अनंतिम परीक्षण अनुसूची और परीक्षण प्रक्रिया
सं:टीईसी/टीजी/एफए/यूपीएस-001/05/मार्च-19
PROVISIONAL TEST SCHEDULE & TEST PROCEDURE
No.: TEC/TG/ FA/UPS-001/05/MAR-19

निर्बाध विद्धुत आपूर्ति प्रणाली

UNINTERUPPTED POWER SUPPLY (UPS) SYSTEM

(सं:. टीईसी/जीआर/एफए/यूपीएस-001/05/मार्च-19)

(No.: TEC/GR/FA/UPS-001/05/MAR-19)

दूरसंचार अभियांत्रिकी केंद्र
खुर्शीदलाल भवन, जनपथ, नई दिल्ली– 110001, भारत
TELECOMMUNICATION ENGINEERING CENTRE
KHURSHIDLAL BHAWAN, JANPATH, NEW DELHI– 110001, INDIA
www.tec.gov.in

Index

A. INTRODUCTION

Introduction : The Uninterrupted Power Supply (UPS) Systems, conforming to TEC Generic Requirements No. GR No. : TEC/GR/FA/UPS-001/05/DEC-18, shall be offered for type evaluation along with factory tests conducted by the manufacturer at their premises and a copy of Installation and Maintenance Manual. **TAC will be accorded only for the UPS in configuration of clause 1.1.4 in case of Standalone and Unitary UPS Systems. UPS system shall be offered for Type testing, only for the Ultimate system capacity.**

Before start of the type approval tests, testing authority will ensure that :

- The manufacturer has a valid Infrastructure approval from the competent authority for the product has been offered.
- The study of the factory test report & the Installation & Maintenance Manual submitted & it is found the product offered is fully in compliance of the GR.

Testing shall start with the verification of component layout, bill of materials, documents & PCBs etc. before commencing the performance tests.

Clause-wise compliance & performance tests as give in this document shall be conducted to ensure that the product is in compliance of the GR.

All the necessary set-ups, test jig & test/measuring instruments/meters, duly calibrated at an authorised test lab/centre are to be provided by the manufacturer for testing. All the test/measuring instruments/meters shall only be digital.

All the necessary **set-ups & digital measuring instruments duly calibrated by an Authorised Lab. are to be provided by the manufacturer for testing.**
All the basic test facilities & measuring equipment as per the **'List of test instruments & Test Set-up'** enclosed, shall be provided by the manufacturer.

Note: Though every care has been taken to cover all the parameters of the GR correctly in this Test Schedule, yet to avoid any inadvertent error/ misprint, the testing officer shall ensure that all the parameters of the GR have been tested & verified in accordance with the provisions of the GR.

B History Sheet

S.No.	Document No.	Test Schedule issue	Remarks
1.	Test Schedule & Test Procedure as per GR UNINTERUPPTED POWER SUPPLY (UPS) SYSTEM (GR No. : TEC/GR/UPS-001/03/MAY.2006) TSTP No. TSTP/ TEC/GR/UPS-001/03/MAY-2006	Issue - I MAY 2006	-
2.	Test Schedule & Test Procedure as per GR UNINTERUPPTED POWER SUPPLY (UPS) SYSTEM (GR No. : TEC/GR/FA/UPS-001/05/MAR-19) TSTP No. TSTP/ TEC/GR/FA/UPS-001/05/MAR-19	Issue - II (Provisional) NOV.2018	Revised and Supersedes previous TSTPs

C..General information for type approval against GR/PO

General information regarding vendor and equipment etc. as per following:

S.N.	General Information	Details	
1.	Name and Address of Applicant		
2.	Date Of registration:		
3.	Name of GR against which type approval sought	Test Schedule & Test Procedure as per GR UNINTERUPPTED POWER SUPPLY (UPS) SYSTEM	
4.	GR no.	TEC/GR/FA/UPS-001/05/MAR-19	
5.	Details of Equipment		
	Type of Equipment	Model No.	Serial No.
I.			
II.			
	Any other relevant Information:-		
	TAC is against GR		

General Instruction:

1) Name of the Vendor:
2) Name of the technology:
3) TAC is against: TEC/GR/FA/UPS-001/05/MAR-19
4) In case of PO, PO no:
5) Date of registration:
6) Date of Commence of tests;
   - Place of testing :

9) Details of equipment;
   a) :
   b) :
   c) Details of Sub racks :

- Size of the Sub rack :
- Type of PCB guide used: Built in embossed type PCB guides / Metallic PCB guides riveted type/ Non metallic removable PCB guides
- In case of Non metallic removable PCB guides, manufacturer shall give the details of material used
  Comments:

❖ Please inspect the Sub rack and record the following information;

- Max. No. of PCB that can be loaded in the sub rack:

- The space between any two PCB is sufficient for the purpose of
  - Air Circulation/heat dissipation
    Yes/No

  - Smooth flow of PCB within the Sub rack without colliding/touching the adjacent PCB
    Yes/No

  - Locking arrangements of PCB is provisioned. If yes, whether the Screwing to the body of Sub rack/ Clips at the top and bottom of the PCB/Any other arrangement
    Yes/No

- Are the Top and bottom plates of Sub rack are of sufficient strength and do not sag / bend when slightly pressed from the center of these plates, if so please indicate
  Yes/No

- Whether the Sub rack has got the front cover to avoid the ingress of dust.
  Yes/No

- Whether care has been taken for the EMI and EMC induction or not. If yes what sort of arrangement has been engineered by the manufacturer?
  Yes/No

- Please check the detailed arrangements for fixing the Sub rack to the full/main rack (It should preferably be the screwing arrangements, with minimum four undetectable screws).

  Yes/No

- Please check the material of the Sub rack, in case it is mild steel, check that the proper enameling has been done or not.

  Yes/No

Details of Rack:

Dimension of full size :
Model /version of full rack if any :
Details of the Rack as stated in this clause are :
Yes/No
If no, please ensure that the manufacturer is essentially amending the his manuals to provide these details; listed in the manuals
No of sub racks a Full Rack can accommodate :

How many sub rack a manufacturer proposes to :
Accommodate in a full rack
Please ensure that the full rack has sufficient strength, so that it does not get twisted while erecting.

Yes/No

Please ensure that the top and base plates of the Full Rack is sufficiently thick and have proper arrangements i.e holes etc are there to mount the rack on floor.

Yes/No

Please ensure that there is a sufficient space for running the Optical fiber cables/optical patch cord/ electrical cables etc.

Yes/No

Details:
Name of the PCB **Sr No,**

1)

2)

3)

Undertaking in the case of TAC against PO: Manufacturer shall give an undertaking stating that the PCB s and other hardware is same as he has quoted in the bid.

Connectors: Type of optical used in the system : SC/APC, SC/UPC and LC/APC
Make :
Model no :

In the case connector used are other than FC/PC, ensure that the suitable adapters are provided by the manufacturer.

Types of Electrical connectors used with the equipment:

Make : F-Type RF

Model no :

D. Testing team: (to be filled by testing team)

S. no.	Name	Designation	Organization	Signature
1.				
2.				
3.				
4.				
5.				

E. List of the test instruments with their make model and quantity

S.N.	Name of Instrument	Quantity *(to be filled by testing team*	**Validity of calibratio** *(to be filled by testing team)*

1) Variac or any other set-up in addition to simulating the normal voltage conditions the following shall also be met :

a) To simulate 320V for 3 phase/90V for single phase.
b) To simulate 480V for 3 phase/300V for single phase.
c) To cater the max. load of the UPS system under test as a whole (the full rated load of FR/ FC + Inverter + Static Transfer Switch + Manual Transfer Switch + VR).

2) DC Power source (Battery or any other set-up in addition to simulating the normal voltage conditions the following shall also be met ;

a) To simulate 1.75V/cell to 2.40V/cell
b) To cater the max. load of the UPS ystem under test as a whole.

3) AC Ammeter (Sufficient to read the current when the UPS system under test is running at its full capacity)

4) Watt meter (3 phase/single phase as per requirement)

5) Multimeter

6) Resistive load as per requirements.

7) Insulation Tester 500VDC/100 Meg ohms

8) High Voltage 2000V/50Hz FR-FC & 2000V/50Hz for Inverter & VR & STW & MTS

9) Power Factor Meter

10) Digital Storage Oscilloscope 60 MHz

11) 50 deg C Ambient Temperature Controlled room for burn-in test as per requirement

12) Distortion Meter

13) Audio level Meter.

14) Current Transformer

15) Voltage Transformers for Distortion meter

16) Calculator

17) Stop Watch

18) DC Power Source to simulate for

19) Batteries

20) Thermocouple/Temperature Scanner

21) AC Volt Meter

22) Diesel Generator Set of Required Capacity

23) Frequency Meter

24) Shunt and millivolt meter to read input DC current

25) Inverter output voltage sampling transformer

Note : All the necessary set-ups & test/measuring instruments/meters, duly calibrated by an Authorised Lab/centre are to be provided by the manufacturer for testing. All the test/measuring instruments/meters shall only be digital.

F. Equipment Configuration Offered: *(to be filled by testing team)*

(a) <Equipment/product name> Configuration:

S. No.	Item	Details	Remarks

Relevant information like No. of cards, ports, slots, interfaces, size etc. may be filled as applicable for the product

(b) <Other equipment name> Configuration:

S. No.	Item	Details	Remarks

Relevant information like No. of cards, ports, slots, interfaces, size etc. may be filled as applicable for the product

G. Equipment System Manuals: (to be filled by testing team)

1. System Manuals
1. Maintenance manuals
2. Installation manual
3. Repair manual

H. Clause-wise Compliance :

Part 1 : Technical Requirements

Cl. No.	Clause	Action to be taken	Action Actually Taken/ Observation/Remarks
1.0	Scope	Introductory no action required.	
1.1	Application	Verify & ensure the compliance of clause. & record the configuration offered as the same is to be indicated in TAC. Refer Test No.1.	
1.1.1	**UPS System Concept**	Verify & ensure the compliance of clause. Also refer Test No. 1.	
1.1.2, 1.1.2.1 & 1.1.2.2	UPS System Configuration	Verify & ensure the compliance of clauses & also record the System Configuration, rating, with or without VR, type of UPS system : Standalone or Unitary in configuration etc. & ensure the other requirements of the clauses. Refer Test No. 1.	
1.1.2.3	Redundancy criteria, Paralleling , VR, STS & MTS etc.	Verify & ensure the compliance of clause. -The maximum number of UPS units in a system, as per this GR can five. -The four units shall be taken for load. - Fifth unit shall be taken as the redundant unit. -The rating of the VR unit where ever used shall be equal to the rating of UPS unit multiplied by number of UPS units (maximum four) proposed for the system. -The redundant UPS units are not be considered for the purpose. -The rating of the Static Transfer Switch and Manual transfer switch shall be 1.2 times the VR rating (if used) or ultimate rating of the UPS system (redundant UPS unit not counted). Refer Test No. 1	
11.3 1.1.3.1	UPS system Rating Standalone UPS systems	Verify & ensure the compliance of clauses & record the rating of the UPS systems. Verify & ensure that : -Specified ratings for standalone UPS systems, are 0.5 KVA, 1KVA, 2KVA, and 3KVA. UPS. - shall deliver single phase AC and shall work on single phase AC mains/stand by AC only. -Rating of inverter unit shall be the same as the rating of UPS. -The rating of the battery shall be as per back requirement. -Rating of FR-FC unit shall be such that it shall be capable of catering the inverter load in 110% overload condition and battery load at the charge rate specified by the user. Normally the recommended battery charge rate is C/10. -The rating of Voltage Regulator equal the rating of UPS(redundant unit not included). -The Static Transfer Switch and manual Transfer switch shall be rated at 1.2 of the UPS rating. **Note :** For calculating the rating of Inverter unit, FR-FC unit, VR, Static Transfer Switch, manual transfer Switch, refer guidelines given in Annexure 3. Refer Test No. 1, 5, 14 a, b, c	

Cl. No.	Clause	Action to be taken	Action Actually Taken/ Observation/Remarks
1.1.3.2	Unitary UPS Systems	Verify & ensure the compliance of clause. -Specified ratings for unitary UPS systems, are 1KVA, 2KVA, 3KVA, 4KVA, 6 KVA, 10KVA or any higher rating as per user requirement. -1KVA, 2KVA, 3 KVA and 4 KVA UPS shall be single phase. While all other ratings shall be three phase only. -The maximum number of UPS units in a system shall be 5. -Rating of inverter unit shall be the same as the rating of UPS unit. -The rating of the battery shall be as per back requirement. -The battery shall be the part of individual UPS unit. -Rating of FR-FC unit shall be such that it can cater the inverter load in 110% overload condition and battery load at the charge rate specified by the user. Normally the recommended battery charge rate is C/10. -The rating of Voltage Regulator equal the ultimate rating of UPS System. -The Static Transfer Switch and manual Transfer switch shall be rated at 1.2 of the UPS system rating. Note : For calculating the rating of Inverter unit and FR-FC unit, VR, Static Transfer Switch, manual transfer Switch, the guidelines given in Annexure 3 may be referred to. Refer Test No. 1, 5,14 a, b, c .	
1.1.3.3	**Distribution, Switching, Control, & Alarm Monitoring (DSCA) unit**	Verify & ensure the compliance of clause. **-Distribution, Switching, Control, & Alarm Monitoring (DSCA) unit** shall be part of individual UPS unit. **-**It shall be based only on menu driven Micro Processor Controlled Techniques for control, monitoring & alarms. **-**DSCA shall display its Software version. -Setting of all the parameters shall be through menu-driven microprocessor control only. Refer test No. 1. **-**Use of potentiometer at any stage is precluded. **-**The failure of Micro processor or DSCA shall not affect the setting of individual inverter or FR/FC. Refer Test No. 23 c). **-**No parameter of inverter or FR/FC units shall be disturbed on the failure of DSCA.. -In this condition all the inverter and FR/FC shall take care of the load on default settings and share the load collectively (wherever applicable). Refer Test No. 23. -Only the setting of new parameters from DSCA, shall be affected. -The system shall be RS 485 compatible. It shall be feasible to set any monitoring control parameter from a remote site through RS 485. All the information regarding Control and monitoring of UPS system data shall be accessible on demand from the remote site. The exchange of information and protocol format shall be as given in the Annexure - 4. Refer Test No 31.	

Cl. No.	Clause	Action to be taken	Action Actually Taken/ Observation/Remarks
1.1.3.3.1	DSCA unit	Verify & ensure the compliance of clause. In addition to the alarm, monitoring, control and the provision of the above clause, the DSCA unit shall also provide for the following : • Interconnecting arrangement of the various building blocks/units i.e. Inverter & battery, Inverter & FR-FC , Battery and FR-FC , UPS and load through transfer switch, VR & Transfer Switch etc. • Arrangement for Isolation of Inverter unit at the input, FR-FC output and battery, manually. • Suitably rated contactor for auto battery low cut -off and /Reconnection. • Arrangement for Isolation of Inverter unit at the input. • Terminations for : • AC input to the FR-FC unit • DC output of FR-FC and Battery • Input & output of the Inverter unit • Input & output to VR unit • Static Transfer Switch • Manual Transfer Switch • Load • Circuit Breakers • Fuses etc • Isolation arrangement between Inverter output & AC Commercial Mains. • All supervisory Alarms Indications All necessary protection, control & Monitoring Circuitry at UPS system level. Note : 1. Only CACT approved isolation devices which do not produce spark while isolating or connecting the battery to FR-FC output and inverter input manually. The contactor shall not be used for this purpose. 2. The testing authority shall ensure that the lower rating MCBs/ contactors/ Circuit-Breakers/ fuses are not paralleled to handle the higher current and only single pole devices are used. Refer Test No.1.	
1.1.3.4	Rating of VR, SVR & STS	Verify & ensure the compliance of clause. -The rating of VR unit, wherever required shall be as per the rating of UPS system. Static Transfer switch and Manual Transfer Switch shall be 120% of the rating of UPS system. Refer Test No. 6 a), b) , c) & 28.	
1.1.3.5	Battery requirements	Verify & ensure the compliance of clause. -Battery capacity will depend on back-up requirements. -It shall be calculated in accordance with the guidelines given in Annexure-3. -The battery shall be in compliance of the GR No.GR/BAT-02/02 MAR 2006 with amendments if any. -Maximum permissible rating of 12V (6 cell) mono-blocks is 80AH. -Parallel connection of mono-blocks is not permitted, however series connection of mono-blocks, up to 80AH, is permitted to achieve the rated voltage. -For batteries of AH capacity higher than 80AH, only 2V cells shall be used, the paralleling of 2V cells of AH capacity up to 1500 AH in this case is also not permitted.	

Cl. No.	Clause	Action to be taken	Action Actually Taken/ Observation/Remarks

1.1.4	UPS System Configuration	Verify & ensure the compliance of clause. The following UPS System configurations are proposed :	

STANDALONE UPS SYSTEMS

Category No.	Type of System	Ratings						
1	Single Phase (without redundancy & VR)	0.5KVA	0.5KVA	*Inv + battery requirement	-	0.6KVA	0.6KVA	As per back-up
1a	Single Phase (without redundancy & VR)	1KVA	1KVA	-do-	-	1.2KVA	1.2KVA	As per back-up
1b	Single Phase (without redundancy & VR)	2KVA	2KVA	-do-	-	2.4KVA	2.4KVA	As per backup
1c	Single Phase (without redundancy & VR)	3KVA	3KVA	-do-	-	3.6KVA	3.6KVA	As per backup
2	Single Phase (without redundancy) +VR	0.5KVA	0.5KVA	-do-	1KVA	1.2KVA	1.2KVA	As per backup
2a	Single Phase (without redundancy) +VR	1KVA	1KVA	-do-	1KVA	1.2KVA	1.2KVA	As per backup
2b	Single Phase (without redundancy) +VR	2KVA	2KVA	Do-	2KVA	2.4KVA	2.4KVA	As per backup
2c	Standalone- Single Phase+ VR (without redundancy)	3KVA	3KVA	-do-	3KVA	3.6KVA	3.6KVA	As per backup

UNITARY UPS SYSTEMS

Category No.	**Type of System**	**Ratings**						
		System Configuration **(N+1)	**Basic UPS**	**Basic FR-FC**	**VR**	**Static Transfer Switch**	**Manual Transfer Switch**	**Battery Capacity**
3	Single Phase without VR	4 KVA (4+1)	1KVA	*Inv + battery requirement	-	4.8KVA	4.8KVA	As per back-up
3a	Single phase with VR	4KVA (4+1)	1KVA	-do-	4KVA	4.8KVA	4.8KVA	As per back-up
3b	Single Phase Without VR	8 KVA (4+1)	2 KVA	-do-	-	9.6KVA	9.6KVA	As per backup
3c	Single Phase With VR	8 KVA (4+1)	2 KVA	-do-	8KVA	9.6 KVA	9.6KVA	As per backup
3d	Single Phase without VR	12 KVA (4+1)	3KVA	-do-	-	14.4KVA	14.4K VA	As per back-up
3e	Single phase with VR	12KVA (4+1)	3KVA	-do-	12KVA	14.4KVA	14.4K VA	As per back-up
3f	Single Phase Without VR	12 KVA (3+1)	4 KVA	-do-	-	14.4 KVA	14.4K VA	As per backup
3g	Single Phase With VR	12 KVA (3+1)	4 KVA	-do-	12KVA	14.4 KVA	14.4K VA	As per backup
4	Three Phase (without VR)	24KVA (4+1)	6KVA	-do-	-	28.8KVA	28.8KVA	As per backup
4a	Three Phase (with VR)	24KVA (4+1)	6KVA	-do-	24KVA	28.8KVA	28.8KVA	As per backup
4b	Three Phase (without VR)	40KVA (4+1)	10KVA	-do-	-	48KVA	48 KVA	As per backup
4c	Three Phase (with VR)	40KVA (4+1)	10KVA	-do-	40KVA	48KVA	48 KVA	As per backup
4d	Three Phase (without VR)	4N KVA (4+1)	NKVA	-do-	-	(1.2*4*N) KVA	(1.2*4*N) KVA	As per backup
4e	Three Phase (with VR)	4N KVA (4+1)	NKVA	-do-	4N KVA	(1.2*4*N) KVA	(1.2*4*N) KVA	As per backup

Cl. No.	Clause	Action to be taken	Action Actually Taken/ Observation/Remarks

		* The rating of FR-FC shall be sufficient to take care of 1.1 times the Inverter DC load and battery load as per back-up and rate of charging. ** In this configuration N is the number of Basic UPS units for load and 1 is redundant. **Note-1 :** Type approval shall be accorded for ultimate capacity only. The version of the microprocessor soft-ware shall be indicated in TAC along with the model number and category. **2.** Tendering authority may choose any of the above categories (ultimate capacity) as per load requirements. Load shall include, the equipment load and any other load. While choosing the UPS it may also be ensured that the redundancy requirement has been taken care of. **3**. In all the above configurations, there shall be a provision of automatic load transfer to stand-by power supply within 5 mili seconds, in the event of failure of the inverter unit of the UPS due to any reason. Standby power in this case may be a VR, AC commercial mains or standby Engine alternator. Transfer of load back to inverter unit/ system shall also be automatic but it shall take place, only after the inverter output has stabilised and is within the specified limits. Transfer time in this case shall also be within 5 mili seconds. Manual transfer switch is for the transfer of load from inverter to Stand by power and back to Inverter unit, manually. 4. When VR is used the provision shall be made to transfer the load to standby mains/DG Set in the event of the failure of VR. Refer Test No. 1,6, 14 a, b, c, 22a, b, c & 28.	
1.1.5	UPS system compatibility with Engine alternator	Verify & ensure the compliance of clause. -The UPS system (including FR/FCs, and DSCA, Inverters), shall be suitable for operation from A.C mains or a DG set (of capacity 1.25 times AC load of UPS System). Refer Test No. 1, 5.	
1.2	Technical Requirements	Heading. No action required.	
1.2.1	Operational requirements	Heading. No action required.	
1.2.1.1	Environmental Requirements	Verify & ensure the compliance of clause. Verify & ensure the compliance of the clause in accordance with QM-333 B_2 & Vibration as per clause 12 of QM-333. Note : 1. Test No. 14 (a &b), 22 (a, b & c) & 28 shall be performed during & after each cycle. 2.After completion of all environmental tests 14 (a & b), 22 (a, b & c) & 28 shall be repeated : The unit shall comply the test required without any mark deviation from earlier test values.	
1.2.1.2	Burn-in tests	Ensure the compliance of Test No. 30.	
1.2.1.3 1.2.1.4	Insulation Resistance Tests Voltage Proof Test	Ensure the compliance of Test No. 3(a) Ensure the compliance of Test No. 3 (b)	
1.2.1.5	Operating Noise	Ensure the compliance of Test No. 4	

Cl. No.	Clause	Action to be taken	Action Actually Taken/ Observation/Remarks

1.2.1.6, 1.2.1.6.1 to 1.2.1.6.11	Lightning & Surge Protection	Verify & ensure that the Lightning & Surge Protection arrangement is in full compliance of all the clauses & CACT approved. Obtain, verify & record the necessary CACT certificate. Refer test No. 7.	
1.2.2,1.2.2.1, 1.2.2.2, 1.2.2.3, 1.2.2.4, 1.2.2.5, 1.2.2.6 & 1.2.2.7	Monitoring Alarms and indicating lamps, Functional & Alarm indications	Verify & Ensure the compliance of clauses. Refer Test No. 7	
1.2.3	Remote control and monitoring	Verify and ensure the compliance of the clause. Refer Test No. 7, 31.	
1.2.4 1.2.4.1, & 1.2.4.2	Float Rectifier -Cum Float Charger Switching frequency & DC power,	Heading, No action required. Verify & Ensure the compliance of clauses. Refer Test No. 5, 14 (a, b & c)	
1.2.4.3	Starting of UPS without battery supply	Verify & Ensure the compliance of clauses. Refer Test No. 1, 14 (a, b & c)	
1.2.4.4	**UPS unit** compatibility with commercial AC as well as Engine alternator	Verify & ensure the compliance of the clause & also ensure that the UPS unit, shall be suitable for operation from A.C mains or a DG set (of capacity 1.25 times AC load of power plant). Refer Test No. 5, 14 a, b & c.	
1.2.4.5 & 1.2.4.5.1	AC input Supply	Verify & Ensure the compliance of clauses. Refer Test No. 14 a, b & c	
1.2.4.6, 1.2.4.6.1, 1.2.4.6.2 & 1.2.4.6.3	DC output Characteristics Auto Float Mode Auto Charge Mode Output voltage maintained	Ensure the compliance of clauses. Refer Test- 14 a, b & c & 15 (b) Ensure the compliance of Test No.14 (a) Ensure the compliance of Test No.14 (b) Ensure the compliance of Test No.14 a, b & c.	
1.2.4.7	Efficiency	Ensure the compliance of Test No.14 (a & b) & 22 (a, b, & c)	
1.2.4.8	Input Power Factor	Ensure the compliance of Test No.14 (a & b)	
1.2.4.9	Capacitor discharge Resistor	Verify & Ensure that the capacitor discharge resistors have been provided & are in compliance of the clause. Refer test No. 8.	
1.2.4.10	Electrical Noise	Verify that the provision of filters are in compliance of clause. Refer Test No. 8.	
1.2.4.11	Peak-to-Peak Ripple	Verify & ensure the compliance of clause. Refer Test No. 14 a, b & c	
1.2.4.12 1.2.4.12.1	Transient response Soft Start Feature	Heading. No action required. Verify & ensure the compliance of the clause. Refer Test No. 9.	
1.2.4.12.2, 1.2.4.12.3 & 1.2.4.12.4	Voltage overshoot/ Undershoot	Verify & ensure the compliance of clauses. Refer Test 9, 10 (a & b)	
1.2.4.13 1.2.4.13.1 1.2.4.13.2	Total Harmonic Distortion Total Voltage Harmonic Distortion Total Current Harmonic Distortion	Heading, No action required Verify & ensure the compliance of clause. Refer Test 11(a) Verify & ensure the compliance of clause. Refer Test 11(b)	
1.2.4.14	Current limiting (Voltage Droop)	Verify & ensure the compliance of clause. Refer Test 12	

Cl. No.	Clause	Action to be taken	Action Actually Taken/ Observation/Remarks

1.2.4.15 1.2.4.15.1 1.2.4.15.2 1.2.4.15.3 1.2.4.15.4 1.2.4.15.5	Battery Monitoring Battery Under Voltage Isolation Battery Health Monitoring in auto mode Battery Health check Battery path Current Limiting circuit Battery Temperature Compensation	Heading, No action required. Verify & ensure the compliance of clause. Refer Test No. 15(a) Verify & ensure the compliance of clause. Refer Test No. 15(b) Verify & ensure the compliance of clause. Refer Test No. 15(d) Verify & ensure the compliance of clause. Refer Test No. 15(c) Verify & ensure the compliance of clause. Refer Test No. 16 (a &b)	
1.2.4.16 1.2.4.16.1 & 1.2.4.16.2	Protections AC Input	Heading, No action required. Verify & ensure the compliance of clauses. Refer Test No. 8	
1.2.4.16.3, 1.2.4.16.3.1 to 1.2.4.16.3.7	D.C. Over voltage	Verify & ensure the compliance of clauses. Refer Test No. 8	
1.2.4.16.3.8 & 1.2.4.163..9	Fuse/Circuit Breakers	Verify & ensure that proper rated fuse/ circuit- breakers have been provided as required by the clause. Record the rating & type of every fuse/circuit breaker. Also ensure the compliance of clauses. Refer test No. 8	
1.2.4.16.10	Over Load/ Short Circuit Protection	Verify & ensure the compliance of clause. Refer Test No. 8 & 13	
1.2.5 1.2.5.1, 1.2.5.2, 1.2.5.3 & 1.2.5.4	Inverter Inverter switching frequency, Inverter input operating range, Input switch over & Inverter output & standby mains isolation	Heading. No action required. Verify and ensure the compliance of the clauses. Refer Test 22 (a, b & c)	
1.2.5.5 1.2.5.5.1 & 1.2.5.5.2	Automatic Load transfer Transfer switch	Verify & ensure the compliance of the clause for the following : -Provision of automatic transfer of load to stand by power (AC mains, DG Set or another Inverter system) through a Static Transfer Switch along with isolation arrangement of the rated system capacity within 5 milli seconds, in the event, the inverter/s fail/s to take load due to any reason. -Transfer of load back to inverter unit shall also be automatic only after the inverter output has stabilised and is within the specified limits. Transfer time in this shall only be 5 mili seconds. Also refer Test No. 5 & 6 The transfer switch used for the purpose shall be capable of transferring load at PF between **0.7** lead to **0.7** lag. The Static Transfer switch shall not add any distortion to the output. Also refer Test No. 5, 6 & 22.	
1.2.5.6 & 12..5.6.1	Parallel operation	Verify & ensure the compliance of the clauses. Refer Test No. 23	
1.2.5.7, 1.2.5.7.1 to 1.2.5.7.7 1.2.5.7.8	Protections against Reverse polarity, Under/ Over Voltage, High/Low Voltage, Frequency out of range, Over Load & Crest factor etc. Surges & transients	Verify & ensure the compliance of the clauses. Refer Test No. 17, 20, 21 & 24. Verify & ensure the compliance of clause. Refer Test 24	

Cl. No.	Clause	Action to be taken	Action Actually Taken/ Observation/Remarks
1.2.5.8 1.2.5.8.1	Input DC protection for manual safety & batter floated Positive terminal earthed	Verify & ensure the compliance of the clause. Refer Test No. 24. Verify & ensure that the positive terminal of the input shall be taken as earthed. Refer Test No. 24	
1.2.5.9 , 1.2.5.9.1 1.2.5.9.2 1.2.5.9.3	Output Output voltage settablity, Use of frequency & PF Free of modulation & hunting oscilator	Verify & ensure the compliance of the clauses. Refer Test No. 22 (a, b & c) Refer test No. 22 (a, b & c) Refer test No. 22 (a, b & c)	
1.2.5.10	Power Factor	Verify & ensure the compliance of clause. Refer Test No. 19, 22	
1.2.5.11	Transient Response	Verify & ensure the compliance of clause. Refer Test No. 17 (a, b & c)	
1.2.5.12	Inrush Current	Verify & ensure the compliance of clause. Refer Tests 17(a , b & c)	
1.2.5.13 1.2.5.13.1	Total Harmonic distortion Total Voltage Harmonic Distortion.	Heading. No action required. Verify & ensure the compliance of clause. Refer Test No. 18.	
1.2.5.14	Tendency to hunt	Verify & ensure the compliance of clause. Refer Test No. 17, 22 (a & b)	
1.2.6	Voltage Regulator (VR)	Heading . No action required.	
1.2.6.1	VR design	Verify & ensure the compliance of the clause. Also refer test No. 28.	
1.2.6.2	Cooling	Verify & ensure that the VR is natural air cooled & conforming other clauses of GR. Refer Test No. 28.	
1.2.6.3	Non-current carrying metal part	Verify & ensure that the non-current carrying metal part is bonded together & earthed in compliance of the clause.	
1.2.6.4	Transformers & Inductors	Verify & ensure the compliance of the clause	
1.2.6.5	Operation	Verify& ensure the compliance of clause. Also refer Test No. 28	
1.2.6.6	Output voltage	Verify & ensure the compliance of clause. Refer Test No. 25, 28	
1.2.6.7	Regulator & Frequency	Verify & ensure the compliance of clause. Refer Test No. 29	
1.2.6.8	Input range	Verify & ensure the compliance of clause. Refer Test No. 28	
1.2.6.9	Sudden variation in AC	Verify & ensure the compliance of clause. Also refer Test No. 27	
1.2.6.10	Efficiency	Verify & ensure the compliance of clause. Refer Test No. 28	
1.2.6.11	Total Voltage Harmonic Distortion	Verify & ensure the compliance of clause. Refer Test No. 28	
1.2.6.12	Total Current Harmonic Distortion	Verify & ensure the compliance of clause. Refer Test No. 28	
1.2.6.13	Power Factor	Verify & ensure the compliance of clause. Refer Test No. 28	
1.2.6.14	Short Circuit	Verify & ensure the compliance of clause. Refer Test No. 26	

Part 2 : General requirements

Cl. No.	Clause	Action to be taken	Action actually taken/ Observation/Remarks
2.0	**General requirements**	Heading. No action required.	
2.1, 2.1.1 to 2.1.9	RFI Suppression	Verify & ensure that the offered UPS (FR-FC, Inverter, DSCA,, Static Transfer Switch and VR) system is in fully compliance of the clauses. Note : These tests shall be conducted on the offered UPS System from an authorised Test Lab.	
2.2	Constructional Features	Verify and ensure that the rack structure shall be in compliance of all the clauses. -The structure shall be made up of rigid and self-supporting steel profiles. -It shall be free of sharp edges or corners. -The rack shall have suitable ventilating arrangements(forced cooling from the sides is not permitted). -The front door(if provided) and rear door may be of hinged or removable type. -Rear door and front door (if provided) shall have proper ventilation arrangement. -The gauge of panels shall be 2 mm (minimum).	
2.2.1		-The structural strength shall be capable of withstanding its ultimate mechanical load, without any deformity.	
2.2.2		-The base of rack shall ensure uniform floor loading of not more than 320 kg/Sq. metre. -Lifting facilities shall be provided by removable eyebolt located at the top of the rack/unit. -The necessary arrangement for fixing the rack/unit on the floor shall also be provided.	
2.2.3		- The top of the rack shall be fully covered except for ventilation and cable entries. -Each air flow vent shall be covered by a grill to prevent the entry of foreign material larger than 5mm.	
2.2.4		-With doors in position, all the common Visual alarms and meters shall be clearly visible. -In case of hinged door, meters and alarm indications are permitted on door also. However, the fixtures on the door shall not restrict the movement of door in any way.	
2.3.5		-The rack shall be designed for easy access from front, rear and top for easy Installation and Maintenance.	
2.2.6		-The rack shall be made standalone with a rigid framework with bottom clearance of 110 mm with a tolerance of +/- 10mm.	
2.2.7		-In case of unitary system if more than one UPS can be accommodated in a rack there shall be provision of easily mounted to/removed from the front side of the rack. - In such case UPS unit shall be designed to slide into the rack on a suitable mechanical arrangement. -The associated AC output, DC input connections, Control, alarms & interface cable connecting the modules shall be connected/ disconnected easily without causing any interruption in the supply and damage to load or other working units.	

Cl. No.	**Clause**	**Action to be taken**	Action actually taken/ Observation/Remarks

2.2.8	Cooling arrangement	Verify & ensure the compliance of the clause. - All basic units shall be preferably cooled by natural convection, however forced cooling is permitted, subject to the compliance of the clause 2.2.10.	
2.2.9	Dimensions	Verify & ensure the compliance of the clause. UPS Unit shall preferably 19 inch rack configuration. Depth of rack Shall not be more than 600 mm from front door (when provided) to rear with door fitted. Width : Shall not be more than 600 mm. Height : Shall not be more than 2200 mm (max). In case it is not feasible to accommodate the unit in 19 inch rack. Dimension shall be as per manufacturer design. Once Type approved the dimensions shall not be changed. Refer test No. 1.	
2.2.10	Cooling arrangement/ Thermal Engineering	Verify & ensure the compliance of the clause. & also ensure that fan if used is in complying with MTBF requirements of this GR. Failure of the fan does not cause any fire hazard and draw the immediate attention of the maintenance staff. Fan shall be switched off when output of the unit fails due to any reason and shall start automatically on the restoration of their output. Use **of fans on the sides of the unit is not permitted.**	
2.2.11	Unitary system	Verify & ensure that the unitary systems, the units shall be removable from the front of the rack only. All AC and DC input , DC and AC output and control, alarm and monitoring cables interconnecting the units and rack shall be easily disconnected by plugs or connectors.	
2.2.12 2.2.12.1 2.2.12.2	Distribution, Switching, Control, Alarm and Monitoring (DSCA) unit DSCA unit	Heading. No action required. Verify & ensure that the DSCA shall be housed in the upper portion of the rack(if mounted in a rack), above the Inverter unit and FR-FC unit. The Distribution/ Switching Sub-system of DSCA may be accommodated in a rack with Inverter, FR-FC units or in a separate rack. These sum- systems shall be rack mountable . Verify & ensure that the DSCA unit shall be equipped to meet the ultimate system capacity. All AC, DC or control/alarm cabling/wiring shall be pre-wired for the ultimate Rack capacity so that mere plugging-in of UPS unit shall add to the AC power output.	
2.3.13, 2.3.13.1 to 2.3.13.3	Accessibility	Verify & ensure that the rack/unit configuration is as per clauses & in compliance of the clauses	

Cl. No.	**Clause**	**Action to be taken**	Action actually taken/ Observation/Remarks

2.2.14 2.2.14.1 2.2.14.1.1 2.2.14.1.2 2.2.14.1.3 2.2.14.1.4	Terminations AC input connections Marking/sign-writing AC Terminations AC terminals protection Danger marking Screening between AC & DC Input cables Accessibility to fuses/circuit-breakers	Verify & ensure the compliance of clause. - Input & output AC terminals for single phase systems shall be clearly marked as L and N and for three phase systems as R, Y, B & N and Input DC terminals as +ve & -ve respectively. Heading. No action required. Verify & ensure the compliance of the clauses for the following : AC termination shall be suitably protected against the accidental touch/contact with the working staff for their protection. -Shall also have clear and prominent "DANGER" Marking. Screening shall be provided between AC & DC components to prevent accident. All the connections between DSCA unit and individual units shall be through proper rated cables only. Fuses & Circuit-breakers provided shall be easily accessible and properly rated.	
2.2.14.2 2.2.14.2.1 2.2.14.2.2 2.2.14.2.3 2.2.14.2.4 2.2.14.2.5	DC Termination	Heading. No action required. Verify & ensure the compliance of clauses. -All the Connection between the individual units and DSCA unit shall be through a proper rated lugged and cables only. All the AC, DC and Control, alarm cabling shall be supplied with the system. All conductors shall be properly rated to prevent excessive heating. DC output of the FR-FC unit & input to the Inverter unit shall be through proper rated hot plug-in connectors on the unit and lugged termination on the termination end. The DC input through the cable is permitted for UPS systems with the input load up to 200A. For higher input loads, bus-bar only shall be used. However for inter-rack connections, cables of proper rating are permitted	
2.2.15, 2.2.15.1 & 2.2.15.2	Mounting of component & layout	Verify & ensure the compliance of clauses.	
2.3	Bus Bars	Verify & ensure the compliance of the clause. Also verify & ensure for the size of the bus-bars and necessary Test Certificate from an authorised Test Lab. for purity and tinning of copper as per clause.	
2.4 & 2.4.1	Cables & Wiring	Verify & ensure the compliance of the clause. Also verify & ensure that all the wires & cables used are fire retardant & rodent/reptile repellent and in compliance of the clause. Also Verify & ensure that all the wiring has been neatly secured in position and adequately supported. Where wires pass through any part of metal panel or cover the hole through which they pass shall be suitably bushed.	
2.5	Earthing	Verify & ensure the compliance of the clause. Also t**he manufacturer shall clearly specify the earthing requirements for trouble-free performance of the UPS system.**	
2.6 & 2.6.1	Documentation	Verify & ensure that Installation & Maintenance Manual is in compliance of the clauses.	
2.7	Quality Requirements	Heading, No action required	

Cl. No.	**Clause**	**Action to be taken**	Action actually taken/ Observation/Remarks

2.7.1,2.7.1.1 and 2.7.1.2	Components	Verify & ensure the compliance of the clauses & also ensure that all the components used are fire retardant & CACT approved. **Use of potentiometer is precluded.**	
2.7.1.3 & 2.7.1.3.1	Static Transfer Switch & Manual Transfer Switch	Verify & ensure the compliance of the clause. Also refer test No. 1,5, 6 & 22.	
2.7.1.4	Meters	Verify & ensure the compliance of the clause. Also refer Test No. 2	
2.7.1.5	Component approval	Verify & ensure that all the components used are approved by CACT wing of BSNL and also in compliance with the requirement of the clause.	
2.8	Quality & Workmanship	Verify & ensure the compliance of the clause.	
2.9	Quality Assurance Tests	To be conducted by QA wing of BSNL. after type approval.	
2.10	Finish and painting	Verify & ensure the compliance of the clause.	
2.11, 2.11.1, 2.11.2 & 2.11.3	Marking & Labelling & cabling diagram.	Verify & ensure the compliance of the clauses.	
2.11.4	Danger Label	Verify & ensure that the danger label is in compliance of the clause.	
2.11.5 & 2.11.5.1	Name plate & designation strip.	Verify & ensure that the name plate & designation strip are in compliance of the clauses.	
2.12 2.12.1 2.12.2	MTTR & MTBF MTTR MTBF	Heading, No action required. Verify & ensure that the Mean time to repair/replace a faulty unit is less than 20 minutes. Verify and ensure that : -MTBF of the system shall not be less than 100,000 hours. The MTBF for fans shall be better than 70,000 hours at 40 degree C. -The concurrence of CACT of QA wing of BSNL in this regard is mandatory. -The MTBF shall be verified as per QM-115. -MTBF, predicted and observed values shall be furnished along with calculations by the manufacturer. -Based on these figures three years maintenance spares shall be specified by the equipment supplier. -The equipment availability shall exceed 99.9%.	
2.13	Field Observations	To be decided and verified by BSNL..	
2.14	Packing	No action is required at the time of type testing.	
Annexure -1	Lay out	Only for reference. No action is required .	
Annexure -2	Ordering information	No action is required at the time of type testing.	
Annexure - 3	Sample calculation	Only for reference. No action is required.	
Annexure - 4	Protocol	Verify & ensure the compliance of the annexure. Refer test No. 31.	
	Abbreviations	Only for reference. No action required.	

GENERAL TESTS :

Test No. 1

General System Requirements : Clause 1.1, 1.1.1, 1.1.2, 1.1.2.2, 1.1.3, 1.1.4

S. No	GR requirements	Observation/Remarks
1.	**Type of UPS : Standalone /Unitary**	
A. Standalone UPS System		
a.	Category	
b.	Micro Microprocessor soft-were version	
C.	Model No.	
d.	UPS Rating	
e.	Type of system (with or without VR)	
f.	Type of system application : Single phase	
g.	UPS system capacity	
h.	SMPS (FR-FC) Ultimate rating	
i	Inverter rating	
j	DSCA unit rating (ultimate capacity)	
k	Battery capacity (as per backup requirement)	
l	Voltage Regulator rating (To provide standby regulated AC to the load	
m	Static Transfer Switch rating	
n	Manual Transfer Switch rating	
o	Inverter Output & Standby mains isolation arrangement	
B. Unitary UPS System		
a.	Category	
b.	Micro Microprocessor soft-were version	
C.	Model No.	
d.	UPS Rating	
e.	Type of system (with or without VR)	
f.	Type of system application : Single phase/ Three phase	
g.	UPS ultimate system capacity	
h.	SMPS (FR-FC) rating (Ultimate)	
i	Inverter rating (Ultimate)	
j	DSCA unit rating (ultimate capacity)	
k	Battery capacity (as per backup requirement)	
l	Voltage Regulator rating (To provide standby regulated AC to the load	
m	Static Transfer Switch rating as per requirement	
n	Manual Transfer Switch rating as per requirement	
o	Inverter Output & Standby mains isolation arrangement	

Note : 1. All the details above shall form a part of the product details in TAC.
2. Single phase UPS system shall be configured by single phase UPS unit and Three phase UPS system shall be configured by Three UPS unit only (Clause 1.2.4.5.1)

Continued on next page

Continued…….

Termination , Interconnecting & Switching Arrangement(Clause 1.1.3.3.1) :

S. No.	GR requirement	Observation/ Remarks
1.	**Termination &** Interconnecting arrangement along with switching arrangements of the various building blocks/units i.e. Inverter & battery, Inverter & FR-FC , Battery and FR-FC , UPS and load through transfer switch, VR & Transfer Switch etc. All necessary protection, control & Monitoring Circuitry at UPS system level.	
2.	1.Arrangement for Isolation of Inverter unit at the input. and FR-FC output and battery, manually. 2. Suitably rated contactor for auto battery low cut -off and /Reconnection.	
3.	**Terminations for :** • AC input to the FR-FC unit • DC output of FR-FC and Battery • Input & output of the Inverter unit • Input & output to VR unit • Static Transfer Switch • Manual Transfer Switch • Load • Circuit Breakers • Fuses etc • Isolation arrangement between Inverter output & AC Commercial Mains.	
4.	All supervisory Alarms Indications	
5.	All necessary protection, control & Monitoring Circuitry at UPS system level as per GR.	
6.	Inverter Output & Standby mains isolation arrangement	
7.	RS 485 compatibility	

Note : 1. Only CACT approved isolation devices which do not produce spark while isolating or connecting the battery to FR-FC output and inverter input manually. The contactor shall not be used for this purpose.

2. The testing authority shall ensure that the lower rating MCBs/ contactors/ Circuit-Breakers/ fuses are not paralleled to handle the higher current and only single pole devices are used.

System offered is :

GR	Requirement	Observation/Remarks
1. Standalone system	: In this type of system both inverter unit, FR-FC unit and DSCA, the battery of the desired rating as per backup requirements, Static Transfer Switch, manual transfer switch and Voltage regulator (in case of UPS system with regulated stand by DC) are mounted in a single cabinet/rack. It may with or without a regulated standby power supplied by a Voltage regulator.	

Continued on next page

Continued…….

GR	Requirement
Observation/Remarks	
2. Unitary UPS system	**:** In these type of systems, UPS unit is composed of one FR-FC unit, one inverter unit, DSCA unit and the battery. Rating of the Inverter unit is equal to rating of the UPS in KVA. The rating of FR-FC unit shall be as per the load requirement of the battery and inverter unit. The battery AH capacity will be according to the battery backup requirement. DSCA unit provides for all the control, monitoring, alarm functions and necessary terminations/switches as per the GR. In addition to this, the DSCA shall also have the capability of operating its inverter unit in synchronous mode with the inverter units of other UPS units of same make and rating. VR unit (if require), Static Transfer Switch and manual transfer switch in this concept will be common for the ultimate system capacity (as envisaged by the user) proposed to be constituted by paralleling of these UPS units). These type of UPS unit shall be capable of sharing load with other UPS units of same rating and make, in synchronous load sharing mode. Maximum number of UPS unit which can be paralleled is 5.

Load transfer, System configuration, Micro Processor control, Software version, default setting and share of load, remote monitoring control etc (Clause 1.1.3.3 and 1.1.4)

Requirement
Observation/Remarks

Load transfer :

In all the above configurations, there shall be a provision of automatic load transfer to stand-by power supply within 5 mili seconds, in the event of failure of the inverter unit of the UPS due to any reason. Standby power in this case may be a VR, AC commercial mains or standby Engine alternator. Transfer of load back to inverter unit/ system shall also be automatic but it shall take place, only after the inverter output has stabilised and is within the specified limits. Transfer time in this case shall also be within 5 mili seconds.

System configuration :

UPS systems envisaged in this GR may be a Standalone or Unitary in configuration as Standalone and Unitary UPS system.

Micro Processor control, Software version, default setting and share of load, remote monitoring control etc.

It shall be based only on menu driven Micro Processor Controlled Techniques for control, monitoring & alarms. DSCA shall display its Software version. Setting of all the parameters shall be through menu-driven microprocessor control only. Use of potentiometer at any stage is precluded. The failure of Micro processor or DSCA shall not affect the setting of individual inverter or FR/FC. No parameter of inverter or FR/FC units shall be disturbed on the failure of DSCA. In this condition all the inverter and FR/FC shall take care of the load on default settings and share the load collectively (wherever applicable). Only the setting of new parameters from DSCA, shall be affected.

The system shall be RS 485 compatible. It shall be feasible to set any monitoring control parameter from a remote site through RS 485. All the

information regarding Control and monitoring of UPS system data shall be accessible on demand from the remote site. The exchange of information and protocol format shall be as given in the Annexure (test No. 31). DSCA unit shall provide for the following :

Continued on next page

Continued…….

Dimension of the rack/unit (Clause 2.2.9) :

GR Requirement	Observation/Remarks
Depth : Shall not be more than 600mm From front door (when provided) To rear door fitted.	
Width : Shall not be more than 600mm(max	
Height : Shall not be more than 2200mm (Max	

Starting of UPS without battery supply (Clause 1.2.4.3) :

S. No.	GR requirement	Observation/ Remarks
1.	There shall be provision to start the UPS without battery supply	

UPS unit compatibility with Engine alternator (Clause 1.2.4.4) :

S. No.	GR requirement	Observation/ Remarks
1.	The UPS unit shall be suitable for operation from A.C mains or a DG set (of capacity 1.25 times AC load of power plant). The generator output voltage distortion shall not exceed 5% at different load conditions. The UPS unit shall be suitable for operation from A.C mains or a DG set (of capacity 1.25 times AC load of power plant). The generator output voltage distortion shall not exceed 5% at different load conditions.	

Note : 1. Only CACT approved ' Handled enclosed Knife fuse assembly ', 'Contactor' or 'MCBs' which do not produce spark while isolating or connecting the battery shall be used. If the contactor provided for battery under voltage isolation can be used for isolating & connecting the battery with power plant manually by a switch provided in the contactor, 'Handled enclosed Knife fuse assembly' or 'MCB' may not be required.

2. The testing authority shall ensure that the lower rating MCBs/ contactors/ Circuit-Breakers/ fuses are not paralleled to handle the higher current and only single pole devices are used.

Test No. 2

Meter/Shunt Verification (Clause 2.7.1.4)

a) Meters :																							
	FR-FC							INVERTER							UPS								
Ammeters :																							
Range Amps->																							
DC Ammeters	Digital : S No. : Make : Range : Scale/ Length :							Digital : S No. : Make : Range : Scale/ Length :							Digital : S No. : Make : Range : Scale/ Length :								
Readings On a)Under test b)Standard Accuracy																							
Voltmeters :																							
Range Volts->																							
AC Voltmeter	Digital : S No. : Make : Range : Scale/ Length :							Digital : S No. : Make : Range : Scale/ Length :							Digital : S No. : Make : Range : Scale/ Length :								
Readings On a)Under test b)Standard Accuracy																							
DC Voltmeter	Digital : S No. : Make : Range : Scale/ Length :							Digital : S No. : Make : Range : Scale/ Length :							Digital : S No. : Make : Range : Scale/ Length :								
Readings On a)Under test b)Standard Accuracy																							
Frequency Meter	Digital : S No. : Make : Range : Scale/ Length :							Digital : S No. : Make : Range : Scale/ Length :							Digital : S No. : Make : Range : Scale/ Length :								
Readings On a)Under test b)Standard Accuracy																							

b) Shunts :	LOAD PATH							BATTRY PATH							INVERTER						
Range Amps->																					
Readings On a)Under test b)Standard Accuracy																					
	FR-FC							STS							MTS						
Readings On a)Under test b)Standard Accuracy																					
	VR																				
Readings On a)Under test b)Standard Accuracy																					

Limits : All Meter & hunts shall be CACT approved. The meters & Shunts shall comply with :

Meters : Only CACT approved meters with accuracy shall be used.

Current : +/- 1.5% of the range or better, shall be able to read up to full digit for meter range 50A & above & 1 place decimal for lower meter range.

Voltage : +/- 1.5% of the range or better with a resolution of one decimal point in case of DC voltmeter and full digit in case of AC voltmeter.

Frequency : The CACT approved Frequency meter of accuracy of +/- 1% & resolution of one place decimal (sufficient to read +/- 0.1 Hz) and range 45 Hz to 55 Hz shall be used.

Shunts :

The CACT approved shunts (75mV) for ammeters shall have an accuracy class 1.5 & conform to IS : 1248 (latest issue). Separate shunt shall be used for each path. Other proven techniques having higher accuracy and resolution are also permitted.

Accuracy shall be calculated as given : Accuracy = (error/standard meter reading) X 100

Where 1. Error =(Actual meter reading - standard meter reading.

2. Standard meter reading is the reading on the standard meter for the same condition.

Note : Digital display meters shall be used. Use of rotary switch for the purpose is precluded .This shall be done with the help of Digital (with Digital display of intensity enough to read from a distance of 1 metre) metres to read the voltage and current of the system and individual inverter (at individual inverter unit/module also permitted) . Normally the meters mounted at DSCA shall indicate the system voltage and current.

Test No. 3

Voltage Proof & Insulation Tests :

a) Insulation Resistance Test (Clause 1.2.1.3) :

The insulation resistance of the complete UPS unit, VR, Static Transfer Switch, Manual Transfer Switch shall be tested with a 500V DC megger.

	UPS unit		VR		Static Transfer Switch		Manual transfer Switch	
Between Terminal	Required	Observation	Required	Observation	Required	Observation	Required	Observation
Interconnected Input Terminal & earth	>5 m Ω	m Ω	>5 m Ω	m Ω	>5 m Ω	m Ω	>5 m Ω	m Ω
Interconnected Output Terminal & Earth	>5 m Ω	m Ω	>5 m Ω	m Ω	>5 m Ω	m Ω	>5 m Ω	m Ω
Interconnected Input terminals & Interconnected Output Terminal	>5 m Ω	m Ω	>5 m Ω	m Ω	>5 m Ω	m Ω	>5 m Ω	m Ω

b) High Voltage Test (Clause 1.2.1.4) : A. test voltage of 2000V/50 Hz shall be applied for one minute.

Observation : Between	UPS Unit	VR	Static Transfer Switch	Manual Transfer Switch
Earth & Interconnected output Terminal	OK/Not OK	OK/Not OK	OK/Not OK	OK/Not OK
Earth & Interconnected input Terminal	OK/Not OK	OK/Not OK	OK/Not OK	OK/Not OK
Input & Output Terminal	OK/Not OK	OK/Not OK	OK/Not OK	OK/Not OK

Note : 1. While taking above tests printed circuit boards, EMI/RFI capacitors and MOVs/Tranzorbs removed from the circuit

2. No breakdown or abnormal temperature rise shall occur.

Alternatively without removing EMI/RFI capacitors, the lightning protection circuitry and Tranzorbs etc., but with EMI/RFI discharge resistors removed :

a) A 2150V DC can be applied for one minute between shorted AC output & DC input terminals.
b) 650V DC can be applied for one minute between shorted AC Input terminals, shorted input DC terminals, shorted DC output terminals & earth.

This DC voltage test is in accordance with UL950 & IEC 950 Standards.

Note : This Test is to be conducted on each of the basic units of the system.

Test No. 4

Operating Noise (Clause 1.2.1.5)

a) When system working on FR/FC & Inverter :

Input Voltage (V)	Output Current (A)	Noise level reading (dBA) for meters position with respect to System							
		System `OFF'		System `ON'		Contribution factor		Noise Corrected	
		Front	Rear	Front	Rear	Front	Rear	Front	Rear
320/150V									
400/230V (Nom.)									
480/275V									
Unbalance +10%									
Unbalance –10%									

b) When system working on VR :

Input Voltage (V)	Output Current (A)	Noise level reading (dBA) for meters position with respect to System							
		System `OFF'		System `ON'		Contribution factor		Noise Corrected	
		Front	Rear	Front	Rear	Front	Rear	Front	Rear
320/150V									
400/230V (Nom.)									
480/275V									
Unbalance +10%									
Unbalance –10%									

Note-1 : In all cases the Audio Level Meter shall be placed at a distance of 1 metre & 1.25 metre above floor level from the unit.
Note-2 : All noise inducing appliances may be shut down during the test to achieve the minimum ,ambient noise level.
Note-3 : Tests is to be conducted on a fully loaded system.

Limits : The fully equipped UPS system at full load shall not contribute more than 15 dB (weighted) to the ambient noise level taken as 45dBA. The correction factor for Total Noise when the ambient noise level is more than 45dBA shall be as given below :

Ambient Noise	Correction Factor	Ambient Noise	Correction Factor	Ambient Noise	Correction Factor	Ambient Noise	Correction Factor
45dBA	0dB	49dBA	0.86dB	53dBA	2.07dB	57dBA	3.69dB
46dBA	0.18dB	50dBA	1.12dB	54dBA	2.47dB	58dBA	4.17dB
47dBA	0.39dB	51dBA	1.41dB	55dBA	2.82dB	59dBA	4.68dB
48dBA	0.61dB	52dBA	1.73dB	56dBA	3.25dB	60dBA	5.21dB

Note : The correction Factor shall be added to the limit of 60dBA to arrive at the limit when the ambient is greater than 45dBA.

Test No. 5

Performance Tests On DG Set (Clause 1.1.5) :

a) FR-FC on DG SET :

Type of UPS System : **S. No. of the Unit :**

AC Input						DC Output				
Voltage (V)	Current (A)			Power (W)	P.F.	Current (A)		Voltage (V)	Ripple Peak-to-Peak (Mv)	Efficiency (%)
	R	Y	B			Actual	%			
							25			
							50			
							100			

b) VR on DG set :

Type of UPS System : **S. No. of the Unit :**

AC Input						DC Output					
Voltage (V)	Current (A)			Power (W)	P.F.	Current (A)		Voltage (V)	Ripple Peak-to-Peak (Mv)	Efficiency (%)	Distortion
	R	Y	B			Actual	%				
							25				
							50				
							100				

Note : 1. The system shall be capable of working with DG set of capacity 1.25 times the capacity of FR-FC unit, VR under DSCA load if any.

2. Static Transfer Switch (Clause 2.7.1.3) : CACT approved Static Transfer Switch, capable of handling 120% of the rated system capacity in compliance of Note 3 of clause 1.1.4 and clause 1.2.5.5.

3. **Manual Transfer Switch (Clause 2.7.1.3.1) :** CACT approved Manual Transfer Switch, capable of handling 120% of the rated system capacity in compliance of Note 3 of clause 1.1.4 shall be used.

Test No. 6

a) Transfer of Load (Clause 1.1.4 Note 3, 1.2.5.5)

Condition	Requirement	Observation/Remarks
1. Transfer of Load a) From Inverter to VR - Switch on all the Inverters	Ensure the load is fed by the Inverter unit	
- Fail all the Inverters and observe	Load is automatically transferred to VR through Static Transfer Switch (provided for isolation between inverter system output and stand by power), within 5 ms without any interruption to load, in the event, the inverter/s fail/s to take load due to any reason. The rating of Static Transfer Switch shall be 1.2 times the rating of UPS System.	
b) VR to Stand by Power (AC mains and DG Set)	Ensure the load is fed by VR.	
- Fail the VR	Load is automatically transferred to stand- by power (AC mains and DG set) through Static Transfer Switch (provided for isolation between inverter system output and stand by power), within 5 ms without any interruption to load, in the event, the inverter/s fail/s to take load due to any reason. The rating of Static Transfer Switch shall be 1.2 times the rating of UPS System.	
c) Transfer of load back to inverter unit/system :	Ensure the load is fed by stand by power.	
- Fail the Stand by power	Transfer of load back to Inverter unit/System shall also be automatic but it shall take place, only after the Inverter output has stabilized and is within the specified limits. Transfer time in this case shall also be within 5 mili second.	
2. Inverter load from FR-FC to battery and vice versa - Switch on all the FR-FCs	Ensure the Inverter & battery are being fed FR-FC.	
- Fail all the FR-FC of the unit & observe.	Inverter load is transferred to battery without battery dipping.	
- Switch over the FR-FC unit	Inverter & battery load is fed by FR-FC unit in Charge mode.	

b) Static Transfer Switch (Clause 1.1.3.4, 1.1.4, 1.2.5.5, 1.2.5.5.2 &1.2.6) :

Condition	Requirement	Observation/Remarks
1. Rating of the transfer switch	Shall be 120% of the ultimate rating of the inverter unit.	
2. Load Transfer at 100% load at load P.F. 0.7 lag.	Shall be automatic for transfer time less than 5 ms.	
3. Load Transfer at 25% load at load P.F. 0.7 lag.	Shall be automatic for transfer time less than 5 ms.	
4. Load Transfer at 100% load at load P.F. 0.7 lead.	Shall be automatic for transfer time less than 5 ms.	
5. Load Transfer at 25% load at load P.F. 0.7 lead.	Shall be automatic for transfer time less than 5 ms.	
6. Distortion contributed by Static Transfer Switch.	nil	

Note : CACT approved Static Transfer Switch capable of handling 120% of the rated UPS system capacity shall be used.

c) Manual Transfer Switch (Clause 1.1.3.4, 1.1.4 & 2.7.1.3.1)

GR Requirement	Requirement	Observation/Remarks
1. Rating of the transfer switch	Shall be 120% of the ultimate rating of the inverter unit.	
2. Load Transfer at 100% load at load P.F. 0.7 lag.	Takes place without any interruption & hunting.	
3. Load Transfer at 25% load at load P.F. 0.7 lag.	Takes place without any interruption & hunting.	
4. Load Transfer at 100% load at load P.F. 0.7 lead.	Takes place without any interruption & hunting.	
5. Load Transfer at 25% load at load P.F. 0.7 lead.	Takes place without any interruption & hunting.	
6. Distortion contributed by Static Transfer Switch.	nil	

Note : CACT approved Manual Transfer Switch capable of handling 120% of the rated UPS system capacity shall be used.

Test No. 7

Monitoring Alarms and Indicating Lamps (clause 1.2.2) :

Visual indications/display such as LEDs, LCDs or a combination of both shall be provided on DSCA of the UPS unit.

Functional Indications : (Clauses 1.2.2.1) : The following functional indications shall be provided on FR/FC, Inverter & DSCA :

Functional Indications :

GR requirement	Observation /Remarks
a) Mains available	Provided/Not Provided
b) FR/FC of the Unit on : Auto Float (Battery Charged) : Auto Charge (Battery Charging)	Provided/Not Provided
c) Load on : UPS : VR (if used) : Standby	Provided/Not Provided

Alarm Indications : Clause 1.2.2.2 & 1.2.1.6

GR requirement	Observation /Remarks
a) AC Input out of range	Provided/Not Provided
b) DC over voltage (voltage droop)	Provided/Not Provided
c) DC under voltage	Provided/Not Provided
d) AC Mains “ON” and Battery Discharging	Provided/Not Provided
e) Temp. Compensation fail	Provided/Not Provided
f) Battery low/Battery fail or No battery	Provided/Not Provided
g) FR-FC over load	Provided/Not Provided
h) FR-FC unit Fail (FR-FC unit fail due to any reason)	Provided/Not Provided
i) Inverter unit fail (inverter fail due to any reason)	Provided/Not Provided
j) Lightning Protection stage II device fail	Provided/Not Provided
k) UPS Overload	Provided/Not Provided
l) UPS Fail	Provided/Not Provided
m) AC Input Frequency out of range.	Provided/Not Provided
n) UPS fain fail (due to any reason)	Provided/Not Provided

Note :

1. All the alarms shall be available even in the absence of AC input and output. Also all alarm circuits shall be provided with suitable delay to ensure that they do not operate to transients. (Clause **1.2.2.3**)

All the alarms and protection limits shall be settable through a menu driven program(Clause **1.2.2.4)**.

All the protections/alarms shall be within a tolerance of 1% in case of DC voltage and current. For AC voltage it shall be +/-5V (Clause **1.2.2.5)**.

Every Alarm condition shall be accompanied with an Audio alarm, with a non locking type key or push button, audio cut-off facility. The visual alarm indication will, however, continue to glow to attract the attention of maintenance staff and shall extinguish by pressing the alarm reset key, only after the alarm condition is cleared by rectifying the fault or repair/replacement of the faulty unit (Clause **1.2.2.6)**.

Potential Free Contacts two (one for alarm and one redundant) shall be provided for extension of alarms to Centralised Display (Clause **1.2.2.7**)

Continued on next page :

Continued …….

Lightning & Surge Protection (Clause 1.2.1.6)

GR requirement	Observation /Remarks
Lightning and surge protection (Stage I, Stage II and Co-ordination between the two stages and its alarms and other requirements of clauses) shall be in compliance of the clauses of the GR.	Provided & complied/ Not Provided & Not Complied

Remote control and monitoring (Clause 1.2.3.) :

GR requirement	Observation /Remarks
1. The UPS system shall be RS 485 compatible	Provided/Not Provided
2. It shall provide for the monitoring, alarm and control of the UPS system and its associated batteries from a remote site through RS 485.	Provided/Not Provided
3. It shall provided the exchange of information and protocol format between the UPS system and remote site shall be as given in the Annexure-4. Also Refer Test No. 31.	Provided/Not Provided

Test No. 8

Protection & Alarm Clause : 1.2.4.9, 1.2.4.10, 1.2.4.14, 1.2.4.16, 1.2.4.16.1, 1.2.4.16.2, 1.2.4.16.3, 1.2.4.16.3.1, 1.2.4.16.3.2, 1.2.4.16.4, 1.2.4.16.5, 1.2.4.16.6, 1.2.4.16.7, 1.2.4.16.8, 1.2.4.16.9 & 1.2.4.16.10) :

On FR-FC unit/ UPS unit :

S.No.	Alarm Description	Alarm Condition	Extension of Indication to Switching, Control & Monitoring unit	Remarks
1.	AC Under/Over Voltage (Galvanic isolation)	As per Clause 1.2.4.16.1, 1.2.4.16.2 & 1.2.2.2		
2.	DC Over voltage : a. In case output DC voltage exceeds 2.33V/cell, the over voltage protection circuit shall operate & shut-off the faulty unit. A tolerance of +/- 1% is permitted in this case. Restoration of the FR/FC shall be through a reset switch/push button. b. FR-FC unit shall be fitted with an internal over- voltage protection circuit. c. The over voltage protection circuit failure shall not cause any safety hazard.	DC voltage exceeds 2.33V /cell +/-1%		
3.	DC under-voltage or output fail Battery under-voltage (clause 1.2.4.15.1)	Not Below1.75V/cell +/-1% Cut-off between 1.75V/cell & 1.9V/cell (settable) Reconnect : 2.15 to 2.35V/cell (settable)		
4.	Overload(voltage droop) /Short Circuit Mode : Float/Charge (Clause 1.2.4.14)	50 to 100% load 1.85V/cell to 2.33V/cell		
5.	UPS system Fan fail (Due to any reason)	Fan not working		

Continued on next page

Continued …….

S.No.	Alarm Description	Alarm Condition	Extension of Indication to Switching, Control & Monitoring unit	Remarks
6.	protection against the discharge of the Battery through the FR/FC unit	The circuit design shall ensure protection against the discharge of the Battery through the FR/FC unit under any condition.		
7	Discharge of capacitors	A resistor shall be provided to discharge the capacitors after the FR-FC unit have stopped operation and output is isolated		
8.	Electrical noise	The FR/FC units shall be provided with suitable filter on the output side.		
9.	Fuse or circuit breaker shall be provided for each FR/FC unit as follow : 1. AC input live (MCB) 2. -ve DC output (Handled enclosed ultra-fast fuse assembly or DC circuit breaker: 3. failure control sensing circuit. **Note : Fuse/ circuit breaker used shall be suitable fault rated.**			
10.	Over load/ Short circuit	Each unit of UPS shall be protected for Over voltage/Short circuit.		

Note :

1. Operation of over-voltage shut down shall be suitably indicated on the unit and also extended to DSCA unit.
2. The circuit design shall ensure protection against the discharge of the Battery through the FR/FC module in any case.
3. Each FR-FC unit shall be fitted with an internal over- voltage protection circuit. The over voltage protection circuit failure shall not cause any safety hazard.
4. All the alarms shall be available even in the absence of AC input and output. Also, all alarm circuits shall be provided with suitable delay to ensure that they do not operate with transients.
5. All the alarms and protection limits shall be settable through a menu driven program.
6. All the protections/alarms shall be within tolerance of 1% in case of DC voltage and current. For AC voltage it shall be +/-5V.
7. Every Alarm condition shall be accompanied with an Audio alarm, with a non locking type key or push button, audio cut-off facility. The visual alarm indication will, however, continue to glow to attract the attention of maintenance staff and shall extinguish by pressing the alarm reset key, only after the alarm condition is cleared by rectifying the fault or repair/replacement of the faulty unit..
   Potential Free Contacts two (one for alarm and one redundant) shall be provided for extension of alarms to Centralised Display.
8. Every Alarm condition shall be accompanied with an Audio alarm, with, audio cut-off facility.
9. Shutting-off of faulty UPS unit shall not affect the operation of other UPS units (if used) in the rack.
10. Remote control and monitoring : The power plant shall be RS 485 compatible. It shall provide for the monitoring, alarm and control of the power plant and its associated batteries from a remote site through RS 485. The exchange of information and protocol format between the power plant and remote site shall be as given in the Annexure-4.

Test No. 9

Soft Start Test (Clause 1.2.4.12.1 & 1.2.4.12.2)

		On 25% Load	On Full Load
		FR-FC	FR-FC
i) Build up time		s	s
ii) Over/Under shoot		%	%
iii) Stabilising time		ms	ms
iv) Instant. Current		A	A

Limits :1.Slow start circuitry shall be employed such that the FR/FC input current and output voltage shall reach their nominal value within 10 seconds.

2. The maximum instantaneous current during start up shall not exceed the peak value of the rectifier input current at full load at the lowest input voltage specified.

3. The FR/FC shall be designed to minimise output voltage Overshoot/Undershoot such that when they are switched on the DC output voltage shall be limited to +/- 5% of the set voltage & return to their steady state with in 20ms for any load of 25 to 100%.

Note : a) The above conditions shall be met without battery floated.
b) Necessary graph shall also be provided for ready reference.

Test No. 10

a) Voltage Overshoot/Undershoot (Clause 1.2.4.12.3) :

a) Step change in Input Voltage from X to Y (As applicable)
a) 90V to 300V & Vice Versa
b) 320V to 480V & Vice Versa

		At 25% Load	At 100% Load
		FR-FC	FR-FC
X to Y			
i) Over/Under shoot		%	%
ii) Stabilising time		ms	Ms
Y to X			
i) Over/Under shoot		%	%
ii) Stabilising time		ms	Ms

Limits : AC mains as specified shall not cause shut-down of FR/FC module and shall be limited to +/- 5% of its set voltage and return to steady state within 20ms.

Note : a) The above conditions shall be met without battery floated.
b) Necessary graph shall also be provided for ready reference.

b) For Step Change in Load at Nominal Input 400V for Three Phase & 230V for Single Phase : (Clause 1.2.4.12.4)

		From 25-100% (rated load)	From 100-25%(rated load)
		FR-FC	FR-FC
i) Over/Under shoot		%	%
Ii) Stabilising time		ms	ms

Limits : The step load change of 25 to 100% shall not result in DC output voltage Overshoot/Undershoot of not more than 5% and return to steady state value within 10 ms without resulting the unit to trip.

Note : a) The above conditions shall be met without battery floated.
b) Necessary graph shall also be provided for ready reference.

Test no. 11

a) Total Voltage harmonic Distortion (Clause 1.2.4.13.1)

I/P Voltage(V)			O/P Current(A)			% Voltage Distortion		
Unit OFF	Unit ON		Actual		%	R	Y	B
	FR- FC	FR-BC*	FR-FC	FR-BC*		FR-FC	FR-FC	FR-FC
320/90V					50 100			
400V/ 230V (nom)					50 100			
480/300V					50 100			
Unba-Lance +10%					50 100			
Unba-Lance -10%					50 100			

Limits : 1. In case of single phase use only one column from R, Y & B.
2. The Total line Harmonic voltage Distortion shall not be more than 10% in conformity with CIGRE's limits.

b) Total Current harmonic Distortion (Clause 1.2.4.13.2)

I/P Voltage(V)			O/P Current(A)			% Current Distortion		
Unit OFF	Unit ON		Actual		%	R	Y	B
	FR-FC	FR-BC*	FR-FC	FR-BC*		FR-FC	FR-FC	FR-FC
320/90V					50 100			
400V/230V (nom)					50 100			
480/300V					50 100			

Limits : 1. In case of single phase use only one column from R, Y & B.
2.The Total Current Harmonic Distortion contributed by the unit at the input shall not exceed 10%, in any of the above case

Test No. 12

Current Limiting {Voltage Droop} (Clause 1.2.4.14) :

Output Voltage	Settability Range (...% to …….. %)		Voltage Droop Starts at % Load	
	Auto Float	Auto Charge	Auto Float	Auto Charge
1.85V /cell 2V/ cell 2.15V/cell 2.25V/cell 2.33V/cell				

Note : a) Shall be settable between 50 to 100% of rated output current for output voltage range of 1.85V/cell to 2.33V/cell. For test purposes upper limit of 100% + 5 and lower limit of 50% - 5% shall be acceptable.

b) Further increase in load shall not increase the current and should result only in further voltage droop.

c) Test shall be performed at 100% setting in case Auto Float/Charge Mode.
d) The float and charge limit adjustment shall be provided through a minu driven program on DSCA.

Test No. 13

Short Circuit Test (Clause 1.2.4.16.10)

	UPS unit	Remarks
Switch-on the unit at rated full load & Note O/P Voltage after the unit has stabilized :	V	
Apply a short at its output. :	Goes into voltage droop	
Maximum Short Circuit Current : (in case of voltage droop)	A	
Remove Short Circuit. Unit Starts automatically to take the load :	Yes/No	
It takes the load :	Yes/No	
Note the output voltage :	V (shall be same as before)	

Note : Ensure that short circuit shall not lead to any excessive temperature rise or fire Hazard.

Test No. 14

Regulation/AC Input Range/Peak-to-Peak Ripple/Efficiency/Load PF Tests :

Specification Requirements :

a) Switching Frequency (clause 1.2.4.1) . Limits : > 20KHz

b) AC Input Range (Clause 1.2.4.5) FR/FC unit (0.5KVA,1KVA,2KVA,,3KVA & 4KVA) of the UPS system rating up to 12KVA shall operate on single phase AC input while FR/FC unit of UPS systems of rating higher than 12KVA shall operate only on 3phase/4wire AC input.

The nominal input frequency is 50Hz which may vary from 48-52Hz. The input voltage range shall be as given below :

i))Single Phase (Nominal230V) : 90V to 300V
ii) Three Phase/4wire (nominal400V) : 320V to 480V

For three phase/4 wire FR/FC unit only delta connection are permitted. FR/FC units shall work satisfactorily for unbalance of +/- 10% of nominal input. Phase current unbalance under all working conditions, mentioned in this document, shall not be more than 10%. Neutral phase current shall not exceed 100mA under all specified input, output and load conditions (Clause 1.2.4.5.1).

Note : Single phase and Three phase UPS system shall be configured by single phase and three phase UPS unit only at both UPS unit as well as rack level.

c) Output Voltage Regulation (Clause 1.2.4.6.3). **Limits :**The DC output voltage shall be maintained within +/-1% of the half load preset voltage in the range 25% load to full load when measured at the output terminals over the full specified input range.

d**) Peak-to-Peak Ripple Voltage (C1ause 1.2.4.11) .Limits:** Peak to peak ripple imposed on DC voltage, without battery connected, but full load Inverter being fed by it. shall not exceed 1% of the DC voltage at the Switching Frequency measured by an Oscilloscope of 50/60 MHz band-width (Typical).

e) Efficiency (Clause1.2.4.7) . Limits : The efficiency of the UPS unit while working on FR-FC and Inverter shall be as given below :

	Units working on	
	Single phase AC	**Three phase AC**
i) At all AC input, output, Specified DC range (1.85V to 2.3V/cell) and load between 25% to 100%	: better than 90%	better than 92%

f) Input Power Factor (Clause 1.2.4.8) : **Limits:** The true input Power Factor at all input, output voltage and load between 25 to 100% shall be better than 0.95. Active Power factor correction only shall be employed for the purpose.

g) Clause 1.2.4.5.1 Note : Single phase and Three phase UPS system shall be configured by single phase and three phase UPS unit only at both UPS unit as well as rack level.

h) Clause 1.2.4.3 : Starting of UPS without battery supply : There shall be provision to start the UPS unit without battery supply.

Note : Clause 1.1.3.2 : Rating of FR-FC unit shall be such that it shall be capable of catering the inverter load in 110% overload condition and battery load at the charge rate specified by the user. Normally the recommended battery charge rate is C/10.

The rating of Voltage regulator equal the ultimate rating of UPS System.

The Static Transfer Switch and Manual Transfer switch shall be rated at 1.2 of the UPS system rating.

For calculating the rating of Inverter unit and FR-FC unit, VR, Static Transfer Switch, Manual Transfer Switch, the guidelines given in Annexure 3 may be referred .

Continued on next page

Continued ……

a) FR-FC in Auto Float Mode (Clause 1.2.4.6.1) :

a) Half Load output voltage set at (2.25V * Number of cells) : Volts
b) Output voltage settability 2.1 * Number of cells to 2.33 * Number of cells.) : Volts

AC Input									DC Output				
Voltage (V)	Current (A)			Power (W)	True P.F.	SW Freq.(Hz)			Current (A)		O/P Voltage (V)	Ripple Peak-to-Peak mV)	Efficiency (%)
	R	Y	B			R	Y	B	Actual	%			
320/90V										25 50 100			
400V/ 230V (nom)										25 50 100			
480/300V										25 50 100			
Unba-Lance +10%										25 50 100			
Unba-Lance -10%										25 50 100			

Note :1. In case of single phase use only one column from R, Y & B.
2. Single phase and Three phase UPS system shall be configured by single phase and three phase UPS unit only at both UPS unit as well as rack level.
3. Starting of UPS without battery supply : There shall be provision to start the UPS unit without battery supply.

b) FR-FC in Auto Charge Mode (Clause 1.2.4.6.2) :

a) Half load voltage set at (2.3V/cell) : Volts
b) Output voltage settability 2.01 * Number of cells to 2.40 * Number of cells.) : Volts

AC Input									DC Output						
Voltage (V)	Current (A)			Power (W)	load P.F.	SW Freq.(Hz)			Current (A) Actual				O/P Voltage (V)	Ripple peak-to-Peak (mV)	Efficiency (%)
	R	Y	B			R	Y	B	R	Y	B	%			
320/90V												25 50 100			
400V/ 230V (nom)												25 50 100			
480/300V												25 50 100			
Unba-Lance +10%												25 50 100			
Unba-Lance -10%												25 50 100			

Note : 1. In case of single phase use only one column from R, Y & B.
2. Single phase and Three phase UPS system shall be configured by single phase and three phase UPS unit only at both UPS unit as well as rack level.
3. Starting of UPS without battery supply : There shall be provision to start the UPS unit without battery supply.

c) Frequency Tolerance (Clause 1.2.4.5) :

AC Input						DC Output						
Frequency (Hz)	Current (A)			Power (W)	Load P.F.	Current (A) Actual				O/P Voltage (V)	Ripple Peak to-Peak (mV)	Efficiency (%)
	R	Y	B			R	Y	B	%			
FR-FC in Auto Float Mode :												
48									25 50 100			
50									25 50 100			
52									25 50 100			
FR-FC auto Charge Mode :												
48									25 50 100			
50									25 50 100			
52									25 50 100			

Note : 1. At DG set all the parameters tested as per above sheet shall be within limit.
2. The nominal input frequency is 50Hz which may vary from 48-52Hz.

Test No. 15

Battery Monitoring :

a) Battery Under Voltage Isolation (Clause 1.2.4.15.1) :

CONDITION	Battery Cut -Off		Battery Reconnect		REMARKS
	Required (V)	Observed (V)	REQUIRED (V)	OBSERVED (V)	
Bty Total Discharged (BTD)	(shall be settable between 1.75V to 1.9V/cell)		When the FR/FC Voltage has buit-up fully. Shall be Settable between 2.15V to 2.35V/cell		

Note : 1. In above case battery isolation alarm shall be created.
2. Only the single pole DC contactor shall be used.

b) Battery Health Monitoring In Auto Mode (Clause 1.2.4.6 & 1.2.4.15.2)

Start Mode Test :

Switch-ON the Unit/System & Observe the O/P Voltage : V (Shall always be Float voltage)

Mode Change over :

i) As per manufacturer's design change the battery path : V (shall change over
current or voltage & observe O/P voltage to charge voltage)

Remarks :

i) Set the battery path current or voltage as per : V (shall change back
manufacturer's manual and observe O/P voltage to float voltage)

Remarks :

c) Battery Current Limiting (Clause 1.2.4.15.4) :

S. No.	Battery path current (Amps)	Requirements	Observation	Remarks
1.	Increase battery path current to set limit slowly	It shall increase Gradually		
2.	Increase Battery load further	It shall not Increase beyond Set limit.		

Battery path Current limit settability :
Battery path current is settable between % & %

The current in each battery path shall be settable as per the battery capacity so that the battery path

current is kept to 10% to 20% of battery AH capacity. Tendering Authority will give the capacity of the battery to be used for this purpose. For the type approval the manufacturer shall demonstrate the facility & undertake to make provision as per order.

d) Battery Health Check (Clause 1.2.4.15.3) :

S. No.	Battery Health Check	Requirements	Observation /Remarks
1.	Battery health check feature hardware equipment etc required for the purpose shall be provided to have the provision of :	1. Mmonitor the voltage, current, trickle current and temperature (programmable) of the batteries associated with the UPS system at a set periodicity. 2. Monitoring of each cells of the battery bank for voltage and temperature. 3. Conduct a partial discharge (about 20%) test, of a pre-determined duration and frequency, shall be made available in the power plant (Frequency and duration of partial discharge test shall be programmable). During this test, the current and voltage of the battery as well as each individual cell shall be recorded. 4. It shall also record the temperature of each cell. 5.Any abnormality observed during above observations shall be highlighted by initiating an alarm. 6. All the above information shall be made available to the remote site through RS 485(Refer Annexure 4 for specified protocol). Also refer test No. 39. **Note : All the above readings shall be recorded and verify & ensure the compliance of the clause.**	

Note : 1. There shall be a provision of monitoring the voltage, current, trickle current and temperature (programmable) of the batteries associated with the power plant at a set periodicity. There shall also be a provision of monitoring of each cells of the battery bank for voltage and temperature.

2. The provision for conducting a partial discharge (about 20%) test of a pre-determined duration and frequency, shall be made available in the power plant (Frequency and duration of partial test discharge shall be programmable). During this test, the current and voltage of the battery as well as each individual cell shall be recorded. It shall also record the temperature of each cell.

3. The provision of partial test discharge shall be implemented in such a way that at a time only one battery is put to discharge, so as to ensure that necessary battery reserve is available in case of power failure during or immediately after the test discharge. Provision shall be made for observing the state of charge of battery before commencing this test. In case the battery is not fully charged this test may be deferred till the battery is fully recouped.

4. Any abnormality observed during above observations shall be highlighted by initiating an alarm. All the above information shall be made available to the remote site through RS 485(Refer Annexure 1 for specified protocol).

5. The Battery Health Check feature shall be optional. However, type approval shall only be accorded with the above provision. The manufacturer will give the list of hardware equipment required for the purpose in the instruction and maintenance manual. User shall clearly indicate the requirement of battery health check feature while ordering the power plant. The manufacturer shall also undertake that the above provision will become fully function by adding the hard ware (indicated in the instruction manual) for the purpose.

Test No. 16

Temperature Compensation for the Battery (Clause No. 1.2.4.15.5) :

a) In Auto Float Mode of Operation

Float Voltage set at : V (2.25V/cell)

Temp. sensed (deg C)	System O/P Voltage	Change in Voltage

b) In Auto Charge Mode of Operation :

Output Voltage set at : V (2.30V/cell)

Temp. sensed (deg C)	System O/P Voltage	Change in Voltage

Limit : The output voltage of the rectifier in Float/Charge operation shall decrease or increase at the rate of 3mV/cell per degree increase or decrease in temperature over the set voltage. The output voltage shall decrease till the open circuit voltage of the battery is reached. The open circuit voltage range shall be settable between 2.1V/cell to 2.2V/cell. When the output voltage reaches 2.33V/cell due to the increase in output voltage owing to decrease in temperature, it shall get locked at this voltage & any further decrease in temperature shall not lead to further rise in the output voltage of the FR-FC. A tolerance of +/-5mV may be acceptable over the specified rate of 3mV/cell/deg C. The nominal distance between the battery & power plant may be 20 metres. The manufacturer shall provide the necessary sensor and card for purpose with the UPS. Failure of temperature compensation circuit including sensors shall create an alarm and shall not lead to abnormal change in output voltage. Proper sign-writing shall be made in DSCA and both end of temperature compensation card for its easy termination

INVERTER UNIT :

Test No. 17

Transient Response :

a) Switch on /Soft Start Test (Clause 1.2.5.7.7,1.2.5.11 &1.2.5.12)

		On no Load	On 50% load	On Full Load
		Inverter unit	Inverter unit	Inverter unit
i) Build up time	S		S	S
ii) Over/Under shoot	%		%	%
iii) Stabilising time	ms		ms	ms
iv) Inrush Current	A		A	A
v) Crest Factor Inrush current/ Steady state current				

b) Voltage Overshoot/Undershoot (Clause 1.2.5.11 & 1.2.5.12) :

Step change in Input Voltage from X to Y (As applicable) : 1.75V/cell to 2.33V/cell & Vice Versa

		At 10% Load	At 100% Load
		Inverter unit/ module	Inverter unit/ module
X to Y			
i) Over/Under shoot	%		%
ii) Stabilising time	ms		ms
Y to X			
i) Over/Under shoot	%		%
ii) Stabilising time	ms		ms

c) For Step Change in Load at Nominal Input 2V/cell (Clause 1.2.5.11 & 1.2.5.12) :

		From 10% to100% (rated load)	From 100% to 10%(rated load)
		Inverter unit/ module	Inverter unit / module
i) Over/Under shoot	%		%
Ii) Stabilising time	ms		ms

Limits: 1.The Inverter shall be capable of delivering a continuous uninterrupted single phase sine wave full output power as per its rating at 230V/50Hz AC in case of 0.5 KVA, 1KVA, 2KVA, 3KVA & 4 KVA UPS unit and 400/50Hz AC in case of three phase sine- wave full output power as per its rating in case of higher ratings at any power factor from 0.7 lead to 0.7 lag..

2.It shall be possible to start the unit on no load or any load up to full load. On energisation, the output built up gradually within 5 seconds.

3.The maximum instantaneous current during start up shall not exceed the peak value of inverter input current at full load for the lowest input voltage specified. The voltage shall not dip more than 20% of its set value without battery at the input.

4. The UPS system shall be capable of handling crest factor of 3.5 times the study state for period of 40ms.

5. The transient overshoot shall not exceed 10% with battery floated under switch on, step change and load change from 100% to 10% and vise versa (Clause 1.2.5.7.7).

6. For test purposes, the transient Overshoot/Undershoot at the output can be up to 30% when the battery not floated at the input, provided it is restored within the limit of 10% under the two cycles(40ms) and regulating range within 100ms.

7.The inverter shall not have any tendency to hunt under any input and output condition (Clause 1.2.5.14).

8. **Inrush Current** : It shall be possible to start the unit on no load or any load up to full load. Maximum instantaneous current during start-up shall not exceed the peak value of inverter input current at full load for the lowest input voltage specified.

Note : a) The above conditions shall be met without battery floated.
b) Necessary graph shall also be provided for ready reference.

Test No. 18

Total Harmonic Distortion : ;

a) Total Voltage harmonic Distortion (Clause 1.2.5.13.1 & 1.2.5.5.2)

I/P Voltage(V)		Output Voltage (V)	O/P Current(A)		% Voltage Distortion		
Unit	Unit ON		Actual	%	At PF		
					Unity	08 Lagging	0.8 Leading
OFF	Inverter unit/ module		Inverter unit/ module		Inverter unit/ module	Inverter unit/ module	Inverter unit/ module
1.75V/cell				25 50 100			
2.0V/cell				25 50 100			
2.25V/cell				25 50 100			
2.30V/cell				25 50 100			

Limits :1.The Total Current Harmonic Distortion contributed by the Inverter unit at the output shall not exceed 3% in conformity with CIGRE's limits.

2. The Static Transfer switch shall not add any distortion to the output

Test No. 19

Power Factor Test (Clause 1.2.5.10) :

Condition	Procedure	Requirements	Observation/ Remarks
Power Factor Test without Pf Improvement Capacitors	Set the Input Voltage at : 2.25V/cell Set the Output Voltage at : 230V / 400V Connect the full rated resistive load Read & record the PF at AC Output	Out PF shall be near unity	

Test No. 20

Overload/Short Circuit Test (Clause 1.2.5.7.7) :

DC input Voltage	Load				Output Voltage (V)			% of change in Output Voltage			Inverter/system trips in (mts Hr)	Observation/Remarks
	Actual			%								
	R	Y	B		R	Y	B	R	Y	B		
1.75V/cell				100% 105% 110% >110% 150% >150% Short cct Crest Factor								
2.15V/cell				100% 105% 110% >110% 150% >150% Short cct. Crest Factor.								
2.25V/cell				100% 105% 110% >110% 150% >150% Short cct. Crest Factor								
2.35V/cell				100% 105% 110% >110% 150% >150% short cct. Crest Factor								

Limits: 1. The Inverter/system shall be capable of taking 110% of its full rated load for one hour without any damaged or overheating of the components.

2. While taking 110% overload the output voltage shall remain within the specified limits.

3. Inverter/system shall also be capable of withstanding an overload of 150% for one minute.

3. In case of short circuit or overload of 150% for more than 1 minute at the output, the inverter/system shall shutdown and create over load alarm. Rrestore only when the load is within specified limits.

4. UPS shall be capable of handling load crest factor of 3.5 times the steady state value for 40ms (two cycles).

Note : In case of single phase use only one column from R, Y & B.

Test No. 21

Reverse Polarity at the Input (Clause 1.2.5.7.1) :

Condition	Requirement	Observation/ Remarks
Reverse Polarity at the Input	i) There shall not be any damage to the components of the Inverter , battery and load in case the Input polarity is reversed. (Unit should trip and shall not be any damaged to the components of the Inverter, Battery and Load). ii) The unit shall start its normal functioning when the correct polarity is restored.	

Note : In above case alarm & indication shall be created.

Test No. 22

Regulation Tests :

Specification Requirements (Limits) :

a) Switching Frequency (Clause 1.2.5.1) : The inverter shall be based on Switch Mode Power Supply (SMPS) techniques. using switching frequencies of 20KHz and above.

b) Inverter Input Operating Range (Clause 1.2.5.2) : The Inverter of the UPS unit shall operate without any degradation between the voltage range between 2.33 X Number of cells in the battery and 1.75 X number of the cell in the battery.

c) Output (Clause 1.2.5.9) : The inverter shall be capable of delivering a continuous uninterrupted single phase sine wave full output power as per its rating, at 230V/50Hz AC in case of 0.5KVA, 1KVA, 2KVA, 3 KVA and 4 KVA UPS unit and 400V/50Hz three phase sine-wave full output power as per its rating in case of Higher ratings, at any power factor from 0.7 lagging to 0.7 leading. On energisation, the output shall build up gradually within 5 seconds

1. Clause 1.2.5.9.1 : The output of the inverter shall be continuously settable at any value between 210 to 230V in case of single phase unit and 400V +/- 10V in case of three phase inverter units. It shall be maintained within +/-2% of the set value for :
   a) Input voltage variations in the range as specified in clause above.
   b) Load current variations from Zero to 100% (full load).
   c) Load power factor variations from 0.7 lagging to 0.7 leading.

2. Clause 1.2.5.9.2 : The output voltage shall be free of modulation and hunting.

d) Frequency (Clause1.2.5.9.3) : To get the stabilised frequency the crystal oscillators shall only be used. The frequency of the output voltage shall be remain within 50 +/- 0.5 Hz for all specified conditions of the GR.

d**) Peak-to-Peak Ripple Voltage (C1ause 1.2.4.11) .Limits:** Peak to peak ripple imposed on DC voltage, without battery connected, but full load Inverter being fed by it. shall not exceed 1% of the DC voltage at the Switching Frequency measured by an Oscilloscope of 50/60 MHz band-width (Typical).

e) Efficiency (Clause1.2.4.7) . Limits : The efficiency of the UPS unit while working on FR-FC and Inverter shall be as given below :

	Units working on	
	Single phase AC	**Three phase AC**
i) At all AC input, output, Specified DC range (1.85V to 2.3V/cell) and load between 25% to 100%	: better than 90%	better than 92%

f) Power Factor (Clause 1.2.5.10) : The power Factor with resistive load and at nominal input shall be near unity without the use of Power Factor improvement capacitors.

g) **Input Switch over (Clause 1.2.5.3) : The switch-over to battery and vice versa shall not cause any interruption to the inverter output AC power.**

h) Static Transfer Switch (Clause 2.7.1.3) : CACT approved Static Transfer Switch, capable of handling 120% of the rated system capacity in compliance of Note 3 of clause 1.1.4 and clause 1.2.5.5.

i) Manual Transfer Switch (Clause 2.7.1.3.1) : CACT approved Manual Transfer Switch, capable of handling 120% of the rated system capacity in compliance of Note 3 of clause 1,.1.4 shall be used.

Output voltage Settable at any value between : 210V to 230V for single phase and 400V + /- 10V for three phase : Yes/ No

Continued on next page

a) At PF unity (Clause 1.2.5.9.1,1.2.4.7) :

1.Switch on the Inverter at No load **: Starts/ Does not start.**
2.Switch on the Inverter at 100% load **: Starts/ Does not start**
3. Set the output voltage at Half load & input 2.25V/cell

DC Input Voltage			AC output Voltage					
Input Voltage (V)	Input Current (A)	Input Power (W)	Current (A) Actual	Current (A) %	Output Voltage (V)	Output Power (W)	Frequency (F)	Efficiency (%)
1.75V/cell				25 50 100	210V			
				25 50 100	230V			
2.15V/cell				25 50 100	210V			
				25 50 100	230V			
2.25V/cell				25 50 100	210V			
				25 50 100	230V			
2.3V/cell				25 50 100	210V			
				25 50 100	230V			
2.35V/cell				25 50 100	210V			
				25 50 100	230V			
2.40V/cell				25 50 100	210V			
				25 50 100	230V			

b) AT 0.8 PF Lagging (Clause 1.2.5.9.1,1.2.4.7) :

1.Switch on the Inverter at No load **: Starts/ Does not start** .
2.Switch on the Inverter at 100% load **: Starts/ Does not start**
3. Set the output voltage at Half load & input 2.25V/cell

Dc Input Voltage			AC output Voltage					
Input Voltage (V)	Input Current (A)	Input Power (W)	Current (A) Actual	Current (A) %	Output Voltage (V)	Output Power (W)	Frequency (F)	Efficiency (%)
1.75V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.15V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.25V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.3V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.35V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.40V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			

c) AT 0.8 PF Leading (Clause 1.2.5.9.1,1.2.4.7) :

1.Switch on the Inverter at No load **: Starts/ Does not start .**
2.Switch on the Inverter at 100% load **: Starts/ Does not start**
3. Set the output voltage at Half load & input 2.25V/cell

DC Input Voltage			AC output Voltage					
Input Voltage (V)	Input Current (A)	Input Power (W)	Current (A) Actual	Current (A) %	Output Voltage (V)	Output Power (W)	Frequency (F)	Efficiency (%)
1.75V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.15V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.25V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.3V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.35V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.40V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			

Note : Setting of all the parameters shall be through menu-driven microprocessor control only. Use of potentiometer at any stage is precluded.

Test No 23

Load Sharing clause 1.1.2.3, 1.2.4.16.4,1.2.5.6 &1.2.5.6.1

a) Load Sharing Under Different Input Conditions :

Input Voltage	Total load (Amps)		UPS-1						UPS -2						UPS - n						% of Unbalance (max.)
			Voltage			Current			Voltage			Current			Voltage			Current			
	Actual	%	R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B	
320V 90V		50 100																			
400/230V (nom)		50 100																			
480/300V		50 100																			
Unbalance -10% nom.		50 100																			
Unbalance +10% nom		50 100																			

Remark : Maximum unbalance in load sharing is %.

% of Unbalance = (Unbalance in load/Average load per unit) X 100

Note : It shall be less than 10%.

Note : In case of single phase use only one column from R, Y & B.

b) Load Sharing on Failure of any Unit (Clause 1.2.4.16.4) : Shutting-off of faulty UPS unit shall not affect the operation of other UPS units.

S.No.	Condition	Total load (Amps)	UPS-1						UPS-2						UPS-n						% of Unbalance (max.)
			Voltage			Current			Voltage			Current			Voltage			Current			
			R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B	
1.	Before failure of any unit: *Condition-1 *Condition-2																				
2.	ON failure of Inverter-1 Condition-1 Condition-2																				
3.	ON failure of Inverter-n Condition-1 Condition-1																				

Note : In case of single phase use only one column from R, Y & B.

* Condition-1 : When the shutting down of unit does not leads to overload condition for the remaining units.
* Condition-2 : When the shutting down of unit leads to overload condition for the remaining units.

Remarks : Condition-1 : On failure of any unit other units shall share the load with in the limits of +/- 10%.

Condition-2 : On failure of any unit, since load is more than rated capacity of individual unit, the units shall come on current limit without any problem.

C) Load Sharing on failure of Micro processor or DSCA unit (Clause 1.1.3.3)

S.No.	Condition	Total load (Amps)	UPS -1						UPS-2						UPS -n						% of Unbalance (max.)
			Voltage			Current			Voltage			Current			Voltage			Current			
			R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B	
1.	Before failure of Microprocessor or DSCA unit																				
2.	ON failure of Microprocessor or DSCA unit																				

Remark : Maximum unbalance in load sharing is %.

% of Unbalance = (Unbalance in load/Average load per unit) X 100

Note : 1. In the event of failure of DSCA, UPS -Inverter unit parameter shall not be disturbed. All the UPS- Inverter unit shall take care of the load on default settings and share the load collectively with in the limits of +/-10%.

Note : In case of single phase use only one column from R, Y & B.

d) Load Sharing On Mains Restoration :

S. No.	Condition	Total load (Amps)	UPS -1						UPS-2						UPS -n						% of Unbalance (max.)
			Voltage			Current			Voltage			Current			Voltage			Current			
			R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B	
1.	Before Input Supply failure																				
2.	ON Input Supply failure																				
3.	ON input Supply restoration																				

Note : There shall be no change in the value before and after Input Supply failure.
Note : In case of single phase use only one column from R, Y & B.

Test No 24

Protection and Alarm : (Clause 1.2.5.7, 1.2.5.7.1, 1.2.5.7.2,1.2.5.7.3, 1.2.5.7.4, 1.2.5.7.5, 1.2.5.7.6,1.2.5.7.7, 1.2.5.7.8, 1.2.5.8, 1.2.5.8.1) :
On Inverter unit :

S. No.	Alarm Description	Alarm Condition	Indication		Extension of Indication to DSCA unit	Remarks
			Visual	Audio		
1.	Reverse Polarity at the input	There shall not be any damage to the components of the inverter battery and load in case the DC polarity is reversed & the unit shall start its normal functioning when the correct polarity is restored.				
2.	Input Under voltage	Trip : Below the set value Settable between 1.75V/cell to 1.9V/cell with normal setting at 1.85V/cell. Reconnect : Higher than 2V/cell Shall be automatically				
3.	Input DC Over voltage	Trip Beyond 2.5V/cell Reconnect : Lower than 2.3V/cell Shall be automatically				
4.	Output Voltage High	Voltage exceeding more 10% over the set output voltage for more than 1 second due to any reason. Inverter shall be automatically get switched off or disconnected.				
5.	Output Voltage Low	In the event of output voltage goes below 10% of the set output voltage for more than 1 second, due to any reason, Inverter should trip				
6.	Output Frequency out of range	Beyond 2Hz of the nominal 50Hz. Inverter should trip				
7.	Overload	The inverter shall be capable of taking 110% of its full rated load for one hour without any damage or overheating of the components. While taking 110% overload, the output voltage shall remain within the specified limits. Inverter shall also be capable of withstanding an overload of 150% for one minute. The over load condition shall also create inverter over load alarm. If the over load of 150% persists for more than 1minute the inverter shall trip creating inverter fail alarm. In case of short circuit or overload of 150%, the inverter shall shutdown instantly, creating “inverter fail” alarm at DSCA. In all the above cases it shall restore only when the load is within specified limits. Over load at system level shall also create “ system over load alarm ”. The UPS system shall be capable of handling Crest Factor of 3.5 times the steady state for period of 40ms (two cycles) .				

S. No.	Alarm Description	Alarm Condition	Indication		Extension of Indication to DSCA unit	Remarks
8.	UPS Fan fail (in case fan provided)	Fan not working				
9.	Surge & transients	Check the necessary protection circuit against Surge & Transients				
10.	Voltage protections for manual safety	The DC voltages shall be as per manufacturers design. All the protections for manual safety shall be provided as per the latest IEC UL standards for the purpose. The battery shall remain floated across the DC FR-FC unit output and Inverter input.				
11.	positive terminal	The positive terminal of the input shall be taken as earthed.				

VOLTAGE REGULATOR (VR) :

Test No. 25

Output Voltage Satiability (Clause 1.2.6.6) :

Condition	Product Requirement	Satiability	Observation/Remarks
Output Voltage satiability	The output voltage shall be maintained within 2% of the set nominal output voltage (220V +/- 2% or 230V +/- 2%) in case of single phase unit and & output voltage (400V +/- 10) in three phase systems at all loads from 25 to 100%, and PF between 0.7 lead and l0.7ag. Output voltage shall be settable between 210V and 230V in case of single units and 390V to 410 in case of the 3 phase systems.	V & V	

Test No. 26

Over Load and Short Circuit Test (Clause 1.2.6.14)

Condition	Product	Requirement	Observation/Remarks
Over Load and Short Current	**a.** Switch 'ON ' the unit & Short the output	Current flowing shall be limited to certain limit to avoid damage to the components.	
	b. Remove the short circuit	Unit shall come to normal operation without any degradation in its performance (Healthy state).	

Note : The rating of VR unit, wherever required shall be as per the rating of UPS (Clause 1.1.3.4).

Test No. 27

Transient Response :

a) Voltage Overshoot/Undershoot (Clause 1.2.6.9) :

i) Step change in Input Voltage from X to Y (As applicable)

a) Single phase : 90V to 300V & Vice Versa

b) Three phase : 320V to 480V & Vice Versa

	At 25% Load	At 100% Load
	Voltage regulator unit	Voltage Regulator unit
X to Y		
i) Over/Under shoot	%	%
ii) Stabilising time	ms	ms
Y to X		
i) Over/Under shoot	%	%
ii) Stabilising time	ms	ms

ii) For Step Change in Load at Nominal Input 230V (single phase)/ 400V(Three phase):

	From 25% to100% (rated load)	From 100% to 25%(rated load)
	Voltage regulator unit	Voltage regulator unit
i) Over/Under shoot	%	%
Ii) Stabilising time	ms	ms

Limits : 1.The transient Overshoot/Undershoot at the output can be up to +/- 5% of the set value within 50 ms provided it is restored within the specified regulating range within 250ms in all the above cases.

2. The VR shall not have any tendency to hunt under any input and output condition.

Note : Necessary graph shall also be provided for ready reference.

Test No. 28

Regulation Tests : Specification Requirements (Limits) :

a) Clause 1.2.6.5) : VR shall be designed for continuous operation at any load from no load to full load.
b) Clause 1.2.6.6 : 1. The output voltage shall be maintained at nominal value of 220V + 2%in case of single phase and 400V +/- 2% in case of three phase systems at all load from 25% to 100%.
c) Clause 1.2.6.8 : The VR shall work satisfactorily for input range 90V to 300V of 50 Hz in case of single phase units & 320v to 480V in case of three phase units respectively without degradation in its performance.
d) Clause 1.2.6.10 : The full load efficiency of the VR shall not be less than 90% for input voltage 230V and an output voltage of 230V AC in case of single phase and 400V input and output in case of three phase and load power factor 0.7 lead to 0.7 lag. It shall also not be less than 85% for other input and Load between 25% to 100% and power factor between 0.7 lagging and 0.7 leading.
e) Clause 1.2.6.11 : Total line Voltage Harmonic Distortion at the input shall be less than 10%.
f) Clause 1.2.6.12 : Total Current Harmonic Distortion shall be less than 5% for load 25% to 100% under all working conditions.
g) Clause 1..2.6.13 : The VR shall be capable of handling any load from unity PF to 0.7 lad to 0.7 lead without degradation in THD as specified in clause. The voltage shall remain within +/- 5% for the change in the PF from unity to 0.7 lag to 0.7 lead.

Note : 1. The rating of VR unit, wherever required shall be as per the rating of UPS (Clause 1.1.3.4).
2. The VR provided shall be capable of providing regulated AC to the load. VR for single phase UPS System shall be single phase and three phase UPS Systems shall be three phase (Clause 1.2.6.1).
3. Output voltage Settable at any value between : 210V to 230V for single phase and 400V +/- 10V : Yes/ No
4. The VR is natural air cooled & shall be in conforming of ensuring clauses of the GR(Clause 1.2.6.2).

Note : Testing officer shall test on all the above output voltages.

AC Input							AC Output								
Voltage (V)	Current (A)			Power (W)	THD (A)	Load PF	Current (A)				Voltage	Power (W)	Ripple Peak-to-Peak mV)	THD (V)	Efficiency %
	R	Y	B				%	Actual							
								R	Y	B					
90/ 320V						0.7 lag	0								
						unity	0								
						0.7 lead	0								
						0.7 lag	25								
						unity	25								
						0.7 lead	25								
						0.7 lag	50								
						unity	50								
						0.7 lead	50								
						0.7 lag	100								
						unity	100								
						0.7 lead	100								
230/400V (Nom)						0.7 lag	0								
						unity	0								
						0.7 lead	0								
						0.7 lag	25								
						unity	25								
						0.7 lead	25								
						0.7 lag	50								
						unity	50								
						0.7 lead	50								
						0.7 lag	100								
						unity	100								
						0.7 lead	100								
300/480V						0.7 lag	0								
						unity	0								
						0.7 lead	0								
						0.7 lag	25								
						unity	25								
						0.7 lead	25								

Continued on next page

Continued ……

AC Input							AC Output								
Voltage (V)	Current (A)			Power (W)	THD (A)	Load PF	Current (A)				Voltage	Power (W)	Ripple Peak-to-Peak mV)	THD (V)	Efficiency (%)
	R	Y	B				%	Actual							
								R	Y	B					
						0.7 lag	50								
						unity	50								
						0.7 lead	50								
						0.7 lag	100								
						unity	100								
						0.7 lead	100								
Phase Unbalance + 10%						0.7 lag	0								
						unity	0								
						0.7 lead	0								
						0.7 lag	25								
						unity	25								
						0.7 lead	25								
						0.7 lag	50								
						unity	50								
						0.7 lead	50								
						0.7 lag	100								
						unity	100								
						0.7 lead	100								
Phase Unbalance - 10%						0.7 lag	0								
						unity	0								
						0.7 lead	0								
						0.7 lag	25								
						unity	25								
						0.7 lead	25								
						0.7 lag	50								
						unity	50								
						0.7 lead	50								
						0.7 lag	100								
						unity	100								
						0.7 lead	100								

Note : In case of single phase use only one column from R, Y & B.

Note : 1. The rating of VR unit, wherever required shall be as per the rating of UPS (Clause 1.1.3.4).

2. The VR provided shall be capable of providing regulated AC to the load. VR for single phase UPS System shall be single phase and three phase UPS Systems shall be three phase (Clause 1.2.6.1).

3. The VR is natural air cooled & shall be in conforming of ensuring clauses of the GR (Clause 1.2.6.2).

Test No 29

a) Voltage variation against change in frequency (Clause 1.2.6.7)

Output voltage Settable at any value between : 210V to 230V for single phase and 400V +/- 10V : Yes/ No

Note : Testing officer shall test on all the above output voltages.

Frequency Hzs	Input Voltage (V)	Input Current (A)	Output Current (A)		Output Voltage (V)	Output Frequency (F)
			Actual	%		
49	90/320V			25 100		
	230/400V			25 100		
	300/480V			25 100		
49.5	90/320V			25 100		
	230/400V			25 100		
	300/480V			25 100		
50	90/320V			25 100		
	230/400V			25 00		
	300/480V			25 00		
50.5	90/320V			25 100		
	230/400V			25 100		
	300/480V			25 100		
51	90/320V			25 100		
	230/400V			25 100		
	300/480V			25 100		

Note : 1. At DG set all the parameters tested as per above sheet shall be within limits.

2. The regulator shall work satisfactorily within supply frequency of 50 Hz +/- 2%. For every 1% variation in frequency, up to 1.5% change in output voltage is permissible.

Test No 30

Burn-in (Clause 1.2.1.2) :

The complete UPS unit/ System with a Static Transfer Switch, Manual Transfer Switch & VR, shall be capable of withstanding a burn-in test for 72 hours at an ambient temperature of 50°C when the equipment is working at full rated load. This test may be performed in a temperature controlled room with free air flow. The ambient temperature shall be measured at a distance of 1 foot from the equipment under test. The necessary set-up for the purpose shall be provided by the manufacturer.

The temperature rise of the heat dissipating components above the ambient measured directly or at heat sink in the first eight hours of the test shall not be more than :

a) Transformers and Chokes : 70 deg C for Grade B insulation.
For higher grade of insulation, higher temperature rise may be permissible subject to the following conditions :
i) It is at least 20 deg C below the permissible limit for the grade of Insulation used.
ii) The temperature rise shall be at least 30 deg C below Curie temperature of the magnetic material.
iii) This temperature shall neither affect the other components nor shall lead to fire hazard.

b) Transistors/diodes/FETs etc. : 60 deg C or as per component spec

a) Heat Run Test (First 8 hours) :

Complete UPS unit with a Static Transfer Switch, Manual Transfer Switch & VR .

i) UPS Unit/ System :
ii) Static Transfer Switch :
iii) Manual Transfer Switch :
iv) Voltage Regulator :

1) Unit Model & Sr. No.: 4) Unit Switched ON :
2) Output Rating : 5) Unit Switched OFF:
3) Input Voltage :

	UPS											STATIC TRANSFER SWITCH										
Reading->	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6	7	8	9	10	11
Recording Time ->																						
Temp. Ambient-> (Outside)																						
Inside ->																						
Component																						

Continued on next page

Continued ……

1) Unit Model & Sr. No.: 3) Input Voltage : 5) Unit Switched OFF :
2) Output Rating : 4) Unit Switched ON :

	VR											**MANUAL TRANSFER SWITCH**										
Reading->	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6	7	8	9	10	11
Recording Time ->																						
Temp. Ambient-> (Outside)																						
Inside ->																						
Component																						

Note 1 : The unit under test shall be subjected to Heat run for 8 hours at full load.
2 : All temperature readings shall be recorded in deg. C.
3 : Reading are to be recorded at an hourly interval for first 5 hours & after every half an hour afterwards till end.

b) Burn-in Test (Remaining 64 hours)

a) This test shall be conducted at 100% load at nominal input.
b) No failure of any component during the burn-in-test of 72 hrs
c) All the component's temperature shall remain well within limits.
d) Performance tests such as regulations, input power factor, efficiency, peak to peak ripple, voltage droop,
Short Circuit, Load sharing, Indications & alarms & Alarm settings etc shall be repeated after bringing the unit/ system to ambient & shall meet all the requirements of the GR.

Observations :

Date/time of test start :
Date/time of test end :

S.No.	DATE	TIME	Output of Units					
			UPS		STS & MTS		VR	
			Voltage	Current	Voltage	Current	Voltage	Current

c) Temperature Rise On Critical Components During Burn-in-Test

Date->								
Time ->	M/E	M/E	M/E	M/E	M/E	M/E	M/E	M/E
	UPS	UPS	STS	STS	MTS	MTS	VR	VR
Temp. Ambient Outside->								
Inside ->								
Component								

Test No. 31

Protocol or Sequence of Exchange of Information between power plant & its peripheries(UPS system) & Remote Site Monitoring equipment.

RS 485 (4 wire) interface at speed 19.2Kbps (minimum) shall be used for both monitoring & control between inverter systems and other associated equipment (UPS) and Remote site (First level) of monitoring & control. The protocol shall be as given below ;

- First four bytes as starting or hand shake bites (includes identifications etc.)
- 5th Byte for equipment Identification (Power plant , battery, Inverter etc.)
- 6th Byte for Class of parameter (Alarms urgent, alarms non-urgent, Monitoring etc.)
- 7th , 8th and 9th Bytes for the parameter observation/medications :

  Equipment side will along with parameter code same that on Master side along with desired information.

- 10th and 11th for checksum for parity on both sides in communication.

The exchange of information between the Remote site controller and the power equipment shall on 4 wire RS 485 bus. All the eleven bytes shall be sent as a packet for exchange of information.

In this concept Remote site equipment shall work as a Master and power equipment as slave in the Master slave concept. In this concept :

- The master will send all the above 11 bytes containing the information for each byte as given above..
- UPS after verify the correctness of the data will send back the desired information in the same pattern as given above with bytes 7 to 9 shall contain the desired information and 10th 11th the checksum number.
- In case of mismatch, UPS or remote controller will send a fixed anomaly signal.
- On receipt of mismatch the previous data will again be offered by the concerned end.
- In case of acknowledgement (desired information or next information) the concerned end will put-up the next information.

Each byte information in HEX shall be as detailed below :

5th Byte : Equipment Designation

Equipment Designation	Hex Code		Observation/Remarks
	From Master	From Slave Equipment	
Power Plant s(AC-DC Converters) (sixteen Max.)	00 to 0F	00 to 0F	
Battery Bank (Maximum sixteen)	10 to 1F	10 to 1F	
Inverter Systems (Max Sixteen)	20 to 2F	20 to 2F	
UPS System (Max Sixteen)	30 to 3F	30 to 3F	
SPV System(Max Sixteen)	40 to 4F	40 to 4F	
DG Set (Max Sixteen)	50 to 5F	50 to 5F	
Air conditioning group (Max Sixteen)	60 to 6F	60 to 6F	
Fire Alarm Group ((Max. Sixteen)	70 to 7F	70 to 7F	
Security Group (Max Sixteen)	80 to 8F	80 to 8F	
Flood Group (Max Sixteen)	90 to 9F	90 to 9F	
Any other equipment	A0 to FF	A0 to FF	

6th Byte : Classification of Information

Class of Parameter	Hex Code		Observation/Remarks
	From Master	From Slave Equipment	
Alarms Urgent	01	01	
Alarms Non-urgent	02	02	
Monitoring of Parameters	03	03	
Parameter Control	04	04	
System Details	05	05	
Any other information	06 to FF	06 to FF	

7th to 9th Byte : Parameter name :

UPS Systems (5th Byte 30 to 3F)

i) Alarms Urgent (6th Byte : 01)

Parameter Name	Hex Code		Observation/Remarks
	From Master	From Slave Equipment	
Mains "ON"/Battery Discharging - Any reason for failure of Charger unit of UPS to deliver the output (including AC input contactor failure)	01, 00, 00	01, 01, 00 : OK 01, 02, 00 : FAULT	
Battery Fail OR No Battery –Battery	02, 00, 00	02, 01, 00 : OK 02, 02, 00 : FAULT	
System Over Load	Same sequence	Same sequence	
FR/FC unit Voltage High	Same sequence	Same sequence	
FR/FC unit Voltage Low	Same sequence	Same sequence	
Fan Fail – Rack	Same sequence	Same sequence	
Temp. Compensation fail –Battery	Same sequence	Same sequence	
Inverter System Over Load	Same sequence	Same sequence	
Load Voltage High	Same sequence	Same sequence	
Load Voltage Low	Same sequence	Same sequence	
Unit Input Voltage High	Same sequence	Same sequence	
Unit Input Voltage Low	Same sequence	Same sequence	
Inverter Frequency Out of Range	Same sequence	Same sequence	
Any other Alarm condition	Same sequence	Same sequence	

ii) Alarms Non-Urgent (6th byte : 02)

Parameter Name	Hex Code		Observation/Remarks
	From Master	From Slave Equipment	From Slave Equipment
Mains High	01, 00, 00	01, 01, 00 : OK 01, 02, 00 : FAULT	01, 01, 00 : OK 01, 02, 00 : FAULT
Mains Low	02, 00, 00	02, 01, 00 : OK 02, 02, 00 : FAULT	02, 01, 00 : OK 02, 02, 00 : FAULT
FR/FC : Fail	Same sequence	Same sequence	Same sequence
Fan Fail	Same sequence	Same sequence	Same sequence
Over Voltage	Same sequence	Same sequence	Same sequence
Under Voltage/Output Fail	Same sequence	Same sequence	Same sequence
Over Load	Same sequence	Same sequence	Same sequence
Inverter : Fail	Same sequence	Same sequence	Same sequence
Fan Fail	Same sequence	Same sequence	Same sequence
Output Voltage High	Same sequence	Same sequence	Same sequence
Output Voltage Low	Same sequence	Same sequence	Same sequence
Input Voltage High	Same sequence	Same sequence	Same sequence
Input Voltage Low	Same sequence	Same sequence	Same sequence
Over Load	Same sequence	Same sequence	Same sequence
Any other Alarm condition	Same sequence	Same sequence	Same sequence

iii) Monitoring Parameters (6th Byte : 03)

Parameter Name	Hex Code		Observation/Remarks
	From Master	From Slave Equipment	
UPS on Mains/Stand by	01, 00, 00	01, 01, 00 : MAINS 01, 02, 00 : STAND BY	
Inverter Load on power plant/Battery	02, 00, 00	02, 01, 00 : Power Plant 02, 02, 00 : Battery	
Load on Inverter/ Stand by	03, 00, 00	03, 01, 00 : Inverters 03, 02, 00 : Stand by Mains	
FR/FC unit Voltage	04, 00, 00	04, VALUE(H), VALUE(L)	
FR/FC unit Load	05, 00, 00	05, VALUE(H), VALUE(L)	
Battery Path Current	Same sequence	Same sequence	
Battery trickle Current	Same sequence	Same sequence	
System Load	Same sequence	Same sequence	
UPS unit Output Voltage	Same sequence	Same sequence	
Input Voltage	Same sequence	Same sequence	
Frequency	Same sequence	Same sequence	
Load Sharing performance of Inverters (%)	Same sequence	Same sequence	
Any other Alarm condition	Same sequence	Same sequence	

iv) Parameter Control (6th Byte : 04)

Parameter Name	Hex Code		Observation/Remarks
	From Master	From Slave Equipment	
Mains High	01, VALUE(H), VALUE(L)	01, VALUE(H), VALUE(L)	
Mains Low	02, VALUE(H), VALUE(L)	02, VALUE(H), VALUE(L)	
FR/FC unit Over Load	03, VALUE(H), VALUE(L)	03, VALUE(H), VALUE(L)	
FR/FC unit Float Voltage	04, VALUE(H), VALUE(L)	04, VALUE(H), VALUE(L)	
FR/FC Charge Voltage	05, VALUE(H), VALUE(L)	05, VALUE(H), VALUE(L)	
FR/FC Load Voltage High	Same sequence	Same sequence	
FR/FC Load Voltage Low	Same sequence	Same sequence	
Battery : Path Current Limit	Same sequence	Same sequence	
FR/FC : Over Voltage	Same sequence	Same sequence	
Under Voltage	Same sequence	Same sequence	
Over Load	Same sequence	Same sequence	
UPS unit Over Load	Same sequence	Same sequence	
Load Voltage High	Same sequence	Same sequence	
Load Voltage Low	Same sequence	Same sequence	
Input Voltage High	Same sequence	Same sequence	
Input Voltage Low	Same sequence	Same sequence	
Any other parameter to be control	Same sequence	Same sequence	

Note : 1. If the remote controller wants to check the current setting, it shall send 8th and 9th bytes as 00 00 along with the data of 7th byte as given above, the associated equipment shall return the current value.

2. If the associated equipment returns the same value as sent by controller it shall be taken as accepted otherwise not accepted and shall be resent after doing the needful.

v) System details : (6th Byte : 05)

Parameter Name	Hex Code		Observation/Remarks
	From Master	From Slave Equipment	
System Make	May be generated in the remote controller by manual inputting		
System Ultimate capacity	May be generated in the remote controller by manual inputting		
System Equipped capacity	03,00,00	03, VALUE(H), VALUE(L)	
Number of FR/FCs	04,00,00	04, VALUE(H), VALUE(L)	
Rating of FR/FCs	Same sequence	Same sequence	
Number of FR/FC Working	Same sequence	Same sequence	
Number of FR/FC Faulty	Same sequence	Same sequence	
Number of Inverters	Same sequence	Same sequence	
Rating of Inverters	Same sequence	Same sequence	
Number of Inverters Working	Same sequence	Same sequence	
Number of Inverters Faulty	Same sequence	Same sequence	
Any other information	Same sequence	Same sequence	

Note : In case the above information can not be provided by the UPS system the same may be generated in the First stage manually by in-putting the information. Faulty FR/FC & inverter details can be generated from the FR/FC & inverter Fail alarms.

J. SUMMARY OF TEST RESULTS

GR/IR No._____
TSTP No._____
Equipment name & Model No._____

Clause No.	***Compliance*** *(Complied /Not Complied / Submitted/Not Submitted / Not Applicable)*	***Remarks / Test Report Annexure No.***

[Add as per requirement]

Date:

Place: ***Signature & Name of TEC testing Officer /***

**** Signature of Applicant / Authorized Signatory***

**** Section J as given above is also to be submitted by the Applicant/ Authorised signatory as part of in-house test results along with Form-A. The Authorised signatory shall be the same as the one for Form 'A'.***