for virus and spam on the actual email server. With this implementation the actual email server processing load has reduced from 20,000 emails per day to 2,000 mails per day, thus giving a performance increase of 10 folds.

E) Commissioning of a secure web server for access of Ph.D. application over Internet:

For hosting of Ph.D. application over Internet, a hardened secure web server with necessary open source based host level firewall and Host Intrusion Detection System (HIDS) software has been commissioned. This allows prospective Ph.D. candidates to securely fill up and submit the application forms over Internet to the RRCAT servers. The web server based on Apache (ver. 2.2.3) has been chrooted for providing additional security to the other resources on the network. ConfigServer Firewall (CSF), which is automatically updated over Internet has been configured along with Login failure daemon (LFD) as the host level firewall. Open Source Security (OSSEC) based HIDS has also been configured on the server. The Ph.D application web server has been hosted on a new domain accessible using the Universal Resource Locator (URL) https://www.info-rrcat.ernet.in/phdappl/index.php on any web browser.

F) Commissioning of a hot standby ANUNET email server:

A new email server has been commissioned on ANUNET. This server will act as an email gateway to various ANUNET sites. The new server has been configured, using Red Hat Enterprise Linux (RHEL3) as operating system, Qmail (ver. 1.03) as Mail Transfer Agent (MTA) and djbDNS as name server package. The server has been configured to work in failover mode with the already existing email server. This allows server level redundancy of the ANUNET email gateway at RRCAT.

G) Expansion of communication network:

Forty one number of new telephone connections were provided at various locations in RRCAT campus including Ferrite Lab, New Fire Station Building, IT building extension and C & S Division building extension. Approximately twenty eight telephone connections were shifted to other location as per user requirement. Mobile facility was enabled for fourteen users and five number of Digital Reflex Phones were installed.

H) RRCATNet Planning, Expansion and Upgradation:

Two number of new points were added to LSL network. One number of new point was added in H Block network. Eight number of new points were provided in the console room of IT Extension building. Connectivity of 10 Mbps bandwidth was provided at Electrical control room in Colony area. Inter rack and CAT-6 copper links were provided at 24 points in IT extension building. LAN installation work in PG Hostel and RTS Hostel buildings is in progress. Phase V of the OFC termination work is also in progress. Installation of a 24 port switch (LMD building), a 48 port switch (Purchase building), a 48 port switch (4th switch in ADL building), and restoration of a 48 port switch (Photocathode building) to expand/improve network connectivity was completed. In all 144 ports were added to RRCATNet.

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I.4: Construction & Services

A) Integration and Commissioning of Power Conditioning System for Indus-2

Introduction:

Synchrotron Radiation facility (SRF) Indus-2 is a power intensive set up. The stringent power quality requirements due to major involvement of power electronics and various sensitive subsystems call for large, reliable and regulated power input. In view of above, Power Conditioning System (PCS) comprising rotary UPS of rating 415V; 6110kVA has been provided for Indus-2.

Building details:

The building has been constructed adjacent to Indus substation for optimized operation and control of the services. The special foundations for PCS have been designed and constructed for static and dynamic loads of the machines including vibration isolation. The building has a mezzanine floor. Design considerations of the foundation are as given below:

1. The foundation gradient (max): 5 mm / metre.
2. Static design load: 90000 N.
3. Dynamic design load: 2000 N (vibration 30 –55 Hz.).
4. The natural resonance of the elastic mounted machine is between 250 - 900 rpm.
5. Concrete foundation grade: M 25.

In order to meet the ventilation requirements, an evaporative cooling system with filtration units was designed. The air washer rooms have been constructed to house the units with all necessary services including ducts, fresh air louvers, water supply network etc

Integration of PCS with existing power distribution system:

The Input/output electrical panels are kept on the mezzanine floor in the PCS building. This is to reduce the heat load on the ventilation system. There are four Power Conditioning Systems, 3 of 1670kVA and 1 of 1100 kVA. The three 1670 kVA units feed the magnet power supply, RF power supply and Indus-2 dipole power supply loads respectively. The 1100kVA unit feeds the auxiliary systems like LCW plant, Ultra High Vacuum, Beam Lines, Accelerator Controls etc. The 415V, 3200A sandwich bus ducts have been used for the interconnections. The system configuration after PCS integration is as shown in Fig. I.4.1.

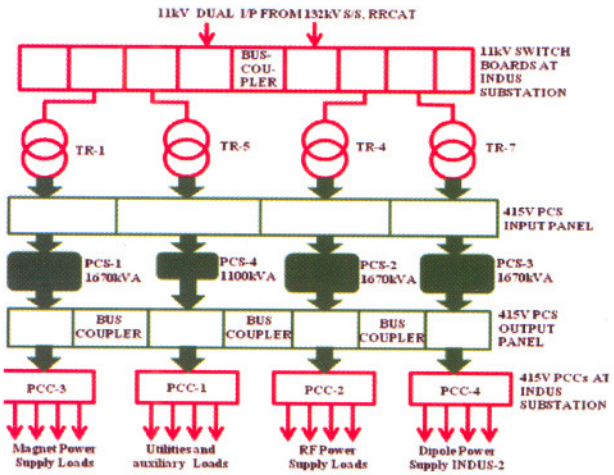

Fig. I.4.1: Electrical system configuration after PCS integration

PCS machine Single Line Diagram (SLD):

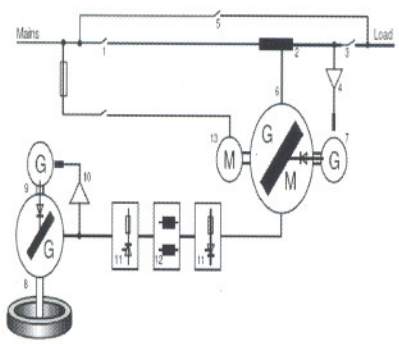

Fig. I.4.2: SLD of the PCS machine

Fig. I.4.2 shows the SLD of the PCS machine. Various parts of the machine as numbered in the Fig. I.4.2 are as given below:

Part No.	Part Name
1.	UPS Input Breaker
2.	Coupling Choke
3.	UPS Output breaker
4.	Voltage regulator UBT
5.	Bypass breaker
6.	Uniblock machine
7.	Excitation UBT
8.	Power Bridge
9.	Excitation generator PB
10.	Voltage regulator Power bridge
11.	6-pulse SCR convertor
12.	DC link choke
13.	Pony motor UBT (Uniblock – Machine)

Components of the PCS:

Fig. I.4.3 depicts the inside view of the PCS machine.

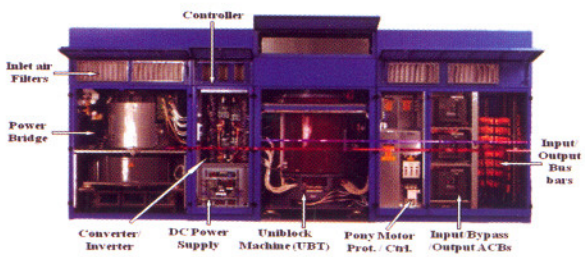

Fig. I.4.3: Inside view of the PCS machine

1. A three terminal-coupling choke (2) connects the load to supply mains and decouples the input and output section voltages. The third terminal is connected to the Uniblock-Machine (unified motor-gen set/UBT) (6).

2. The Uniblock-machine is a specially designed synchronous machine having two identical armature windings on stator. One is called generator winding and the other is called motor winding. The generator winding is connected to the coupling choke (2) tapping and the motor winding to the Power Bridge (PB) (8) through double stage six pulse converters (11). They are interconnected through DC link choke (12). A pony motor (13) (induction motor) is used for starting the Uniblock-machine. Brushless excitation has been used in the machine.

3. The PB comprises a standard four pole synchronous machine with Kinetic energy storage device in the form of a 3.5 MT flywheel.

4. Main microcontroller acts as the brain of the machine for control of voltage, current, frequency, phase and monitoring of temperature, speed, vibration, air flow etc.

5. Air Circuit Breakers (ACB) (1, 3, and 5) have been used for electrical protection and bypass to the machine.

Working Principle:

The coupling choke offers 49% impedance towards mains side and 1% toward the load side. This decouples output section voltage from the input mains and maintains the voltage within set limits by excitation control of the Uniblock-machine. Both the sections of the choke are strategically wound for better voltage stability, balancing of loads, fault current limiting on input side etc.

The armature windings are mutually coupled through choke which blocks the transfer of voltage harmonics to the generator winding/load from the motor winding. The six pulse converters are capable of operating in four quadrants and interconnected through DC link choke.

The flywheel is connected to the Motor/Generator through the DC link. This combination helps in utilising maximum stored energy and enhances the backup period. The flywheel can store up to 16.5MJ energy corresponding to its maximum speed of 3300 rpm. At rated loads 12 seconds of back up is available for the 1670 kVA unit while for 1100 kVA the back-up time is 17 seconds as the similar flywheel has been used in both the ratings. Magnetic levitation and helium cooling reduces the losses in the machine. The PB terminal voltage is maintained at 440V whereas frequency varies depending on speed of the rotor. This constant voltage; variable frequency output from the PB is fed to the converter. Constant voltage; constant frequency output is delivered by this converter to the Uniblock motor winding.

The Controller Area Network (CAN) bus is used for communication among various parts of the machine. The front touch panel provides the control and observation of the status of various parts along with electrical and mechanical parameters.

OUTPUT OPERATING PARAMETERS

S.No	Parameter	Data
1.	Rated power kVA	1670 kVA/1100kVA
2.	Rated power kW	1336kW/880kW*
3.	Rated voltage	415 V
4.	Rated current	2323 A/1530A*
4.	Power factor	0.8 lagging
5.	Static voltage deviation	±1% with symmetrical load
6.	Dynamic voltage deviation	±2% within 200 ms with 50% load change
7.	Recovery time	250 ms to ± 1%
8.	Frequency	Input mains frequency ±0.1% dynamic
9.	Distortion factor	1.5%(Ph-Ph), 2.5%(Ph-N)
10.	Overload capacity	125% for 10 minutes, 165% for 1 minute
11.	Short-circuit current	14 times rated current for 10msec and three times rated current for 5 sec.
12.	Permissible Load Crest factor	Limitless for harmonic load
13.	Phase angle	120° ±1° with symmetrical load

Input Operating Parameters

S.No	Parameter	Data
1.	Rated voltage	415/240V
2.	Permissible static voltage deviation	-20% to +15% -30% for 10 minutes
3.	Permissible dynamic voltage deviation	-50%
4.	Rated frequency	50Hz
5.	Permissible frequency deviation	±1% (adjustable to ±5%)
6.	Rated current	2063A/1374A*
7.	Maximum current	3149A/2073A*
8.	Power factor	> 0.94 lagging at rated load
9.	Harmonic attenuation	>99% (either side)
10.	Maximum input current On mains Short circuit	2 times rated current
11.	Re-synchronisation time	<3 s
12.	Starting current	1000 A for (30 s)

***Details refer to the 1670kVA/1100kVA ratings.**

System features:

Regulated Output: A highly regulated sinusoidal output is maintained. On occurrence of disturbances on the mains, input breaker trips and the load is supplied by PB through Uniblock. The input mains is continuously monitored even during the disturbance interval and machine is resynchronised, as soon as the mains is restored to permissible limits.

Fig. I.4.4: A view of the PCS installation for Indus-2

Harmonics Attenuation: The three terminal AC coupling choke offers high impedance to the higher order load current harmonics.

Current limiting (input side): In case of short circuits on the

input mains, the high impedance choke limits the fault current supplied by the machine approximately up to twice the rated current.

High short circuit current capability: The percentage output impedance of the machine is 7%, which includes 6% machine impedance and 1% choke impedance. It allows the short circuit current up to 14 times the rated current and facilitates the reliable operation of the protection gears.

Power factor: The Uniblock machine has utilised the synchronous condenser feature for maintaining high input power factor.

Unbalanced load: In case of unbalanced loading, the mutual coupling of Input & Output portion of the choke and connections with Uniblock machine ensures that the load seen by mains is almost balanced.

Safe shutdown of loads: User configurable relays can be utilised for initiating safe shutdown process of the Indus-2 machine in case of complete mains failure.

Reliability: Reliability of the machine has been achieved through redundancy of critical components. Various critical parts are continuously monitored by the reliable and redundant sensors. The embedded logic has been configured to transfer the load automatically on mains through bypass in case of severe fault inside the machine. The PCS output electrical panel is provided with bus couplers for load sharing.

Communication: Machine communicates over Simple Network Management Protocol (SNMP) /MODEM /RS232/RS485 and Modbus independently, for all the features. Data watch is standard UPS software, which provides monitoring, Human machine Interface (HMI) screens, remote control, email facility etc.

Status: The System was commissioned on 12th February 2011 and since then has been in continuous operation on round the clock basis.

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B) Data Centre illumination & power distribution system

The new data centre meant for scientific computing and data management at RRCAT has 16 racks with a nominal electrical power requirement of 8-10KW per rack. The loading pattern for such installation is highly fluctuating. Moreover these loads generate high level of voltage and current harmonics. Being an essential facility the permissible downtime is near zero. The flexibility of power tapping has to be ensured depending on the server planning.

The power distribution system for the data centre comprises of two runs of 160A centre-fed bus-trunking system fed by redundant parallel 200KVA UPS. These bus trunks provide enclosed aluminum conductor system having inherent capability to carry harmonics as well as to withstand faults. The regularly spaced tap-off provision makes the system flexible. The joints at the tap-off are well designed for contact reliability and vermin restriction.

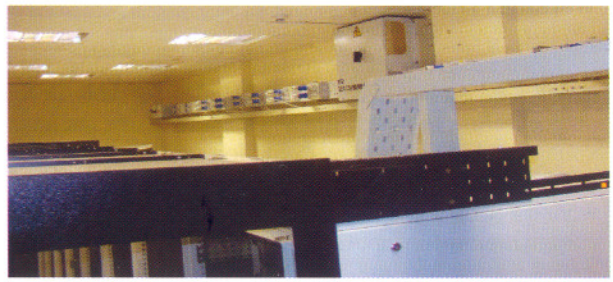

Fig. I.4.5 Luminaires & Bus Trunking System in Data Centre Hall of IT Extension Building

Each run is equipped with a centre feed unit of 250A, 36KA MCCB and tap-off points at every 500 mm on one face of the trunk. The tap-offs consisting of MCB and plug-socket assemblies can range from 16A to 125A three phase and up to 32A single phase units. The tap-off units are interchangeable in all the ratings. Load balancing is achieved through equal distribution of tap-offs on each phase. Flexible copper Cables have been laid in powder coated metallic cable trays between the bus trunk and racks. Power Distribution Units (PDUs) in the racks feeding power to the servers are connected to the bus trunk through mobile straight plug & socket units.

Electrical power distribution system in the data centre has following features:

1. Harmonics compatibility.
2. Flexibility and adoptability with respect to rating and location of a load.
3. High protection co-ordination ensuring minimum disturbance to the neighbouring loads.
4. Modularity through interchangeable components.
5. Electrical power distribution system is compatible with tier three data centre.
6. SCADA compatible switchgear.
7. Aesthetically rich environment.

The high density rack layout called for glare free task oriented lighting levels as per the industry practice. Luminaires selected for the lighting are low heat dissipating type. Fire detection and alarm system has thermal and optical sensor combination. Grounding system has three isolated networks. Interconnected deep bore earth pits provide dedicated grounding to the UPS power distribution.

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