this.
- m) 420 KV current transformers shall be suitable for high speed auto reclosing.
- n) The current transformer shall be filled up under vacuum with insulating oil and be hermetically sealed. The current transformer shall be provided with oil level gauge, drain and pressure relief device. An inert gas cushion shall be provided on the top of the oil.

4.0 TYPE, ROUTINE & SITE TESTS

All current transformers should have been type tested as per IEC/ IS and shall be subjected to routine tests in accordance with IEC60044-1/ IS 2705. Only type-tested equipments only shall be offered. Manufacturer shall submit valid reports of type tests carried out within five years of bid opening. These reports should have been conducted on identical / similar equipment to those offered, in case less than five years old type test reports or valid type tests are not furnished, the tests shall be conducted free of charge. No separate type test charges shall be paid.

SECTION – 3
PROJECT DETAILS AND GENERAL SPECIFICATIONS

SL.NO.	DESCRIPTION	
1.	PROJECT INFORMATION	
	a) Customer	APGENCO, Hyderabad
	b) Consultant	Desein Consulting Engineers, Hyderabad
	b) Projects	1x600MW RayalseemaTPP, Stage-IV, Unit#6-400/220kV Switchyard
	c) Project locations	The project site is located in VV Reddy nagar, Post- Karamala Distt Kadapa (Formarely Cuddapah) about 30KM west-south of Proddatur & 20KM from Yerraguntla. Approx. 7 km north of Chillamkur Village. Nearest Rail head is Muddanur, which is approx. 10 km from Site. Site is approximately 480KM from Hyderabad and 350KM from Chennai.

Equipment to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions:

2.	SITE CONDITIONS	
i.	Maximum Ambient air temp. (max.)	40.3 °C
ii.	Minimum Ambient air temp. (max.) °C	19.1 °C
iii.	Design ambient temperature	50 °C
iv.	Altitude above MSL	190m
v.	Basic wind speed	39m/s at 10m above retarding surface
vi.	Seismic acceleration	Zone-III As per IS-1893
vii.	Terrain Classification	Category-2
viii.	Average Rainfall	742.8 mm Average
ix.	Humidity	Max: 49-74% (June to Oct) Min: 35-60% (march to June)

3. Auxiliary Supply

Normal Voltage	Variation in Voltage	Frequency in Hz	Phase/Wire	Neutral Connection
415 Volts	± 10%	50 ± 5%	3 phsae/4 wire	Solidly earthed
240 Volts	± 10%	50 ± 5%	1 phase/2 wire	Solidly earthed
220 Volts	190V to 240V	DC	---	Isolated 2 wire system (ungrounded)

Combined variation of voltage and frequency shall be limited to ± 10%.

5. DOCUMENTS TO BE SUBMITTED ALONGWITH OFFER

- 1) Drawings.
- 2) Guaranteed Technical Particulars
- 3) Type Test Reports
- 4) Manufacturing Quality Plan

6. DOCUMENTATION SCHEDULE AT CONTRACT STAGE

A : For & After Approval	Soft copies as per clause no. 5 in 1 set
B : For Approval	Hard copies as per clause no. 5 in 12 sets
B : After Approval	Bound sets of Approved Hard copies and Installation, Operation & Maintenance manual and all as built drawings in 20 sets
	3 Set of Computer CD-ROMs (with unbreakable CD Covers) containing all as-built drawings in Auto-Cad version 2006 or later with 2D and 3D drawings, Instruction Manual and GTP.

7. **Title block:** Title block shall be forwarded to successful bidder after placement of order.
8. All outdoor enclosures shall provide a degree of protection of not less than IP 55 as per IS-13947 & colour shade of RAL 7032 and one enclosures of each type shall be tested for the same or evidence of testing shall be furnished in lieu of type testing.
9. **CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT**

All types of boxes, cabinets, etc. shall generally conform to & be tested in accordance with IS-5039/ IS 8623, IEC: 439, as applicable, and the clauses given below:

Control cabinets, junction boxes, Marshalling boxes and terminal boxes shall be made of sheet steel or aluminium enclosure and shall be dust, water and vermin proof. Sheet steel used shall be at least 2.0 mm thick cold rolled or 2.5 mm hot rolled. The thickness of aluminium sheet shall be minimum 3mm. However the junction boxes & switch boxes shall be hot dip galvanized.

Protection Class shall be as follows:

- | | | |
|------|------------------------------|-------|
| i) | INDOOR Air conditioned area- | IP 31 |
| ii) | Indoor Non AC Areas- | IP 54 |
| iii) | Outdoor Areas- | IP 55 |
| iv) | Motors- | |
| | a) Indoor- | IP 54 |
| | b) Outdoor- | IP 55 |

Cabinet/boxes shall be free-standing, floor-mounting type, wall mounting type or pedestal mounting type as per requirements. A canopy and sealing arrangement for operating rods shall be provided in Marshalling boxes/Control cabinet to prevent ingress of rain water.

10. Quality plan:

BHEL or APGENCO approved QP shall be followed.

11. Type Test reports:

Bidder shall submit valid type test reports (as per relevant IEC/IS Standard) of the tests carried out within last five years from the date of bid opening.. The report should have been conducted on identical or similar equipment/ components to those offered. In case type test reports are more than 5 years old OR the reports of type tests are found to be technically unacceptable, the type test shall be conducted without cost and delivery implication to BHEL/APGENCO.

12. INSPECTION, TESTING AND INSPECTION CERTIFICATE

Inspection testing shall be done as per customer specification and inspection plan.

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SECTION -4
GUARANTEED TECHNICAL PARTICULARS

CURRENT TRANSFORMER

1. Name and address of manufacturer
2. Manufacture's type designation
3. Standards applicable
4. Type of CT (Live or Dead Tank)
5. Rated frequency (Hertz)
6. Rated voltage U_r (KV_{rms})
7. Rated current
 - i) Rated continuous normal current (A)
 - ii) Rated extended primary Current (A)
8. Short time thermal current withstand for 1 sec. (KA).
9. Dynamic current withstand (KA_{peak}).
10. 1.2/50 micro second impulse withstand voltage (KV_{peak})
11. 250/2500 micro second switching surge withstand voltage (dry & wet) (kVp)
12. One minute dry and wet power frequency withstand voltage (kV_{rms})
13. No. of Primary winding
14. No. of cores per CT
15. Current Ratio (for all cores)

**SECTION -4
GUARANTEED TECHNICAL PARTICULARS**

CURRENT TRANSFORMER

- 16 Output Burden for all cores
- 17 Accuracy class
- 18 Knee point voltage (V) at different taps
- 19 Secondary winding resistance at different ratios (for all cores)
- 20 Maximum exciting current at knee point voltage at different ratios (for all cores) (mA)
- 21 Instrument security factor at different ratios for metering cores
- 22 Radio interference voltage at 1.1 $U_r/(\sqrt{3})$ at 1.0 MHz (μ Volts)
- 23 Corona extinction voltage (KVrms)
- 24 Partial discharge level (pico coulombs)
- 25 Standard to which oil conforms generally
- 26 Total weight (kg)
- 27 Confirm whether similar equipment are type tested and in successful operation for at least 2 years
- 28 Maximum exciting current at knee point voltage at different ratios (for all cores) (mA)

SECTION 5
CHECK LIST FOR INFORMATION TO BE FURNISHED WITH OFFER
RETURN THIS CHECKLIST AS PART OF THE OFFER DULY SIGNED

The offer may not be considered if the following information and this Checklist are not enclosed with the Offer.

BHEL ENQUIRY NO:

BIDDER OFFER REFERENCE:

A)

S. No.	Parameters	Data	Yes / No	Remarks
1.	Applicable Standard	IEC: 60044-1, IS-2705	Yes	
2.	Type	Outdoor	Yes	
3	Rated Frequency	50 Hz	Yes	
4	Highest System Voltage	420kV	Yes	
5	Rated current	2000A	Yes	
6	Rated short time withstand current for 1 sec	40 kA for 1 sec.	Yes	
7	Rated extended current	120%	Yes	
8	Rated dynamic current	100kAp	Yes	
9	Type of Insulation	Class A	Yes	
10	Rated Insulation Levels : a. Power Freq. Withstand Voltage b. Lightning Impulse withstand voltage	630kV (rms) 1425kVp	Yes	
11	Creepage Distance	10500 mm	Yes	
12	The CT Core Parameters	As per Clause 1.2 b of Section I	Yes	
13	CT supplied Suitable for operation in the Climatic and High	Suitable for Climatic and Meteorological Data Specified in Section 3	Yes	

	Altitude conditions.			
14	Max. Temperature rise over design ambient temperature	As per IEC 60044-1 & IS 2705	Yes	
15	External Surface if steel	a. Hot Dip Galvanized b. Painted	Yes	
16.	Drawings & GTP.	Drawings / GTP of the offered CT type available	Yes	
17.	Type Test	List of valid Type Test reports to be submitted along with offer.	Yes	
18	Technical Requirement	Manufacturer qualifies the Technical Requirement as per clause 1.10 of Section-1 of the Technical Specification.	Yes	

B) TYPE TESTS

i) Whether type test reports of the tests as per relevant IS-2705 and IEC 60044 conducted earlier on identical or similar material are available (test reports are of the test conducted not earlier than 5 (five) years prior to the date of bid opening).
(YES)

ii) If type test reports are not acceptable to BHEL/APGENCO, then above tests shall be conducted by the bidder free of cost.
(YES)

Date:

Signature of the authorized representative of Bidder

Company Seal