

THE WEST BENGAL POWER DEVELOPMENT CORPORATION LIMITED
(A Govt. of West Bengal Enterprise)
Bakreswar Thermal Power Project
P.O.Bk.T.P.P , Dist -Birbhum,Pin -731104

NIT No.:WBPDC/ Tend-Adv/CC/13-14/144/BkTPP Date: 28.11.2013

Sealed tenders in two parts, Part A (for technical specification bid) and Part B (for commercial price bid) in duplicate are invited by the General Manager, BkTPP with same material specification for the supply of following material at BkTPP.

1. Description of Material : As per Annexure-I
2. Estimated Cost : Rs. 1, 00, 00,000/- (Supply of Relay & Retrofitting Job).
3. Earnest Money : Rs. 2,00,000/-
4. Cost of Tender Paper : Rs. 1,000/-
5. Sale of Tender Paper : 03.12.2013 to 24.12.2013
6. Pre-bid discussion : 27.12.2013 at 11.00 AM
7. Last Date of Submission of Sealed Tender Paper : 07.01.2014 at 02.30 PM
8. Opening of Tender
- 8a. Part-A (for technical bid) : 07.01.2014 at 03:00 PM
- 8b. Part-B (for price bid) : Opening date will be intimated to the successful i.e technically accepted bidders later on.
- 9a. Material Delivery Period : Sixteen (16) weeks from the date of the order.
- 9b. Job/Scope of Work : (i). Design and engineering for the protection scheme.
(ii) Removal of existing protection scheme.
(iii) Supply of wiring materials, blanking plates, ferrules, lugs etc.,
(iv) Erection and wiring of new protection scheme.
(v) Testing & commissioning of new protection scheme.
(vi) Training on the protection scheme.
- 9c. Job Completion Period (Installation & Commissioning) : Retrofitting Job of Generator Protection Relay for Unit # 1 will be done during S/D Period (within 20 Days) in the month of June - July, 2015. (Tentatively)

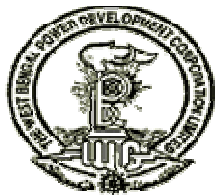
[Qualifying Requirement:

- i) The bidder should be an original manufacturer of all the protection relays involved in this tender. Bidders should have manufacturing facility in India for protection relays.
- ii) The bidder should have supplied, installed and commissioned the similar protection system for various utilities in India.
- iii) The Bidder should have supplied at least 5 schemes in India over past 5 years and shall submit necessary reference list along with the offer.]

Detailed terms & conditions are set forth in the Tender Paper (Non - Transferable) which can be obtained from the Sr. Manager(S&P), BkTPP on application. The cost of Tender Paper is to be deposited in the Account Section, BkTPP from 10.30 AM to 01.30 PM (except Saturday, Sunday and Holiday). Tender Paper will not be issued against DD / MO / Cheque and by post. If any change or extension of due date or any corrigendum, may please visit website. The WBPDC reserves the right to accept or to reject any or all tender either in full or in part or to split up, if necessary without assigning any reasons whatsoever. For qualifying requirements and other details visit website www.wbpdcl.co.in

T. K. BOSE
SR.MGR(S & P)
BkTPP/WBPDC

THE WEST POWER DEVELOPMENT CORPORATION LIMITED



[A Government of West Bengal Enterprise]

BAKRESWAR THERMAL POWER PROJECT
P.O: BkTPP, Dist.: Birbhum, Pin: 731104
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ANNEXURE-I

TECHNICAL SPECIFICATION FOR RETROFITTING JOB OF GENERATOR RELAY PANEL OF UNIT#1

DOCUMENT NO. : BKTPP/TESTING/TECH. SPEC./GRPU#1

REV	DATE	DESCRIPTION	MADE BY	REVIEWED BY	APPROVED BY
0	06.08.2013		ION ROY	S.PATRA	



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1. INTRODUCTION

West Bengal Power Development Corporation Limited (WBPDC) is a company owned by the Government of West Bengal with the goal to carry on the business of electric power generation and supply in the state. The main thermal power plants under WBPDC are in Kolaghat, Bakreswar, Sagardighi, Santaldih and Bandel.

WBPDC works in tandem with West Bengal State Electricity Board (WBSEB) and Calcutta Electric Supply Corporation (CESC).


Bakreshwar Thermal Power Station, with an installed capacity of 1050MW (five units of 210MW) is located in Chinpai and Bhurkuna gram panchayat areas of Birbhum district of West Bengal. It is located off the Panagarh–Morgram Highway, on the bank of Bakreshwar River some distance downstream from the hot springs and temple at Bakreshwar. Chinpai railway station on the Andal-Sainthia Branch Line is nearby.

This specification covers the general requirements for design, engineering, supply, inspection, retrofitting and testing of microprocessor base advanced Generator, GT, UAT protection for Unit#1 of WBPDC-Bakreswar Thermal Power Plant.

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2. DEFINITIONS AND ABBREVIATIONS

WBPDCL	West Bengal Power Development Corporation
BKTPP	Bakreswar Thermal Power Plant.
DI	Digital Input
DO	Digital Output
AI	Analogue Input
AO	Analogue Output
CB	Circuit breaker
HMI	Human Machine Interface
IED	Intelligent Electronic Devices
kV	kiloVolts
MW	MegaWatt (Active Power)
MVA _r	MegaVar (Reactive Power)
SCADA	Supervisory Control and Data Acquisition
RTU	Remote Terminal Unit
LAN	Local Area Network
RS 485	A physical wiring standard for high speed, noise tolerant network communication often used with the Modbus RTU protocol.
TCP/IP	Transmission Control Protocol / Internet Protocol
Modbus RTU	An industrial network communications protocol.
Open Protocol	A protocol which is published and used by other manufacturers and is, therefore, non-proprietary.
Ethernet	A high performance network communication standard (IEEE 802.3)
Gateway	A device that allows networks of different protocols to communicate with each other, e.g. RS485 Modbus to Ethernet.
FO	Fibre Optic.
LIU	Light guide Interconnection Unit for FO cable Termination
STP	Shielded Twisted Pair
UTP	Unshielded Twisted Pair
OPC	OLE Process Control based on Microsoft Windows, used as industry standard for interface between HMI and RTU/DCU
SOE	Sequence of Events
GPS	Global Positioning Satellite

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3. STANDARDS


In general the equipments and the system shall confirm to the latest applicable standards of following professional institutes-

National Electricity Manufacturers Association (NEMA)
 The Institute of Electrical and Electronic Engineers (IEEE)
 Instrument Society of America (ISA)
 American National Standard Institute (ANSI)
 International Electro Technical Commission (IEC)
 Committee European de Normalization Electro Technique (CENELEC)
 European Telecommunication Standard Institute.(ETSI)

The electrical control system shall be designed, built and tested to comply with the following standards


Standard	Title
IEC 60038	IEC Standard Voltages
IEC 60051-9	Direct acting indicating analogue electrical measuring instruments and their accessories
IEC 60255	Electrical Relays
IEC 60304	Standard colours for insulation for low frequency cables and wires
IEC 60391	Marking of insulated conductors
IEC 60409	Guide for inclusion of reliability clauses into specifications for components
IEC 60391	Identification of equipment terminals
IEC 60446	Identification of insulated and bare conductors by colours
IEC 60529	Classification of degrees of protection by enclosures
IEC 60605	Equipment reliability testing
IEC 60706	Guide on maintainability of equipment
IEC 60793	Optical Fiber Cables
IEC 60870	Telecontrol equipment and systems
IEC 61850	Communication networks and systems in substations
IEEE 802.3	Information Processing Systems – Local Area Networks
IEC 60617	Graphical symbols for diagrams
IEC 331	Fire resisting characteristics of electric cables
IEC 801	Electromagnetic compatibility for industrial-process measurement and control Equipment
IEC EN 61508	Functional safety of electrical/electronic/programmable electronic safety related systems.
IEC 1131	Standard for Programmable logic controllers

In event of any conflict between the codes and standards referred to in this specification and the requirement of this specification, the requirements of this specification shall govern. Decision of WBPDCL shall be final.

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4. ENVIRONMENTAL CONDITIONS

Ambient Temperature : 45 degree Celsius
 Relative humidity : 0 to 95 % non-condensing.

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5. SCOPE OF WORK

1. Design and engineering for the protection scheme.
2. Removal of existing protection scheme.
3. Supply of wiring materials, blanking plates, ferrules, lugs etc.,
4. Erection and wiring of new protection scheme.
5. Testing & commissioning of new protection scheme.
6. Training on the protection scheme.
7. All quoted relays will be on IEC61850 protocol.
8. Auxiliary & trip relays will be retained; only main protection relay will be replaced.

6. General Requirements of Relays

The numerical protection equipment shall be provided with the following functions and features :

i) **Measurement:** The electrical quantities like voltages, currents, frequency, active and reactive power etc. shall be constantly measured and be available for display. Other desired quantities such as intermediate values in various protection functions processing shall also be measured and displayed on demand. All measured values shall be time tagged with real clock in the system itself and shall be displayed in either primary or secondary quantities.

ii) **Self Diagnosis and supervision & Programmable LEDs:**

Continuous self diagnostics tests on microprocessor, memory, timers and the analog input module and the stand alone relays shall be carried out by the equipment and a watchdog contact should be made on in any abnormalities. Internal and external auxiliary supplies shall also be continuously supervised. The relay should have minimum 8 Programmable LEDs.

iii) **Programmable Logic:** The relay should have facility of programmable scheme logic for allowing customer to customise the protection and control functions. It should also allow to program LEDs, Opto Inputs and Relay Outputs.

The logic should comprise of gate logic and general purpose timers. The gate logic includes OR, AND and majority gate function with ability to invert the inputs and outputs.

iv) **CT Inputs:** The relays shall be provided with both 1A and 5A CT inputs and shall be selectable at site.

v) **Auxiliary Supply:** It shall be possible to energise the relay from either AC or DC auxiliary supply.

vi) **Display and LEDs:**

1) At least 32 character alphanumeric backlit LCD display unit.


2) LEDs (for trip, Alarm, Relay available & Relay out of service) & programmable at least 8 Tri Colour LEDs which can be assigned to any protection function for local annunciation.

3) Tactile keypad for browsing and setting the relay menu.

vii) **Communication Ports**

The relays should have a front RS232 port for local communication for relay settings, modifications, extraction and analysis of fault/event/disturbance records from a laptop and a Rear RS485 /RJ 45/ Fiber optic for remote communication to SCADA system. **The relay should be IEC-61850 compliant.**

viii) **Fault Diagnostics Tools**

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- Fault record** – The relay shall have the facility to store at least 5 last fault records with information on cause of trip, date, time, trip values of electrical parameters.
- Event record** – The relay shall have the facility to store at least 200 time stamped event records with 1ms resolution.
- Disturbance records** – The relay shall have capacity to store at least 15 secs. of disturbance record waveforms with user defined pre-fault and post fault time. The disturbance recorder should have a minimum sampling frequency of 1000Hz, with all the available analogue channels
- Circuit breaker operations counter and maintenance records.

7. Site Receiving Inspection:

After arrival of all equipment supplied by the Vendor at site, the Purchaser will perform site-receiving inspection in accordance with the related technical documents and packing list. If any damage, defects or shortages occur because of the Vendor's fault, vendor shall carryout the replacement, repair or supplement at his own expense.


8. Prequalification Criteria

- The bidder should be an original manufacturer of all the protection relays involved in this tender.
- Bidders should have manufacturing facility in India for protection relays.
- The bidder should have supplied, installed and commissioned the similar protection system for various utilities in India.
 - The Bidder should have supplied at least 5 schemes in India over past 5 years and shall submit necessary reference list along with the offer.

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9. Location of retrofitting jobs:

Sl. No.	Reference	Description	Type	Make
1	21G1	GEN.BACK-UP IMPEDENCE RELAY(PRE-SYNCHRONISING)	YCG15AA	GECAL
2	21G2	GEN.BACK-UP IMPEDENCE RELAY(POST-SYNCHRONISING)	YCG15AA	GECAL
3	40G	GEN.FIELD FAILURE RELAY	YCGF11	GECAL
4	40G/27	GEN.UNDER VOLTAGE RELAY FOR USE WITH 40G	VAGM22	GECAL
5	50N/2LUT	UAT LV STANDBY EARTH FAULT RELAY	CTU12	GECAL
6	50HUT	UAT HV INSTANTANEOUS OVER CURRENT RELAY	CAG37	GECAL
7	51HUT	UAT HV IDMT OVER CURRENT RELAY	CDG31	GECAL
8	51G	GEN. OVER CURRENT RELAY	CTU12	GECAL
9	51GT	HV OVER CURRENT RELAY	CDG31	GECAL
10	51GTH	THERMAL OVER LOAD RELAY	motPRO	GECAL
11	51NG	GEN. STATOR BACK-UP EARTH FAULT RELAY	CDG11	GECAL
12	51NGT	GEN. TRFR. HV STANDBY EARTH FAULT RELAY	CDG11	GECAL
13	59G1	GEN. OVER VOLTAGE RELAY (STAGE-1)	VTU21	GECAL
14	59G2	GEN. OVER VOLTAGE RELAY (STAGE-2)	VTU21	GECAL
15	160G	FUSE FAILURE RELAY FOR VT-1	MVAPM32	GECAL
16	260G	FUSE FAILURE RELAY FOR VT-2	MVAPM32	GECAL
17	360G	FUSE FAILURE RELAY FOR VT-3	MVAPM32	GECAL
18	64G	STATOR EARTH FAULT RELAY (100%)	PVMM163	GECAL
19	64HGT	GEN. TRFR. HV RESTRICTED EARTH FAULT RELAY	CAG14	GECAL
20	64LUT	UAT LV RESTRICTED EARTH FAULT RELAY	FAC14	GECAL
21	78G	GEN. LOSS OF SYNCHRONISM(POLE SLIPPING) RELAY	ZTO11	GECAL
22	81G1	GEN.UNDER FREQUENCY RELAY(STAGE- 1& 2)	MFVUM22	GECAL
23	81G2	GEN.OVER FREQUENCY RELAY	MFVUM22	GECAL
24	87G	GEN. DIFFERENTIAL RELAY	CAG34	GECAL
25	87GT	OVERALL DIFFERENTIAL RELAY	MBCH16	GECAL
26	87U1	UAT DIFFERENTIAL RELAY	MBCR12	GECAL
27	95G	GEN. INTERTURN FAULT RELAY	VDG14	GECAL
28	95G1	GT OVER FLUXING RELAY (WITH 2 STAGES)	GT1M22	GECAL
29	64F	GEN. ROTOR EARTH FAULT RELAY (WITH 2 STAGES)	7UR22	SIEMENS
30	32G	GEN. REVERSE POWER RELAY	PPX1111	ABB
31	37G	GEN. LOW FORWARD POWER RELAY	PPX1111	ABB
32	46G	GEN. NEGATIVE SEQ. CURRENT RELAY (WITH 2 STAGES)	RARIB	ABB
33		Generator Dead machine Protection	New	

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CT Details:

Sl. No.	CT NO.	RATIO	BURDEN	ACCURACY CLASS	ISF<	VK2	IeS	LOCATION
1	CT-A	10000/5A	-	PS	-	120(R _{CT} + 1.7784)	150 mA AT VK/4	GENERATOR NEUTRAL
2	CT-B	10000/5A	100 VA	5P20	-	-	-	GENERATOR NEUTRAL
3	CT-C	10000/5A	100 VA	0.2	5	-	-	GENERATOR NEUTRAL
4	CT-D	10000/5A	-	PS	-	80(R _{CT} + 1.7784)	150 mA AT VK/2	GENERATOR NEUTRAL
5	CT-E	150/1A	15 VA	5P10	-	-	-	NG CUBICLE
6	CT-F	10000/5A	-	PS	-	80(R _{CT} + 1.7784)	150 mA AT VK/2	GENERATOR BUS DUCT
7	CT-G	10000/5A	75 VA	5P20	-	-	-	GENERATOR BUS DUCT
8	CT-H	10000/5A	100 VA	0.2	5	-	-	GENERATOR BUS DUCT
9	CT-I	10000/5A	100 VA	0.2	5	-	-	GENERATOR BUS DUCT
10	CT-J	10000/5A	100 VA	0.2	5	-	-	GENERATOR BUS DUCT
11	CT-K1 & K2	10000/5A	-	PS	-	120(R _{CT} + 1.8252)	150 mA AT VK/4	UAT 15.75 KV SIDE BUS DUCT
12	CT-L1 & L2	600/5A	60 VA	5P20	-	-	-	UAT 15.75 KV SIDE BUS DUCT
13	CT-M1 & M2	600/5A	-	PS	-	120(R _{CT} + 1.7784)	150 mA AT VK/4	UAT 15.75 KV SIDE BUS DUCT
14	CTN-1	1600/5A	-	PS	-	132(R _{CT} + 1.7784)	50 mA AT VK/2	UAT NGR CUBICLE
15	CTN-2	200/1A	30 VA	5P20	-	-	-	UAT NGR CUBICLE
16	BCT	400/1A	-	PS	-	200(R _{CT} + 1.7784)	30 mA AT VK/2	GT 220 KV SIDE
17	BCTN-1	400/1A	-	PS	-	200(R _{CT} + 1.7784)	30 mA AT VK/2	GT NEUTRAL
18	BCTN-2	400/1A	30 VA	5P20	-	-	-	GT NEUTRAL
19	ICT-1	1/3.849A	-	PS	-	20 V	116 mA AT VK/4	GRP
20	ICT-2A & 2B	1/3.3727A	-	PS	-	20V	112 mA AT VK/4	GRP
21	YARD CT	CORE 1: 2000-1000-500*1		PS	-	1000V	120 mA AT VK	YARD SWITCH
		CORE 2: 2000-1000-500*1		PS	-	1000V	120 mA AT VK	
		CORE 3: 2000-1000*500/1	40 VA	0.5	-	-	-	
		CORE 4: 2000-1000*1		PS	-	2000V	30 mA AT VK	
		CORE 5: 2000-1000*1		PS	-	2000V	30 mA AT VK	

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VT DETAILS:

Sl. No.	VT NO.	QUANTITY	RATIO	BURDEN PER PHASE	ACCURACY CLASS	LOCATION	PURPOSE
1	VT-1	SINGLE PHASE 3 NOS.	15750/ $\sqrt{3}$ / 110 / $\sqrt{3}$	50 VA	0.2	SPVT CUBICLE	PROTECTION & PERFORMANCE TESTING
2	VT-2	SINGLE PHASE 3 NOS.	15750/ $\sqrt{3}$ / 110 / $\sqrt{3}$	50 VA	0.5	SPVT CUBICLE	AVR
3	VT-3	SINGLE PHASE 3 NOS.	15750/ $\sqrt{3}$ / 110 / $\sqrt{3}$	250 VA	0.5/3P	SPVT CUBICLE	PROTECTION & METERING
4	IVT-1 & 2	SINGLE PHASE 3 NOS. EACH	110/63.5V	30 VA	3P	GRP	GENERATOR BACKUP IMPEDENCE PROTECTION
5	IVT-3	SINGLE PHASE 3 NOS. EACH	110/80V	25 VA	3P	GRP	GENERATOR INTER-TURN FAULT PROTECTION
6	IVT-4	SINGLE PHASE	25.4/110V	25 VA	3P	GRP	GENERATOR INTER-TURN FAULT PROTECTION

10. Special Note:

- a) Stator earth fault protection (100%) will be based on 20Hz voltage injection method. Presently 3rd harmonic principle type Model: PVMM163, Alstom make relay is installed. Necessary required CT or PT are to be supplied by the party.
- b) Rotor earth fault protection will be based on 1-3Hz square wave method.
- c) Presently CT inputs for differential protection of GT, UAT and overall are from ICTs. ICTs may be removed and 1A or 5A CT inputs may be used for latest microprocessor base relays.
- d) Auxiliary relays for remote indication, annunciations, SOE and DAS may be retained.
- e) All protections except Stator earth fault, Rotor earth fault, overall Differential protections of Generator must be of dual redundant i.e. two microprocessor based relays of similar type and similar protection feature are to be provided.

Sl. No.	Reference	Description	Type	Make	Relay Setting	CT Inputs	PT Inputs	Aux. Supply	Multiplier used for	Qty
1	21G1	GEN.BACK-UP IMPEDENCE RELAY(PRE-SYNCHRONISING)	YCG15AA	GECAL	Offset:25%,MTA-750, K1-3 , K2 -0.5	CT-B, 10000/5A, 100VA, 5P20	IVT-1, 110/63.5V, 100VA,Dyn11	220V DC		03 Nos. (1 No. per phase)
2	21G2	GEN.BACK-UP IMPEDENCE RELAY(POST-SYNCHRONISING)	YCG15AA	GECAL	Offset:25%,MTA-750, K1-3 , K2 -0.56	CT-G, 10000/5A, 100VA, 5P20	IVT-2, 110/63.5V, 75VA,Dyn11	220V DC		03 Nos. (1 No. per phase)
3	40G	GEN.FIELD FAILURE RELAY	YCGF11	GECAL	K1-1, K2-1.5 , K3 -1 , K4-0.5 , K5 -25.9 Z1=K3+K4=K2 , Z2 = K1xK5	CT-B, 10000/5A, 100VA, 5P20	IVT-1, 110/63.5V, 100VA,Dyn11	220V DC		01 NO
4	40G/27	GEN.UNDER VOLTAGE RELAY FOR USE WITH 40G	VAGM22	GECAL	80.5V	NA	VT#3, 15.75KV/110V, 250VA, 0.5/3P	NA		01 NO
5	50N/2LUT	UAT LV STANDBY EARTH FAULT RELAY	CTU12	GECAL	I = 0.1A , T= 0.7 sec	CTN-2, 200/1,30VA, 5P20	NA	220V DC	ANN,UAT TRIP,BT'S AUTO C/O	02 Nos. (1 no. per UAT)
6	50HUT	UAT HV INSTANTANEOUS OVER CURRENT RELAY	CAG37	GECAL	K= 1.4 , setting(Link)= 1 (50) , Link(1) x K = 50 x1.4 =70A	CT-K1, 10000/5A,PS,Vk≥120(RCT+1.8252), Ie≤150mA at Vk/4	NA	NA	ANN	02 Nos. (1 no. per UAT)
7	51HUT	UAT HV IDMT OVER CURRENT RELAY	CDG31	GECAL	P.S.M= 7.5 , T.M.S = 0.2	CT-K1, 600/5A,5P20,60VA	NA	NA	ANN	02 Nos. (1 no.)

										per UAT)
8	51G	GEN. OVER CURRENT RELAY	CTU12	GECAL	I = 5A , T = 20 sec	CT-B, 10000/5A, 100VA, 5P20	NA	220V DC	NA	01 NO
9	51GT	HV OVER CURRENT RELAY	CDG31	GECAL	P.S.M = 1.0 , T.M.S = 0.35	SW YD CT, Core-2, 500/1A, PS, Vk≥1000, Ie≤120mA at Vk	NA	NA	ANN	01 NO
10	51GTH	THERMAL OVER LOAD RELAY	motPRO	GECAL		CT-B, 10000/5A, 100VA, 5P20	NA	220V DC	ANN	01 NO
11	51NG	GEN. STATOR BACK-UP EARTH FAULT RELAY	CDG11	GECAL	P.S.M = 0.1 , T.M.S = 0.45	CT-E, 150/1A, 15VA, 5P10	NA	NA	ANN	01 NO
12	51NGT	GEN. TRFR. HV STANDBY EARTH FAULT RELAY	CDG11	GECAL	P.S.M = 0.1, T.M.S = 0.65	BC1N-2, 700/1A, 30VA, 5P20	NA	NA	ANN	01 NO
13	59G1	GEN. OVER VOLTAGE RELAY (STAGE-1)	VTU21	GECAL	%Vn (t) =110% , t=2sec	NA	VT#3, 15.75KV/110V, 250VA, 0.5/3P	NA	ANN	01 NO
14	59G2	GEN. OVER VOLTAGE RELAY (STAGE-2)	VTU21	GECAL	%Vn (t) =120% , t= 1sec	NA	VT#3, 15.75KV/110V, 250VA, 0.5/3P	NA	ANN	01 NO
15	160G	FUSE FAILURE RELAY FOR VT-1	MVAPM32	GECAL		NA	VT#1, 15.75KV/110V, 50VA, 0.2	220V DC	NA	01 NO
16	260G	FUSE FAILURE RELAY FOR VT-2	MVAPM32	GECAL		NA	VT#2, 15.75KV/110V, 50VA, 0.5	220V DC	NA	01 NO
17	360G	FUSE FAILURE RELAY FOR VT-3	MVAPM32	GECAL		NA	VT#3, 15.75KV/110V, 250VA, 0.5/3P	220V DC	NA	01 NO
18	64G	STATOR EARTH FAULT RELAY (100%)	PVMM163	GECAL	<u>RMV 64</u> V _s = 6V , N=7, t = 4(1+N)/(V _s / V) - 1 sec ; <u>RMM 62</u>	NA	NGT, 75KVA, 15.75KV/240V, 50 Hz, 5 Min & IVT-3, 110/80V, 30VA, 3P, Ynd11	220V DC	NA	01 NO

					$t = 5\text{sec}, \%K = 45$ $, \%V_{RL} = (70 + \sum 2)$					
19	64HG1	GEN. TRFR. HV RESTRICTED EARTH FAULT RELAY	CAG14	GECAL	P.S.M = 0.1	BC1, 700/1A, PS, $V_k \geq 90(RCT+1.7784)$, $I_e \leq 30\text{mA}$ at $V_k/2$	NA	NA	ANN	01 NO
20	64LUT	UAT LV RESTRICTED EARTH FAULT RELAY	FAC14	GECAL	Setting : 325 V	CT-2 & CTN-1, 1600/5A, PS, $V_k \geq 120(RCT+1.7784)$, $I_e \leq 50\text{mA}$ at $V_k/2$	NA	NA	ANN	02 Nos. (1 no. per UAT)
21	78G	GEN. LOSS OF SYNCHRONISM (POLE SLIPPING) RELAY	ZTO11	GECAL	$K1=1.0, K2=0.82$ $, K3=2.0, t=40,$ $\Phi 1=750, X1=1.0,$ $\Phi 2=750$	CT-B, 10000/5A, 100VA, 5P20	IVT-1, 110/63.5V, 100VA, Dyn11	220V DC	ANN	01 NO
22	81G1	GEN. UNDER FREQUENCY RELAY (STAGE- 1 & 2)	MFVUM22	GECAL	$t1 = 2\text{sec},$ $T1=2083, f1=105/T1;$ $t2=3\text{sec},$ $T2=2109, f2 = 105/T2; <f1 \& <f2$	NA	VT#3	220V DC	TIME TOTALISER, ANN	01 NO
23	81G2	GEN. OVER FREQUENCY RELAY	MFVUM22	GECAL	$t1 = 2\text{sec},$ $T1=1923, f1=105/T1;$ $t2=2\text{sec},$ $T2=1960, f2 = 105/T2, >f1 \& >f2$	NA	VT#3	220V DC	NA	01 NO
24	87G	GEN. DIFFERENTIAL RELAY	CAG34	GECAL	$I = 0.5 \text{ A}$	CT-F, 10000/5A, PS, $V_k \geq 80(RCT+1.7784)$, $I_e \leq 150\text{mA}$ at $V_k/2$ & CT-D, 10000/5A, PS, $V_k \geq 80(RCT+1.7784)$, $I_e \leq 150\text{mA}$ at $V_k/2$	NA	NA	ANN	01 NO

25	87GT	OVERALL DIFFERENTIAL RELAY	MBCH16	GECAL	Setting : 0.1	ICT-1, 1/3.849A, PS, Yd1, V _k ≥20V, I _e ≤116mA at V _k /4, CT-A, 10000/5A, PS, V _k ≥120(RCT+1.7784), I _e ≤150mA at V _k /4, CT-K1, 10000/5A, PS, V _k ≥120(RCT+1.8252), I _e ≤150mA at V _k /4 & CT-K2, 10000/5A, PS, V _k ≥120(RCT+1.8252), I _e ≤150mA at V _k /4	NA	220V DC	NA	03 Nos. (1 No. per phase)
26	87UT	UAT DIFFERENTIAL RELAY	MBCH12	GECAL	Setting : 0.2	ICT-2A, 1/ 4..2156A, PS, V _k ≥60V, I _e ≤30mA at V _k /4 & CT-M1, 600/5A, PS, V _k ≥120(RCT+1.7784), I _e ≤150mA at V _k /4	NA	220V DC	NA	06 Nos. (1 No. per phase for 2 UATs)
27	95G	GEN. INTERTURN FAULT RELAY	VDG14	GECAL	P.S.M = 7.5, T.M.S = 0.5	NA	IVT-4, 25.4/110V, 30VA, 3P	220V DC	ANN	01 NO
28	95GT	GT OVER FLUXING RELAY (WITH 2 STAGES)	GT1M22	GECAL	K1 = 1.15, K2 = 1.1	NA	VT#3, 15.75KV/110V, 250VA, 0.5/3P	220V DC	ANN, EXCITATION CONTROL, CHAGEOVER OF REGULATION	01 NO
29	64F	GEN. ROTOR EARTH FAULT RELAY (WITH 2 STAGES)	7UR22	SIEMENS	Setting : alarm : 80kΩ, trip : 5 kΩ	NA	1-3 Hz	UPS 110V ac	TRIP, ANNN	01 NO
30	32G	GEN. REVERSE POWER RELAY	PPX1111	ABB	$\%P_N = K(P1+P2)$ $\%P_N = 0.5\%$	CT-C, 10000/5A, 100VA, 0.2	VT#1, 15.75KV/110V, 50VA, 0.2	220V DC	TRIP	01 NO

					[P1=0.5,P2=0,K=1 (for R,S,T) ; t1=2.5sec, t2=5sec]					
31	37G	GEN. LOW FORWARD POWER RELAY	PPX1111	ABB	%P _N = K (P1+P2) %P _N = 0.5% [P1=0.5,P2=0,K=1 (for R,S,T) ; t1=2sec, t2=5sec]	CT-C, 10000/5A, 100VA, 0.2	VT#1,15.75KV/110V, 50VA, 0.2	220V DC	TRIP , ANN	01 NO
32	46G	GEN. NEGATIVE SEQ. CURRENT RELAY (WITH 2 STAGES)	RARIB	ABB	I _m = 0.9 x I _n , Alarm= I _{nsc} x(3% I _m) , Start = I _{nsc} x(4% I _m) K = Σ N =8	CT-B, 10000/5A, 100VA, 5P20	NA	220V DC	ANN	01 NO
33		Generator Dead machine Protection								