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Glossary and List of Abbreviations

HA: High Availability.

HPC: High Performance Computing Cluster including compute nodes, HA master nodes, storage server(s), storage solution, backup server and tape library.

HPC Solution: HPC along with DG-Set, UPS, UPS batteries and A.C.

OEM: Original Equipment Manufacturer.

Onsite: Physical Research Laboratory, Navrangpura, Ahmedabad 380009.

PRL: Physical Research Laboratory.

Pure CPU Architecture: Collection of compute nodes that are PCIe Accelerator enabled (empty PCIe Accelerator slots) and contains only CPUs.

Mixed CPU/PCIe Accelerator Architecture: Collection of compute nodes that contains PCIe Accelerators as well as CPUs.

teraFLOPS: Trillions of double precision Floating Point Operations Per Second.

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Technical Specifications

High Performance Computing Cluster of total sustained 100 teraFLOPS with 50 teraFLOPS from CPUs (of pure cpu nodes and PCIe Accelerator nodes) and another 50 teraFLOPS from PCIe Accelerators.

Cluster will comprise of the following components/requirements integrated together as a fully operational High Performance Computing Cluster (HPC):

1) Compute Nodes with Pure CPU Architecture (Minimum 77 nodes over Infiniband[*])

Specifications per compute node

CPU:
2 x Latest 64 Bit Processor from x86, 12 core and 30MB cache with each core capable of executing 8 flops per clock cycle, 2.7GHz or better CPU.

PCIe Accelerator Support:
At least two empty PCI Express bus (Gen 3.0) x16 slots for future FLFH Double wide PCIe Accelerator upgradability.

RAM:
256 GB per node ECC DDR3-1866 MHz or better, and equal distribution of memory on DIMMs and upgradable up to 512 GB.

HDD:
2 × 900 GB SAS 10000 RPM or better, configured for RAID 1.

Infiniband:
FDR Infiniband 56Gbps or better dual port adaptor, QSFP interface in 100% non – blocking modes between the nodes.

NIC:
Dual Gigabit (10/100/1000Mbps) Ethernet onboard with PXE boot capability.

RAID:
On board hardware controller offering RAID levels 0, 1.
        OR
PCI based hardware controller offering RAID levels 0, 1.

Power Supply:
Rack redundant energy efficient (85%) power supply.

Node Serviceability:
Each of the nodes must be independently serviceable without affecting functioning of remaining components of the cluster.

Management Ports:
At least one dedicated port for remote management.

Form Factor:
2U or better.

All the compute nodes must have the same configuration.

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2) Compute Nodes with Mixed CPU/PCIe Accelerator Architecture (Minimum 20 nodes over Infiniband[*])

Specifications per compute node

CPU:
2 x Latest 64 Bit Processor from x86, 12 core and 30MB cache with each core capable of executing 8 flops per clock cycle, 2.7GHz or better CPU

PCIe Accelerator:
2 x Nvidia Tesla K20X or better
      OR
2 x Intel Xeon Phi Coprocessor 7120P or better

RAM:
256 GB per node ECC DDR3-1866 MHz or better, and equal distribution of memory on DIMMs upgradable up to 512 GB.

HDD:
2 × 900 GB SAS 10000 RPM or better configured for RAID 1.

Infiniband:
FDR Infiniband 56Gbps or better dual port adaptor, QSFP interface in 100% non – blocking modes between the nodes.

NIC:
Dual Gigabit (10/100/1000Mbps) Ethernet onboard with PXE boot capability.

RAID:
On board hardware controller offering RAID levels 0, 1.
      OR
PCI based hardware controller offering RAID levels 0, 1.

Power Supply:
Rack redundant energy efficient (85%) power supply.

Node Serviceability:
Each of the nodes must be independently serviceable without affecting functioning of remaining components of the cluster.

Management Ports:
At least one dedicated port for remote management.

Form Factor:
2U or better.

All the compute nodes must have the same configuration.

* Additional details applicable to specification 1 and 2:

The number of nodes specified in the technical specifications is the minimum estimated value calculated with more than 95% efficiency of the theoretical peak. The bidders may quote additional compute nodes (in both categories – Sr. No. 1 and 2) required to satisfy conditions (refer points 1 and 2 – Acceptance Test Procedure) for sustained performance. The bidder must make sure to house the proposed setup within the present HPC room (see Annexure I).

Total number of compute nodes must be accommodated within the proposed HPC room as shown in Annexure I. Refer Terms and Conditions for details.

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3) Master Node with Redundancy High Availability (HA) mode to Administer Pure CPU and Mixed CPU/PCIe Accelerator Nodes

Configuration: Two master nodes in HA mode and redundant to each other, jointly administering compute nodes. Master nodes will share peripherals (KVM switch, 1U Rack mount TFT with keyboard and mouse) mounted on rack within a 1U slide away housing. Both the master nodes must have identical configurations as per specifications given below:

Specifications per master node

CPU:
2 x Latest 64 Bit Processor from x86, 12 core and 30MB cache with each core capable of executing 8 flops per clock cycle,2.7GHz or better CPU

PCIe Accelerator:
2 x Nvidia Tesla K20X or better
            OR
2 x Intel Xeon Phi Coprocessor 7120P or better

RAM:
256 GB per node ECC DDR3-1866 MHz or better, and equal distribution of memory on DIMMs upgradable up to 512 GB.

HDD:
2 × 900 GB SAS 10000 RPM or better, configured for RAID 1 (Software or Hardware).

Infiniband:
FDR Infiniband 56Gbps or better dual port adaptor, QSFP interface in 100% non – blocking modes between the nodes.

NIC:
Dual Gigabit (10/100/1000Mbps) Ethernet onboard with PXE boot capability Ethernet Management port 10/100Mbps.

Power Supply:
Rack redundant energy efficient (85%) power supply.

Node Serviceability:
Each of the nodes must be independently serviceable without affecting functioning of remaining components of the cluster.

Management Ports:
At least one port for remote management.

Form Factor:
2U or better.

The items 1, 2 and 3 (pure CPU nodes, hybrid CPU/PCIe Accelerator nodes and HA master nodes) must be of the same OEM and model.

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5) Storage System and Storage Server

Configuration: RAID 5 (or better) configured commercial and OEM supported parallel file system serving data to the cluster. **Storage system must be Infiniband over fiber based.** The storage server(s) for handling the storage systems and connecting to the cluster must be given as part of the solution. None of the components of the storage server(s) and storage solution must be reaching end-of-life. Fully installed/configured software (RHEL based) for the management of parallel file system (PFS) must be included. Storage must be compatible with any brand of storage server running Linux.

Specifications

Disk Space:
Minimum of 300 TB usable space after RAID 5 or better (Hardware or File System based software) dynamically configurable as per usage. Must be upgradable up to 1PB in the same namespace with same throughput.

Storage Throughput (Read/Write):
Concurrent 3 GB/sec (or higher) write and 3 GB/sec (or higher) read amounting to a total achievable throughput of 6 GB/sec or higher.
The bidder must demonstrate this storage throughput (with 4MB block size) using one or more of the standard benchmark applications like IOzone, IOR or Bonnie++.

Cache:
Minimum 16 GB.

Connectivity to Cluster:
Storage must connect to cluster Infiniband network via storage servers.

Reliability:
The storage solution must have no single point failure.

Management Software:
Appropriate web based management software to monitor the health and status of the Storage System.

Parallel File System Software:
Parallel File System software must be commercially licensed and supported version from the PFS software OEM.

Storage System:
Rack mountable with redundant and hot swappable power supply.

Software:
Commercial and OEM supported PFS configured to present the entire storage as a single unified addressable namespace to the HPC nodes.

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6) Backup Server with Backup Software

CPU:
2 x Latest 64 Bit Processor from x86, 2.5GHz or better (4 core per processor or more)

RAM:
32 GB ECC DDR3-1866 MHz or better and expandable up to 128 GB.

HDD:
2 x 900GB SAS, 10000 RPM or better in RAID-1, expandable to 8 HDDs and mounted on Hot-swap HDD bay.

Interconnect:
Dual Port FDR Adapter and 6Gb/s FC/SAS HBAs to connect Tape Library.

NIC:
At least Four Gigabit Ethernet.

Power Supply:
Rack redundant energy efficient (85%) power supply.

Backup Software:
Licensed and commercial backup software with RHEL support with the required number of licenses for backup of 50 TB data and upgradable up to 300 TB data.

7) Specifications of Tape Library with Barcode reader

Drive:
Min 4 x Half-high LTO6 SAS drives or better.

Number of Slots:
Minimum 48 cartridge slots and minimum 3 mail slots.

Data transfer rate (per drive):
Up to 160 MBps native.

Interface:
6Gb/s fiber cable or SAS.

Management:
Remote library management through a standard web interface, local LCD display and indicators for power, drive and activity, error status and message information.

Power Supply:
Redundant power supply.

Media:
Minimum 200 x LTO6 RW Data Cartridges with 40 Universal Cleaning Cartridges.

Barcode Labels:
200 barcode labels for RW cartridges and 40 (starting with 'CL') for cleaning cartridges.

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8) Operating System

Fully licensed and certified latest (version 6.5 or above) 64 bit Red Hat Enterprise Linux (RHEL) for all the compute nodes, master nodes, storage server(s) and backup server.

9) Cluster Management Software

The solution must have CPU and PCIe Accelerator based hybrid cluster management software with the following minimum features:

   i. Cluster Management Software must support both PCIe Accelerator and CPU based hybrid cluster.
   ii. Software must handle all the nodes (compute and master) provided in the solution.
   iii. OEM supported licensed suite.
   iv. GUI/Web based management.
   v. Extensive cluster monitoring capabilities to access node level performance parameters using GUI and with well-designed graphical reports for both the PCIe Accelerator and CPU.
   vi. Management software must provide proactive notification of an actual or impending component failure alerts.
   vii. Permission for only secure shell based access and a robust parallel execution shell implementation.
   viii. Licensed software for interconnect performance monitoring, communication management and cluster monitoring.

10) Workload Management Software

The solution must have workload management software with the following minimum features:

   i. Integrated workload management solutions for both the PCIe Accelerator and CPU with web based as well as terminal/console based job submission and HPC performance analysis and reporting.
   ii. Ability to view available resources like CPU, PCIe Accelerator, RAM, nodes, etc in the web as well as in the terminal/console for the users and system administrators.
   iii. Commercially licensed job scheduler with complete support and integration of scheduler for job submission and performance analysis for the proposed cluster.
   iv. During the warranty period, the bidder must help users to integrate their applications with batch submission script to facilitate seamless usage of the HPC Solution.
   v. Complete cluster integration with comprehensive onsite support to be provided by the software OEM. (Refer to point number 27 of the Terms and Conditions)
   vi. The software must have the ability to shut down compute nodes which are not utilized for a predefined period of time. It must then boot up the nodes when requirement arises. The bidder must demonstrate this feature.

11) Programming Tools

A. Compilers:
   i.   If the bidder quotes:
         o Nvidia K20X based HPC solution, the bidder must quote for the latest PGI Accelerator CDK for Linux (x86+GPU) with 2 floating user perpetual licenses.
         o Intel Xeon Phi 7120P HPC solution, the bidder must quote for the latest PGI Accelerator CDK for Linux (x86) with 2 floating user perpetual licenses.

   ii.   Latest Intel Cluster Studio XE 2013 with 2 floating user perpetual licenses.
   iii. Latest GNU Compiler Collection version 4.9.0 or higher.

B. Parallel Programming Libraries:
   i.   Support for OpenMPI, Intel MPI and MPICH libraries across all the compilers. The bidder must demonstrate the functionalities of all the three MPI Implementation.
   ii.   The MPI implementation must be accelerator aware.
   iii. All the necessary tools for the parallel programming on CPU and PCIe Accelerator like OpenMP, OpenACC, OpenCL and CUDA must be supplied and installed.
   iv.   All the PCIe Accelerator specific libraries (like CUBLAS, CUFT, CUPARSE in case of NVIDIA GPU) and others to be provided as integrated programming environment.
   v.   Proposed compilers and libraries must be best optimized for the quoted HPC solution and must be commercially licensed and supported by the OEM.

C. Performance analysis tools, profiling and debugging:
   i.   Performance analysis tools for analysis of both the PCIe Accelerator and CPU programs in all the languages covered by the above compiler suites.
   ii.   Intel® VTune™ Amplifier XE.
   iii. Intel® Inspector XE.
   iv.   Intel® Advisor XE.
   v.   Valgrind.
   vi.   GNU project debugger.

D. Miscellaneous:
   i.   Integrated Development Environment on RHEL must be provided.
   ii.   All the patches and updates for all the software tools must be provided during the on-site warranty period.
   iii. Other libraries including but not limited to MKL, BLAS, LAPACK, LINPACK, NetCDF, HDF5, etc must be provided.

12) Power Backup (UPS):

   UPS with SNMP management feature to cater to the full HPC load with minimum of 25 minutes battery backup with the option to scale up backup time.

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i. Minimum 127kW with N+1 redundancy, modular, hot scalable to at-least 157KW.

ii. The proposed UPS system and batteries must be capable enough to cater the load of the HPC setup if all the proposed compute nodes are fully populated with the PCIe accelerator cards.

iii. The bidder must also integrate few of our existing critical servers with the proposed UPS system.

iv. The bidder must include all components including appropriate industry standard cables, power distribution panels, required new copper Earthings, and any other accessories required for the installation and commissioning of the UPS system.

v. The bidder must visit and do the site surveys to measure required cable lengths and any other accessories requirements, PRL will only provide input power cable to the AMF panel. It is the responsibility of the bidder to do the entire power cabling required from AMF panel to UPS, from UPS to racks and component level as well as up to cooling units.

vi. Minimum 25 minutes of battery backup on the full load of the proposed HPC.

vii. The UPS system must have Ethernet and SNMP support along with appropriate software. The Ethernet web/SNMP Adaptor must allow one or more Network Management Systems (NMS) to monitor and manage the UPS in a network environment. Linux supported Management Information Base (MIB) must be provided.

viii. The UPS system, in conjunction with a network interface card, must be capable of gracefully shutting down one or more servers when the UPS is operating from the battery and the available runtime reaches a user defined threshold.

ix. The UPS system must have user replaceable and hot swappable battery modules.

x. The UPS system must have redundant main controller modules, redundant logic power supplies and must be hot swappable.

xi. The UPS system must have internal output distribution system to distribute uninterrupted power for the load. The output distribution must be N+N from the UPS to the rack PDUs. The output power must be distributed through 3 phase and neutral busduct.

xii. Modular hot scalable/swappable power distribution unit with provision to at-least accommodate MCBs of 16 amps, 32 amps and 63 amps rating for the UPS output power distribution. It must be possible to add or replace circuit breaker modules without switching off the load bus. If required, external power distribution system with similar features must be planned and implemented to provide power supply to all the racks. At least 4 nos. of 3 pole or 12 nos. 1 pole MCBs or higher slots must be provisioned for future expansion of the server racks.

xiii. The bidder must provide all the required accessories towards the integration of the UPS to the HPC solution. Modular PDUs must not require a downtime to add a circuit breaker, power cord, or power connection.

xiv. The UPS system must be rated for full capacity output with the following general specifications:

    a. **AC Input Nominal Voltage:** 230 V, 3 Phase, 4 wire + G, 50 Hz.

    b. **Maximum Frequency Range:** 40-70Hz,

    c. **Input Power Factor**: 0.99 with load at 100% or better,

    d. **Input Current Distortion without additional filters**: less than 5%,

    e. **AC Nominal Output**: 230V, 3 Phase, 4 wire + G, 50 Hz.

    f. **AC Output Voltage Distortion**: less than 2% at 100% linear Load. Less than 6% for nonlinear load and must be compliant with EN50091-3/IEC 62040-3.

    g. **AC Output Voltage Regulation**: ±1% for 100% linear or nonlinear Load.

    h. **Voltage Transient Response**: ±5% maximum RMS change in a half cycle at load step 0% to 100% or 100% to 0%. Voltage Transient Recovery within less than 50 milliseconds.

    i. **Output Voltage Harmonic Distortion**: It must be less than 2% THD maximum and 1% single harmonic for a 100% linear load.

    j. **System AC-AC Efficiency:** Normal operation ≥ 96% at 40% to 100% load. Battery operation ≥ 96% at 40% to 100% load or better.

    k. **Output Power Factor Rating**: 0.5 or better (leading or lagging) without any output derating.

xv. The UPS must have an appropriate mechanism to protect the system from overload, over-temperature, input/output and over/under voltage or any other fluctuations.

xvi. The battery charging circuit must have an appropriate mechanism that maximizes the battery life. The battery charging circuit must remain active when the system is in Static Bypass and also during the Normal Operation.

xvii. The UPS system must support an optional battery bank. Each battery module must have a feature to at-least monitor voltage and temperature. Battery charging current must be temperature compensated. The UPS system must incorporate a battery management system to monitor the health of battery modules. The system must have a feature to notify about a failed or weak battery. The batteries must be of long life (5-10 years) with a flame retardant battery casing.

xviii. Input cabling method for both the top or bottom provisions must be available.

xix. **Modes of Operations**:

    a. **Normal**: The UPS must operate on-line continuously to monitor and regulate power to the load. The UPS must be capable of full battery recharge while simultaneously providing the regulated power to the load.

    b. **Battery/Backup**: In instances of input supply failures, the power to the load must be supplied from the battery system. There must be no interruption in power to the load during transfer to battery operation and back to Normal.

    c. **Recharge:** Upon restoration of the input supply, there must be an appropriate mechanism to provide regulated power to the load while concurrently recharging the battery.

    d. **Static Bypass**: The centralized static bypass must be used to provide controlled transfer of the load from the UPS output to the bypass source. This transfer and the corresponding return to the UPS of the load must take place without any interruption of the power. In the event of an UPS output fault or significant output overload emergency,

this transfer must be done automatically. Manual transfer to the Static Bypass must also be available.

xx. A digital display unit must be located on the front of the UPS showing at-least the following parameters: input voltage, output voltage, frequency, battery status, current, logs with date and time stamps.

xxi. **Storage Ambient Temperature**: 0°C to 40°C or better.

xxii. **Operating Ambient Temperature**: 0°C to 40°C or better.

xxiii. **Relative Humidity**: 0 to 95% Non-condensing or better.

xxiv. The OEM must have a nationwide service network, consisting of well qualified service personnel to perform start-up, preventative maintenance, and service of the UPS system and power equipment. The bidder/OEM must offer 24x7 service support in Ahmedabad.

xxv. Original replacement parts must be available through the OEM. PRL will not allow any component level repairs in the UPS system inside the UPS room.

xxvi. The comprehensive onsite warranty must be offered directly by the OEM (Refer to item number 27 of Terms and Conditions).

xxvii. The vendor must provide the onsite operation training to the PRL staffs.

xxviii. The vendor must also provide all the installation and operational manuals.

13) DG-Set

i. **Engine:**

   a. **Design:** 8 Cylinder, Vee design, water cooled, rated at 1500 RPM or higher, developing 490 BHP or more vertical totally enclosed electric start, compression ignition, designed to run continuously.

   b. **Compliance:** The engine along with all the standard accessories like radiator with fan and fan guard, fuel pump, water pump, lube oil pump, air to air charge cooler, electronic governor, dry type air cleaner with vacuum Indicator, stainless steel expansion bellow, exhaust silencer (residential type), lube oil filter, fuel oil filter, flexible fuel pipe (wire braded), battery charging alternator with built-in regulator, etc must be in compliance with the standards like IS 10002, ISO 3046, BS 5514 and DIN 6271.

   c. **Safety:** There must be appropriate safety measures for over speed of moving parts, high water temperature, etc. It must be equipped with a mechanism to display the messages of engine starting and stopping, display current operating values, selectable manual or automatic starting modes, and must have a test mode to facilitate the compliance testing and troubleshooting. It must also provide at-least the following standard protective features pertaining to changes in (i) fuel level (ii) oil pressure (iii) engine speed (iv) battery voltage and (v) temperature of water, oil coolant, canopy, or any other parameters. There must be warnings or alarms for abnormalities in at-least (i) oil pressure (ii) engine temperature and (iii) battery voltage and charge status.

ii. **Alternator:**
Minimum 380KVA/304KW alternator, suitable for continuous operation rated at 1500 RPM 415 V, 0.8 PF, 50Hz, 3Ph. in SPDP enclosure or better, self-excited and self-regulated, brush less, H class of insulation, IP 23 class of protection, floor mounted with ball or bearings on end shields. The alternator must be in compliance with IS: 4722/BS/2613 and must be suitable for the tropical conditions.

iii. **Fuel Tank**: Minimum 8 hours capacity, with inlet and outlet arrangements, with air vent and drain plug arrangements.

iv. **Base Frame**: The base frame must be suitable to couple with the above engine and alternator.

v. **Batteries**: 12V with 180Ah or suitable for the proposed DG set, leads and battery cable.

vi. **Standard Control Panel**: Sheet must be made of steel, duly painted with stoving enamel paint consisting of the following: (a) one MCB/MCCB of suitable rating, (b) three numbers of current transformer, (c) two numbers of indicating lamps and (d) one set of control fuse or more

vii. **Construction:**
The enclosure must be modular in construction and must be fabricated with industry standard 1.6 mm thick Cold Rolled Close Annealed (CRCA) sheet. Base frame must be made of IS MC from the suitable sections/sheet metal. Industrial locking system must be provided on the doors. All the doors must be provided with high quality gaskets. The acoustic enclosure must limit the output noise level to 75 dB (A) or lower at a distance of 1 m around the set.

viii. **Corrosion Resistance**: All sheet metal parts must be processed through 7-tank process. Sheet metal components must be powder coated CRCA sheet. Base frame and all other hardware used must be passivated to avoid rusting.

ix. **Acoustic Insulation**: Sound proofing of the enclosure must be done with foam in compliance with IS-8183 of 64 kg/m^3 density with 50 mm thickness or better. This must be further secured with perforated epoxy paint. Attenuators must be provided to control sound at entry and exit, to and from the container. Specially designed residential silencer must be provided.

x. **Natural Ventilation and Air Circulation**: The engine must be water cooled. The engine must have a special radiator fan to take care of air circulation inside the canopy. Exhaust pipe must be thoroughly insulated by covering it with glass wool and further cladded in the enclosure.

xi. **Electrical**: Neutral/body earthing points at the sides of the enclosure must be isolated through a dough moulded compound.

xii. **Safety**: Emergency push button to stop the DG-set from outside.

xiii. **Automatic Switchover**: AMF panel must be included for automatic switching from the DG-set to the main power supply and vice-versa.

xiv. **Existing server integration**: The bidder must also integrate few of our existing critical servers with the proposed DG-set.

xv. **Installation and Integration**: The bidder must install and integrate the entire DG-set onsite including AMF panel, power cabling, manual change-over switch, cable, spring mounts, exhaust piping, the required copper earth pits and the appropriate civil works.

xvi. **Warranty**: Onsite comprehensive warranty from the OEM as per the Terms and Conditions (item number 27).

xvii. The bidder must take care of any approval required from any agencies related to environment, supply of diesel, etc. The bidder must also liaise between PRL and authorized agencies to provide continuous diesel supply to the DG-set during the warranty period.

xviii. The proposed DG-set must comply with the latest CPCB-II norms and IS/BIS standards.

14) Row Based Precision Air Conditioning

i. Row based air cooled precision cooling system with minimum capacity of 29 KW per unit or better. At least 5 units with N+1 redundancy configuration and Hot Aisle Containment System. Minimum load to cool must be 127 KW or higher.

ii. Cooling units must be placed between two racks to allow horizontal airflow pattern (cooling unit should supply cold air in front of rack and suck hot from rear end of it). However, cooling units must not be placed at the extreme end of the rows.

iii. Supply temperature to be maintained at 23°C or lower with an accuracy of 1°C.

iv. At least two of the units must be with built-in heater and humidifier for humidity control.

v. The units must be of appropriate size, and include casters and leveling feet.

vi. The frame must be constructed of 15 gauge steel or better, and welded for maximum strength. All the units must have the provision for maintenance from the front and rear. Exterior panels must be of high quality steel with high density foam insulation. Insulation must be in compliance with UL94-5VA, ASTM E84, and flame spread and smoke developed rating of 25/50. Front and rear exterior panels must be equipped with a lock.

vii. **Fans**: Each unit must be equipped with a variable speed and electrically commutated fan(s) with finger guard(s). Each unit must also operate in the event of fan(s) failure.

viii. **Power Supply**: The power supply unit must be provided with thermal-magnetic circuit breakers with interrupt capacity ratings as per the UL489/CSA C22.2/IEC 947 standards. The units must include a main disconnect switch, located on the electrical panel.

ix. **Display Interface**: The display interface must allow monitoring and configuration of the air conditioning unit. Functions must include status report and configuration of various parameters.

x. **Water Detector**: Each unit must have a leak detection mechanism with visual and audible alarms.

xi. **Alarms**: The system must automatically activate the visible and audible alarms in case of faults.

xii. **Network Management Card**. Each unit must include a Network Management Card to provide management.

xiii. **Cooling Coil and Condensate Pan**: The cooling coil must use raised lance type corrugated aluminum fin copper tube coils. Coil end supports must be 15 gauge or better, made of G90 galvanized steel. The coil must be rated for a maximum

pressure to cater the entire setup load, and the coils must be compliant with standard UL207. The coil header must be equipped with a drip plate in the bottom to capture and direct the condensation accumulating on the suction header tube to the drain pan.

xiv. **Compressor**:
   a. The compressor must be capable to support varying load conditions and cater to the HPC load by having control on the speed.
   b. The system must have oil return protection feature.
   c. Compressor must have noise reduction feature.
   d. A sight glass must be provided for oil charging.

xv. **Condensate Pump**: A single factory installed and wired condensate pump must have dual internal floats. The system must protect the pump from the corrosion.

xvi. **Filter:** The standard pleated filters must be 30% or higher efficient as per ASHRAE Standards 52.1, UL Class 2 (MERV 8 as per ASHRAE 52.2) and EN779 G4.

xvii. **Temperature Sensors**: Temperature sensors must be mounted behind the front and rear doors to provide control inputs based on the supply and return air temperatures. Sensors must have an accuracy of 1°C. At-least three remote rack inlet temperature sensors must be shipped with each unit to provide control input based on the rack inlet temperature.

xviii. Each unit must be equipped to facilitate field connections from either the top or bottom. Unit connections must be made internal to the unit.

xix. **For machine with Humidity Control**:
a) **Humidifier**: The humidifier must be factory integrated, with disposable cylinder. Humidifier canisters must be replaceable. The humidifier must provide complete status and control. Humidifier must control flush cycling and conductivity via automated controls. Humidifier capacity must be 3 kg or better of steam per hour.
b) **Electric Reheat:** Electric reheat system employing low power density with fin tublar contruction and the casing must be galvanized steel of appropriate guage.

xx. **UL Listing for Containment**: All the system components must be certified as suitable for the proposed HPC setup environment as per UL Listings: UL484, CSA C22.2 No.236 and UL723S.

xxi. **Containment Door**:
(i) Metal doors of appropriate dimensions must be provided to prevent any air leaks.
(ii) Doors must permit access into the contained aisle for maintenance or servicing. Standard door operations must not interfere with access or service on any rack or rack based equipment. Doors must be provided with a window, handles and latches.

xxii. **Ceiling Panels for Containment:**
(i) Ceiling panels must be thick V0 clear panels with aluminum framing, or of thick Lexan clear ribbed panels.
(ii) Smoke development index and flame spread index must be in compliance with UL723 or ASTM84. The nominal thickness, smoke development index, and flame spread index must be in compliance with UL723 or ASTM84.

Minimum Light Transmission as per ASTM D1003 must be equal to 82% or higher.

xxiii. **Warranty**: Comprehensive onsite warranty from the OEM as per the Terms and Conditions (item number 27).

15) Other Components

Infiniband Switch: FDR14 or better managed Infiniband switch in 100% non-blocking topology and using fiber cable with redundant power supply.

Gigabit Switch: L2 manageable 48 ports network switch with redundant power supply.

Rack:

42U Rack enclosure with the required accessories to fit HPC components. The front door and rear door must have perforation pattern. The racks must include cable manager, Earthing kit, casters and levelers, and other required accessories. Rack must comply with the standards either UL 60950-1 or EIA-310-E. Three phase metered PDUs must include real-time monitoring of power, temperature, and humidity and must be accessible through a browser. The PDUs and power cables must be in compliance with the industry standards. All the power cords must be factory integrated. The racks and all other accessories must have standard comprehensive onsite warranty from the OEM (refer to the Terms and Conditions item number 27).

(i)   HPC solution must have computing servers housed in its suitable chassis/racks.
(ii)   The proposed HPC solution must be in compliance with the layout given in Annexure I.
(iii) Appropriate number of high quality racks with accessories and metered PDUs to be provided.
(iv)   Structured power and network cabling must be done by the bidder.
(v)   One 1U rack mount TFT with keyboard and mouse to be provided to monitor all the servers in the solution through management ports.

Replacement spares:
(i)   Spare power supply: total of five.
(ii)   Infiniband cables: Five numbers
(iii) Infiniband switch: One
(iv)   Infiniband adaptors: Five numbers
(v)   HDD: total of four as follows:
    a. One 900 GB SAS 10000 RPM (compatible with the compute servers and backup server)
    b. One spare compatible with the proposed storage server(s).
    c. One spare compatible with the proposed storage solution.

PHYSICAL RESEARCH LABORATORY

Technical Conditions for Acceptance

i.   The bidder must demonstrate 100 teraFLOPS or higher cumulative sustained performance across the CPUs and PCIe Accelerators using LINPACK, CUDA-LINPACK or HPL. This must be run for at-least 48 hours as part of the stress/burn test.

ii. The bidder must demonstrate 50 teraFLOPS or higher cumulative sustained performance across the CPUs (using CPUs of pure CPU as well as of CPU/PCIe Accelerator nodes).

iii. The bidder must demonstrate 300 TB or more storage delivering read and write throughput of 3 GB/s or better (with 4MB block size).

iv. The bidder must demonstrate a total achievable concurrent read and write storage throughput of 6 GB/s or better (with 4MB block size).

v.   The bidder must demonstrate 50 TB of full backup to the tapes with a backup window of 48 hours or less with equal distribution of back up data across each of the proposed tape drives while backing up the data.

vi. The bidder must demonstrate workload management software feature of shutting down and powering up of the compute nodes depending on the predefined idle time and requirement.

vii. All the functionalities of the cluster must be tested including the cluster management, running MPI programs, testing capabilities of PFS, etc.

viii. The bidder must run PRL users' codes on the proposed HPC continuously for two days.

ix. The bidder must demonstrate equal or better performance of the submitted codes (refer to item number 23 of the Terms and Conditions).

x.   All benchmarks must be run in non-turbo mode.

xi. In the event of the delivered equipments failing the acceptance test, a period not exceeding two weeks will be given to rectify the defects and clear the acceptance test, failing which, PRL reserves the right to get the equipments replaced by the bidder at no extra cost. The replaced equipment must clear the acceptance test.

xii. The successful conduct and conclusion of the acceptance test for the installed goods and equipment must be the responsibility, and at the cost of the bidder.

PHYSICAL RESEARCH LABORATORY

Terms and Conditions

1) Technical compliance sheets, block diagram of HPC complimented with the schematic diagram of total HPC solution and OEM authorization letters must be submitted by the bidder, failing which the bid will be rejected.

2) The bidder must visit and do the site surveys for measuring the load bearing capacity or any other parameters.

3) The bidder must deliver a fully operational HPC solution integrating all the components listed in the technical specifications (items 1-15).

4) The bidder must have experience of supplying, supporting and servicing similar HPC clusters involving parallel distributed computing, fast inter connect, file server, etc. The bidder must attach copies of signed certificates from two separate organizations (preferably from educational or R & D) confirming that the bidder had successfully provided complete HPC solutions having performance of minimum 3 teraFLOPS within the last five financial years in India.

5) In the proposed HPC solution, compute nodes, HA master nodes, storage server(s), storage systems, backup server and tape library must be from the same OEM.

6) The OEM of the compute nodes whose product has been quoted must have at least 20 entries in the latest Top 500 list with minimum 10 entries in Top 100 (See http://www.top500.org)

7) The OEM of the compute nodes can only submit one single quotation; either directly or indirectly.

8) The bidder must be OEM or authorized partner/service provider of the OEM or System Integrator (SI) of OEM. Letter of authorization from the OEM for the same and specific to this tender (clearly mentioning PRL tender number) must be enclosed. The OEM must have registered office in India for at least the last 2 years and appropriate documents showing this must be attached along with the technical bid.

9) If the bidder is other than OEM, an undertaking from the OEM must be submitted. This undertaking must be after tender date and clearly mentioning that they would facilitate the bidder on a regular basis with all the hardware, software related issues, technology, products updates and comprehensive onsite warranty period including the probable extended comprehensive onsite warranty period and maintenance contracts as well.

10) The bidder must have well-established service and support facility at Ahmedabad operating for at least the last 2 years. Otherwise, the bidder has to depute two M.Tech engineers in Computer Science or Information Technology, with five years of experience in the field of HPC, for the whole duration of the warranty period. The bidder must provide supporting documents. At least one

of the engineers among the two must be present on-site during working hours throughout the warranty period. The bidder must provide the technical support matrix for getting any technical help during the warranty period. The onsite response time must be within 4 hours of placing a call for support.

11) The bidder must be financially sound to execute the order. The bidder must have an annual turnover of at least 30 crore each in last three financial years. The audited report for the last three years must be submitted along with the proposal.

12) Compute nodes, HA master nodes, storage servers, storage solution, and AC must be housed within the HPC room with enough working space (as described in Annexure I).

13) The bidder must migrate the existing HPC system with at least 10 compute nodes and one AC unit to the proposed room, re-integrate and make it operational (as described in Annexure II) before installing the proposed HPC solution.

14) The bidder must integrate existing EMC ISILON storage solution along with its archival storage server (with capacity of 20 TB and 44 TB respectively) into the proposed HPC and make it operational.

15) UPS, batteries, power panels and AMF panels must be housed in nearby empty UPS room of dimensions 3.53 X 4.6 X 2.34 cubic meters as described in Annexure II.

16) The bidder must provide a schematic diagram of the proposed HPC solution.

17) All cabling must be done properly so as to provide efficient air circulation and must not block any air circulation behind the servers.

18) Details of peak power consumption and peak heat dissipation/output for the HPC must be provided with the quotation.

19) The proposed UPS, DG-set and AC must be capable enough to cater to the load assuming all the proposed compute nodes are fully populated with the PCIe Accelerator cards.

20) PRL will provide only the required input electrical power cable till the UPS room as shown in Annexure II. From this room, the bidder must do the required electrical and civil works related to installation of the electrical power panel, auto switch over power panel, UPS, DG-set along with all the required materials for the same.

21) The bidder must provide all the necessary and sufficient length of cables, connectors, racks, and other components required for the quoted HPC solution.

22) The bidder must submit authorization letter from UPS, DG-set, racks and AC OEM specific to this tender clearly mentioning about the comprehensive onsite warranty.

23) The number of nodes specified in the technical specifications is the minimum estimated value calculated with more than 95% efficiency of the theoretical peak. The bidders may quote additional compute nodes (in both categories – Sr. No. 1 and 2) required to satisfy conditions (refer points 1 and 2 – Acceptance Test Procedure) for the sustained performance. The bidder must make sure to house the proposed setup within the present HPC room (see Annexure I).

24) HPC and air conditioner must be housed in the proposed site. There is a separate UPS room (see Annexure II) only for the power panel, auto switch over panel, UPS and batteries. The bidder must ensure sufficient working space for troubleshooting, servicing the servers, and ACs. The bidder must ensure to provide efficient cooling and hot air circulation inside the HPC room.

25) PRL will provide codes to be run by the technically short listed bidders within a week. They have to submit the results, CPU time and wall time of the codes executed on single/multiple node(s) with the quoted processors along with the hardware and software details, including options used. The codes must be compiled with –O2 and –O3 compiler optimizations. As a part of the acceptance test at PRL, these codes will be executed on the delivered HPC and the performance will be compared with the results submitted earlier by the bidder. Based on the comparison of the results, the bidder, if needed, must fine tune the system.

26) All testing, benchmarking, system tuning, etc. must be done onsite at PRL premises. In addition, if and when required, any other performance related issues must be resolved at the PRL premises.

27) For the proposed HPC solution, the bidder must quote the following:

   a. 3 years comprehensive onsite warranty.
   b. 5 years comprehensive onsite warranty.

   PRL reserves the right to choose one of the alternatives which is binding on the bidder.

28) Extended Warranty:
   a. The bidder has to quote separately for Extension of Warranty for the period beyond the standard Warranty period.
   b. The extended Warranty should be for Comprehensive Onsite warranty with full coverage of Spare parts and Services including Periodic preventive maintenance and breakdown services.
   c. The Rates for the above Warranty services should be quoted for Annum
   d. PRL will take appropriate decision for the Extended Warranty prior to completion of the Standard Warranty including the terms of Payment etc. and a separate Work Order/Contract will be issued.
   e. However, the Rates Quoted for the said Extended Warranty will not have any bearing on the Procurement Decision of the HPC.
   f. The bidder need to ensure uninterrupted Supply of Spares and Services during the period of Warranty and Extended Warranty irrespective of Obsolesce and will be responsible for smooth operation failure of which would be treated as breach of the original Contract inviting appropriate Penalty provisions.

29) The warranty period of the HPC solution will start from the date of the acceptance.

30) The HPC solution must be delivered onsite within eight weeks after the release of the purchase order.

31) The HPC solution must be commissioned within 8 weeks from the date of complete delivery.

32) The bidder must provide separate quotes for HPC, UPS, AC, DG-set and racks.

33) The bidder must provide training to the PRL staffs for general system administration of the proposed HPC management including at-least user/node management, installation/upgrade, queuing system management, and file system managements along with the required documentations.

34) Technical support for the administration/maintenance as and when required/requested (both at the software and hardware levels) of HPC during the warranty period. The bidder must be responsible to protect the data during any upgradation of the firmware/OS.

35) For site survey, the bidder may visit PRL only on the working days (Monday to Friday), after 10 days of release of the tender and before 10 days of closing of the tender between 13:30hrs to 16:00hrs, by taking prior appointment from Mr. Jigar Raval (079 – 2631 4035) / Mr. Samuel Johnson (079 – 2631 4036) / Mr. Tejas Sarvaiya (079 – 2631 4034).

PHYSICAL RESEARCH LABORATORY

High Performance Computing Cluster of total sustained 100 teraFLOPS with 50 teraFLOPS from CPUs (of pure cpu nodes and PCIe Accelerator nodes) and another 50 teraFLOPS from PCIe Accelerators.

1. **Pure CPU Compute nodes:**

	Make and Model		
Ser No	**Technical Specifications Required**	**Compli -ance Yes/No**	**Remarks**
1.1	**CPU**: 2 x Latest 64 Bit Processor from x86, 12 core and 30MB cache with each core capable of executing 8 flops per clock cycle, 2.7GHz or better CPU		
1.2	**PCIE ACCELERATOR Support:** At least two empty PCI Express bus (Gen 3.0) x16 slots for future FLFH Double wide PCIe Accelerator upgradability.		
1.3	**RAM**: 256 GB per node ECC DDR3-1866 MHz or better, and equal distribution of memory on DIMMs and upgradable up to 512 GB.		
1.4	**HDD**: 2 × 900 GB SAS 10000 RPM or better, configured for RAID 1		
1.5	**Infiniband**: FDR Infiniband 56Gbps or better dual port adaptor, QSFP interface in 100% non – blocking modes between the nodes		
1.6	**NIC**: Dual Gigabit (10/100/1000Mbps) Ethernet onboard with PXE boot capability.		
1.7	**RAID**: On board hardware controller offering RAID levels 0, 1. OR PCI based hardware controller offering RAID levels 0,1.		
1.8	**Power Supply**: Rack redundant energy efficient (85%) power supply.		
1.9	**Node Serviceability**: Each of the nodes must be independently serviceable without affecting functioning of remaining components of the cluster.		
1.10	**Management Ports**: At least one dedicated port for remote management.		
1.11	**Form Factor**: 2U or better.		
1.12	Number of additional compute nodes to achieve 50 teraFLOPS or more sustained performance.		
1.13	**Operating System**: Fully licensed and certified 64 bit Red Hat Enterprise Linux.		

PHYSICAL RESEARCH LABORATORY

2. **Mixed CPU/GPU Compute nodes:**

Make and Model			
Ser No	**Technical Specifications Required**	**Compli-ance Yes/No**	**Remarks**
2.1	**CPU**: 2 x Latest 64 Bit Processor from x86, 12 core and 30MB cache with each core capable of executing 8 flops per clock cycle, 2.7GHz or better CPU		
2.2	**PCIE ACCELERATOR:** 2 x Nvidia Tesla K20X or better OR 2 x Intel Xeon Phi Coprocessor 7120P or better		
2.3	**RAM**: 256 GB per node ECC DDR3-1866 MHz or better, and equal distribution of memory on DIMMs upgradable up to 512 GB.		
2.4	**HDD**: 2 × 900 GB SAS 10000 RPM or better configured for RAID 1		
2.5	**Infiniband**: FDR Infiniband 56Gbps or better dual port adaptor, QSFP interface in 100% non – blocking modes between the nodes.		
2.6	**NIC**: Dual Gigabit (10/100/1000Mbps) Ethernet onboard with PXE boot capability.		
2.7	**RAID**: On board hardware controller offering RAID levels 0, 1. OR PCI based hardware controller offering RAID levels 0,1.		
2.8	**Power Supply**: Rack redundant energy efficient (85%) power supply.		
2.9	**Node Serviceability**: Each of the nodes must be independently serviceable without affecting functioning of remaining components of the cluster.		
2.10	**Management Ports**: At least one dedicated port for remote management.		
2.11	**Form Factor**: 2U or better.		
2.12	Number of additional compute nodes to achieve 50 teraFLOPS or more sustained performance.		
2.13	**Operating System**: Fully licensed and certified 64 bit Red Hat Enterprise Linux.		

PHYSICAL RESEARCH LABORATORY

3. **Master Node with Redundancy HA mode**

Make and Model			
Se r No	**Technical Specifications Required**	**Compli -ance Yes/No**	**Remarks**
3.1	**CPU**: 2 x Latest 64 Bit Processor from x86, 12 core and 30MB cache with each core capable of executing 8 flops per clock cycle,2.7GHz or better CPU		
3.2	**PCIE ACCELERATOR:** 2 x Nvidia Tesla K20X or better OR 2 x Intel Xeon Phi Coprocessor 7120P or better		
3.3	**RAM**: 256 GB per node ECC DDR3-1866 MHz or better, and equal distribution of memory on DIMMs upgradable up to 512 GB.		
3.4	**HDD**: 2 × 900 GB SAS 10000 RPM or better, configured for RAID 1 (Software or Hardware).		
3.5	**Infiniband**: FDR Infiniband 56Gbps or better dual port adaptor, QSFP interface in 100% non – blocking modes between the nodes.		
3.6	**NIC**: Dual Gigabit (10/100/1000Mbps) Ethernet onboard with PXE boot capability Ethernet Management port 10/100Mbps.		
3.7	**RAID**: On board hardware controller offering RAID levels 0, 1		
3.8	**Power Supply**: Rack redundant energy efficient (85%) power supply.		
3.9	**Node Serviceability**: Each of the nodes must be independently serviceable without affecting functioning of remaining components of the cluster.		
3.10	**Management Ports**: At least one port for remote management.		
3.11	**Form Factor**: 2U or better		
3.12	**Operating System**: Fully licensed and certified 64 bit Red Hat Enterprise Linux.		

4. **Make and Model**

Make and Model			
Se r No	**Technical Specifications Required**	**Compli -ance Yes/No**	**Remarks**
4.1	**Make and Model**: The items 1, 2 and 3 (pure CPU nodes, hybrid CPU/PCIe Accelerator nodes and HA master nodes) must be of the same OEM and model		

PHYSICAL RESEARCH LABORATORY

5. **Storage System and Storage Server:**

Make and Model			
Se r No	**Technical Specifications Required**	**Compli -ance Yes/No**	**Remarks**
5.1	**Disk Space**: Minimum of 300 TB usable space after RAID 5 or better (Hardware or File System based software) dynamically configurable as per usage. Must be upgradable up to 1PB in the same namespace with same throughput.		
5.2	**Storage Throughput (Read/Write):** Concurrent 3 GB/sec (or higher) write and 3 GB/sec (or higher) read amounting to a total achievable throughput of 6 GB/sec or higher. The bidder must demonstrate this storage throughput (with 4MB block size) using one or more of the standard benchmark applications like IOzone, IOR or Bonnie++.		
5.3	**Cache:** Minimum 16 GB.		
5.4	**Connectivity to Cluster:** Storage must connect to cluster Infiniband network via storage servers.		
5.5	**Reliability:** The storage solution must have no single point failure		
5.6	**Management Software:** Appropriate web based management software to monitor the health and status of the Storage System.		
5.7	**Parallel File System Software:** Parallel File System software must be commercially licensed and supported version from the PFS software OEM.		
5.8	**Storage System:** Rack mountable with redundant and hot swappable power supply.		
5.9	**Software:** Commercial and OEM supported PFS configured to present the entire storage as a single unified addressable namespace to the HPC nodes.		
5.10	**Operating System:** Fully licensed and certified 64 bit Red Hat Enterprise Linux.		

PHYSICAL RESEARCH LABORATORY

6. **Backup Server with Backup Software:**

Make and Model			
Ser No	**Technical Specifications Required**	**Compli -ance Yes/No**	**Remarks**
6.1	**CPU:** 2 x Latest 64 Bit Processor from x86, 2.5GHz or better (4 core per processor or more)		
6.2	**RAM:** 32 GB ECC DDR3-1866 MHz or better and expandable up to 128 GB.		
6.3	**HDD:** 2 x 900GB SAS, 10000 RPM or better in RAID-1, expandable to 8 HDDs and mounted on Hot-swap HDD bay.		
6.4	**Interconnect:** Dual Port FDR Adapter and 6Gb/s FC/SAS HBAs to connect Tape Library.		
6.5	**NIC:** At least Four Gigabit Ethernet.		
6.6	**Power Supply:** Rack redundant energy efficient (85%) power supply.		
6.7	**Backup Software:** Licensed and commercial backup software with RHEL support with the required number of licenses for backup of 50 TB data and upgradable up to 300 TB data.		
6.8	**Operating System:** Fully licensed and certified 64 bit Red Hat Enterprise Linux.		

7. **HPC Tape Library:**

Make and Model			
Ser No	**Technical Specifications Required**	**Compli -ance Yes/No**	**Remarks**
7.1	**Drive:** Min 4 x Half-high LTO6 SAS drives or better.		
7.2	**Number of Slots**: Minimum 48 cartridge slots and minimum 3 mail slots.		
7.3	**Data transfer rate (per drive):** Up to 160 MBps native.		
7.4	**Interface:** 6Gb/s fiber cable or SAS.		
7.5	**Management:** Remote library management through a standard web interface, local LCD display and indicators for power, drive and activity, error status and message information.		
7.6	**Power Supply:** Redundant power supply.		
7.7	**Media:** Minimum 200 x LTO6 RW Data Cartridges with 40 Universal Cleaning Cartridges.		
7.8	**Barcode Labels:** 200 barcode labels for RW cartridges and 40 (starting with 'CL') for cleaning Cartridges.		

PHYSICAL RESEARCH LABORATORY

8. **Operating System**

Ser No	Technical Specifications Required	Compli-ance Yes/No	Remarks
8.1	Fully licensed and certified latest (version 6.5 or above) 64 bit RHEL on all compute nodes		
8.2	Fully licensed and certified latest (version 6.5 or above) 64 bit RHEL on HA master nodes		
8.3	Fully licensed and certified latest (version 6.5 or above) 64 bit RHEL on storage server(s)		
8.4	Fully licensed and certified latest (version 6.5 or above) 64 bit RHEL on backup server		

9. **Cluster Management Software**

Make and Model			
Ser No	**Technical Specifications Required**	**Compli-ance Yes/No**	**Remarks**
9.1	Cluster Management Software must support both PCIe Accelerator and CPU based hybrid cluster.		
9.2	Software must handle all the nodes (compute and master) provided in the solution.		
9.3	OEM supported licensed suite.		
9.4	GUI/Web based management.		
9.5	Extensive cluster monitoring capabilities to access node level performance parameters using GUI and with well-designed graphical reports for both the PCIe Accelerator and CPU.		
9.6	Management software must provide proactive notification of an actual or impending component failure alerts.		
9.7	Permission for only secure shell based access and a robust parallel execution shell implementation.		
9.8	Licensed software for interconnect performance monitoring, communication management and cluster monitoring.		

PHYSICAL RESEARCH LABORATORY

10. **Workload Management Software**

	Make and Model		
Ser No	**Technical Specifications Required**	**Compli -ance Yes/No**	**Remarks**
10.1	Integrated workload management solutions for both the PCIe Accelerator and CPU with web based as well as terminal/console based job submission and HPC performance analysis and reporting.		
10.2	Ability to view available resources like CPU, PCIe Accelerator, RAM, nodes, etc in the web as well as in the terminal/console for the users and system administrators.		
10.3	Commercially licensed job scheduler with complete support and integration of scheduler for job submission and performance analysis for the proposed cluster.		
10.4	During the warranty period, the bidder must help users to integrate their applications with batch submission script to facilitate seamless usage of the HPC Solution.		
10.5	Complete cluster integration with comprehensive onsite support to be provided by the software OEM. (Refer to point number 27 of the Terms and Conditions)		
10.6	The software must have the ability to shut down compute nodes which are not utilized for a predefined period of time. It must then boot up the nodes when requirement arises. The bidder must demonstrate this feature.		

PHYSICAL RESEARCH LABORATORY

11. **Programming Tools:**

Ser No	Technical Specifications Required	Compli -ance Yes/No	Remarks
11.1	If the bidder quotes: • Nvidia K20X based HPC solution, the bidder must quote for the latest PGI Accelerator CDK for Linux (x86+GPU) with 2 floating user perpetual license. OR • Intel Xeon Phi 7120P HPC solution, the bidder must quote for the latest PGI Accelerator CDK for Linux (x86) with 2 floating user perpetual license.		
11.2	Latest Intel Cluster Studio XE 2013 with 2 floating user perpetual licenses		
11.3	Latest GNU Compiler Collection version 4.9.0 or higher.		
11.4	Support for OpenMPI, Intel MPI and MPICH libraries across all the compilers. The bidder must demonstrate the functionalities of all the three MPI Implementation.		
11.5	The MPI implementation must be accelerator aware		
11.6	All the necessary tools for parallel programming on CPU and PCIe Accelerator like OpenMP, OpenACC, OpenCL and CUDA must be supplied and installed.		
11.7	All PCIe Accelerator specific libraries (like CUBLAS, CUFT, CUPARSE in case of NVIDIA GPU or Intel libraries in case of Intel Xeon Phi) and others to be provided as integrated programming environment..		
11.8	Proposed compilers and libraries must be best optimized for the quoted HPC solution and must be commercially licensed and supported by OEM.		
11.9	Performance analysis tools for analysis of both the PCIe Accelerator and CPU programs in all the languages covered by the above compiler suites.		
11.10	Intel® VTune™ Amplifier XE.		
11.11	Intel® Inspector XE.		
11.12	Intel® Advisor XE.		
11.13	Valgrind.		
11.14	GNU project debugger.		
11.15	Integrated Development Environment on RHEL must be provided.		
11.16	All the patches and updates for all the software tools must be provided during the on-site warranty period.		
11.17	Other libraries including but not limited to MKL, BLAS, LAPACK, LINPACK, NetCDF, HDF5, etc must be provided.		

PHYSICAL RESEARCH LABORATORY

12. **UPS:**

Ser No	Technical Specifications Required	Compli-ance Yes/No	Remarks
12.1	Minimum 127kW with N+1 redundancy, modular, hot scalable to at-least 157KW.		
12.2	The proposed UPS system and batteries must be capable enough to cater the load of the HPC setup if all the proposed compute nodes are fully populated with the PCIe accelerator cards.		
12.3	The bidder must also integrate few of our existing critical servers with the proposed UPS system.		
12.4	The bidder must include all components including appropriate industry standard cables, power distribution panels, required new copper Earthings, and any other accessories required for the installation and commissioning of the UPS system.		
12.5	The bidder must visit and do the site surveys to measure required cable lengths and any other accessories requirements, PRL will only provide input power cable to the AMF panel. It is the responsibility of the bidder to do the entire power cabling required from AMF panel to UPS, from UPS to racks and component level as well as up to cooling units.		
12.6	Minimum 25 minutes of battery backup on the full load of the proposed HPC.		
12.7	The UPS system must have Ethernet and SNMP support along with appropriate software. The Ethernet web/SNMP Adaptor must allow one or more Network Management Systems (NMS) to monitor and manage the UPS in a network environment. Linux supported Management Information Base (MIB) must be provided.		
12.8	The UPS system, in conjunction with a network interface card, must be capable of gracefully shutting down one or more servers when the UPS is operating from the battery and the available runtime reaches a user defined threshold.		
12.9	The UPS system must have redundant main controller modules, redundant logic power supplies and must be hot swappable.		
12.10	The UPS system must have redundant main controller modules, redundant logic power supplies and must be hot swappable		
12.11	The UPS system must have internal output distribution system to distribute uninterrupted power for the load. The output distribution must be N+N from the UPS to the rack PDUs. The output power must be distributed through 3 phase and neutral busduct.		
12.12	Modular hot scalable/swappable power distribution unit with provision to at-least accommodate MCBs of 16 amps, 32 amps and 63 amps rating for the UPS output power distribution. It must be possible to add or replace		

	circuit breaker modules without switching off the load bus. If required, external power distribution system with similar features must be planned and implemented to provide power supply to all the racks. At least 4 nos. of 3 pole or 12 nos. 1 pole MCBs or higher slots must be provisioned for future expansion of the server racks.		
12.13	The bidder must provide all the required accessories towards the integration of the UPS to the HPC solution. Modular PDUs must not require a downtime to add a circuit breaker, power cord, or power connection.		
12.14	The UPS system must be rated for full capacity output with the following general specifications: a. AC Input Nominal Voltage: 230 V, 3 Phase, 4 wire + G, 50 Hz. b. Maximum Frequency Range: 40-70Hz, c. Input Power Factor: 0.99 with load at 100% or better, d. Input Current Distortion with no additional filters: less than 5%, e. AC Nominal Output: 230V, 3 Phase, 4 wire + G, 50 Hz. f. AC Output Voltage Distortion: less than 2% at 100% linear Load. Less than 6% for nonlinear load and must be compliant with EN50091-3/IEC 62040-3. g. AC Output Voltage Regulation: ±1% for 100% linear or nonlinear Load. h. Voltage Transient Response: ±5% maximum RMS change in a half cycle at load step 0% to 100% or 100% to 0%. Voltage Transient Recovery within less than 50 milliseconds. i. Output Voltage Harmonic Distortion: It must be less than 2% THD maximum and 1% single harmonic for a 100% linear load. j. System AC-AC Efficiency: Normal operation ≥ 96% at 40% to 100% load. Battery operation ≥ 96% at 40% to 100% load or better. k. Output Power Factor Rating: 0.5 or better (leading or lagging) without any output derating.		
12.15	The UPS must have an appropriate mechanism to protect the system from overload, over-temperature, input/output and over/under voltage or any other fluctuations.		
12.16	The battery charging circuit must have an appropriate mechanism that maximizes the battery life. The battery charging circuit must remain active when the system is in Static Bypass and also during the Normal Operation.		
12.17	The UPS system must support an optional battery bank. Each battery module must have a feature to at-least monitor voltage and temperature. Battery charging current must be temperature compensated. The UPS system must incorporate a battery management system to monitor the health of battery modules. The system must have a feature to notify about a failed or weak battery. The batteries must be of long life (5-10 years) with a flame retardant		

	battery casing.		
12.18	Input cabling method for both the top or bottom provisions must be available.		
12.19	**Modes of Operations**: a. **Normal**: The UPS must operate on-line continuously to monitor and regulate power to the load. The UPS must be capable of full battery recharge while simultaneously providing regulated power to the load. b. **Battery/Backup**: In instances of input supply failures, the power to the HPC must be supplied from the battery system. There must be no interruption in power to the HPC during transfer to battery operation and back to normal. c. **Recharge**: Upon restoration of the input supply, there must be an appropriate mechanism to provide regulated power to the load while concurrently recharging the battery. d. **Static Bypass**: The centralized static bypass must be used to provide controlled transfer of the load from the UPS output to the bypass source. This transfer and the corresponding return to the UPS of the load must take place without any interruption of the power. In the event of an UPS output fault or significant output overload emergency, this transfer must be done automatically. Manual transfer to the Static Bypass must also be available.		
12.20	A digital display unit must be located on the front of the UPS showing at-least the following parameters: input voltage, output voltage, frequency, battery status, current, logs with date and time stamps.		
12.21	**Storage Ambient Temperature:** 0°C to 40°C or better		
12.22	**Operating Ambient Temperature:** 0°C to 40°C or better		
12.23	**Relative Humidity:** 0 to 95% Non-condensing or better		
12.24	The OEM must have a nationwide service network, consisting of well qualified service personnel to perform start-up, preventative maintenance, and service of the UPS system and power equipment. The bidder/OEM must offer 24x7 service support in Ahmedabad.		
12.25	Original replacement parts must be available through the OEM. PRL will not allow any component level repairs in the UPS system inside the UPS room.		
12.26	The comprehensive onsite warranty must be offered directly by the OEM (Refer to item number 27 of Terms and Conditions).		
12.27	The vendor must provide the onsite operation training to the PRL staffs.		
12.28	The vendor must also provide all the installation and operational manuals.		

PHYSICAL RESEARCH LABORATORY

13. **DG-Set:**

Ser No	Technical Specifications Required	Compli -ance Yes/No	Remarks
13.1	**Engine**: a. **Design**: 8 Cylinder, Vee design, Water cooled, rated at 1500 RPM or higher, developing 490 BHP or more vertical totally enclosed electric start, compression ignition, designed to run continuously. b. **Compliance**: The engine along with all the standard accessories like radiator with fan and fan guard, fuel pump, water pump, lube oil pump, air to air charge cooler, electronic governor, dry type air cleaner with vacuum Indicator, stainless steel expansion bellow, exhaust silencer (residential type), lube oil filter, fuel oil filter, flexible fuel pipe (wire braded), battery charging alternator with built-in regulator, etc must be in compliance with standards like IS 10002, ISO 3046, BS 5514, DIN 6271. c. **Safety**: There must be appropriate safety measures for over speed of moving parts, high water temperature, etc. It must be equipped with a mechanism to display the messages of engine starting and stopping, display current operating values, selectable manual or automatic starting modes, and must have a test mode to facilitate compliance testing and troubleshooting. It must also provide at-least the following standard protective features pertaining to changes in at-least (i) fuel level (ii) oil pressure (iii) engine speed (iv) battery voltage (v) temperature of water, oil coolant, canopy, or any other parameters. There must be warnings or alarms for abnormalities in at-least (i) oil pressure (ii) engine temperature (iii) battery voltage and charge status		
13.2	**Alternator:** Minimum 380KVA/304KW alternator, suitable for continuous operation rated at 1500 RPM 415 V, 0.8 PF, 50Hz, 3Ph. in SPDP enclosure or better, self-excited and self-regulated, brush less, H class of insulation, IP 23 class of protection, floor mounted with ball or bearings on end shields. The alternator must be in compliance with IS: 4722/BS/2613 and must be suitable for the tropical conditions.		
13.3	**Fuel Tank**: Minimum 8 hours capacity, with inlet and outlet arrangements, with		

	air vent and drain plug arrangements.		
13.4	**Base Frame:** The base frame must be suitable to couple with the above engine and alternator.		
13.5	**Batteries:** 12 V with 180Ah or suitable enough for the proposed DG set, leads and battery cable		
13.6	**Standard Control Panel:** Sheet must be made of steel, duly painted with stoving enamel paint consisting of the following: (a) one MCB/MCCB of suitable rating, (b) three numbers of current transformer, (c) two numbers of indicating lamps and (d) one set of control fuse or more		
13.7	**Construction:** The enclosure must be modular in construction and must be fabricated with industry standard 1.6 mm thick Cold Rolled Close Annealed (CRCA) sheet. Base frame must be made of IS MC from the suitable sections/sheet metal. Industrial locking system must be provided on the doors. All the doors must be provided with high quality gaskets. The acoustic enclosure must limit the output noise level to 75 dB (A) or lower at a distance of 1 m around the set.		
13.8	**Corrosion Resistance:** All sheet metal parts must be processed through 7-tank process. Sheet metal components must be powder coated CRCA sheet. Base frame and all other hardware used must be passivated to avoid rusting.		
13.9	**Acoustic Insulation:** Sound proofing of the enclosure must be done with foam in compliance with IS-8183 of 64 kg/m 3 density with 50 mm thickness or better. This must be further secured with perforated epoxy paint. Attenuators must be provided to control sound at entry and exit, to and from the container. Specially designed residential silencer must be provided.		
13.10	**Natural Ventilation and Air Circulation:** The engine must be water cooled. The engine must have a special radiator fan to take care of air circulation inside the canopy. Exhaust pipe must be thoroughly insulated by covering it with glass wool and further cladded in the enclosure.		
13.11	**Electrical**: Neutral/body earthing points at the sides of the enclosure must be isolated through a dough moulded compound		
13.12	**Safety:** Emergency push button to stop the DG set from outside		
13.13	**Automatic Switchover:** AMF panel must be included for automatic switching from DG-set to the main power supply and vice-versa		
13.14	**Existing server integration**: The bidder must also integrate few of our existing critical servers with the proposed DG-set.		
13.15	**Installation and Integration**: The bidder must install and integrate the entire DG-set onsite including AMF panel, power cabling, manual change-over switch, cable, spring mounts, exhaust piping, the required copper earth pits and the appropriate civil works.		

13.16	**Warranty**: Onsite comprehensive warranty from the OEM as per the Terms and Conditions (item number 27).		
13.17	The bidder must take care of any approval required from any agencies related to environment, supply of diesel, etc. The bidder must also liaise between PRL and authorized agencies to provide continuous diesel supply to the DG-set during the warranty period.		
13.18	The proposed DG-set must comply with the latest CPCB-II norms and IS/BIS standards.		

14. **AC:**

Ser No	Technical Specifications Required	Compli-ance Yes/No	Remarks
14.1	Row based air cooled precision cooling system with minimum capacity of 29 KW per unit or better. At least 5 units with N+1 redundancy configuration and Hot Aisle Containment System. Minimum load to cool must be 127 KW or higher.		
14.2	Cooling units must be placed between two racks to allow horizontal airflow pattern (cooling unit should supply cold air in front of rack and suck hot from rear end of it). However, cooling units must not be placed at the extreme end of the rows.		
14.3	Supply temperature to be maintained at 23°C or lower with an accuracy of 1°C.		
14.4	At least two of the units must be with built-in heater and humidifier for humidity control.		
14.5	The units must be of appropriate size, and include casters and leveling feet.		
14.6	The frame must be constructed of 15 gauge steel or better, and welded for maximum strength. All the units must have the provision for maintenance from the front and rear. Exterior panels must be of high quality steel with high density foam insulation. Insulation must be in compliance with UL94-5VA, ASTM E84, and flame spread and smoke developed rating of 25/50. Front and rear exterior panels must be equipped with a lock.		
14.7	**Fans:** Each unit must be equipped with a variable speed and electrically commutated fan(s) with finger guard(s). Each unit must also operate in the event of fan(s) failure.		
14.8	**Power Supply:** The power supply unit must be provided with thermal-magnetic circuit breakers with interrupt capacity ratings as per the UL489/CSA C22.2/IEC-947 standards. The units must include a main disconnect switch, located on the electrical panel.		
14.9	**Display Interface:** The display interface must allow monitoring and configuration of the air conditioning unit. Functions must include status report and configuration of various parameters.		
14.10	**Water Detector:** Each unit must have a leak detection mechanism with visual and audible alarms.		
14.11	**Alarms:** The system must automatically activate the visible and audible alarms in case of faults.		
14.12	**Network Management Card:** Each unit must include a Network Management Card to provide management.		
14.13	**Cooling Coil and Condensate Pan:** The cooling coil must use raised lance type corrugated aluminum fin copper tube coils. Coil end supports must be 15 gauge or better, made of G90 galvanized steel. The coil must be rated for a maximum pressure to cater the entire		

	setup load, and the coils must be compliant with standard UL207. The coil header must be equipped with a drip plate in the bottom to capture and direct the condensation accumulating on the suction header tube to the drain pan.		
14.14	**Compressor:** a. The compressor must be capable to support varying load conditions and cater to the HPC load by having control on the speed. b. The system must have oil return protection feature. c. Compressor must have noise reduction feature. d. A sight glass must be provided for oil charging.		
14.15	**Condensate Pump:** A single factory installed and wired condensate pump must have dual internal floats. The system must protect the pump from the corrosion.		
14.16	**Filter:** The standard pleated filters must be 30% or higher efficient as per ASHRAE Standards 52.1, UL Class 2 (MERV 8 as per ASHRAE 52.2) and EN779 G4.		
14.17	**Temperature Sensors:** Temperature sensors must be mounted behind the front and rear doors to provide control inputs based on the supply and return air temperatures. Sensors must have an accuracy of 1°C. At-least three remote rack inlet temperature sensors must be shipped with each unit to provide control input based on the rack inlet temperature.		
14.18	The unit must be equipped to facilitate field connections from either the top or bottom. Unit connections must be made internal to the unit.		
14.19	For machine with Humidity Control: **a) Humidifier**: Humidifier: The humidifier must be factory integrated, with disposable cylinder. Humidifier canisters must be replaceable. The humidifier must provide complete status and control. Humidifier must control flush cycling and conductivity via automated controls. Humidifier capacity must be 3 kg or better of steam per hour. **b) Electric Reheat:** Electric reheat system employing low power density with fin tublar contruction and the casing must be galvanized steel of appropriate guage.		
14.20	**UL Listing for Containment:** All the system components must be certified as suitable for the proposed HPC setup environment as per UL Listings: UL484, CSA C22.2 No.236 and UL723S.		
14.21	**Containment Door:** i) Metal doors of appropriate dimensions must be provided to prevent any air leaks. ii) Doors must permit access into the contained aisle for maintenance or servicing. Standard door operation must not interfere with access or service on any rack or rack based equipment. Doors must be provided with a window,		

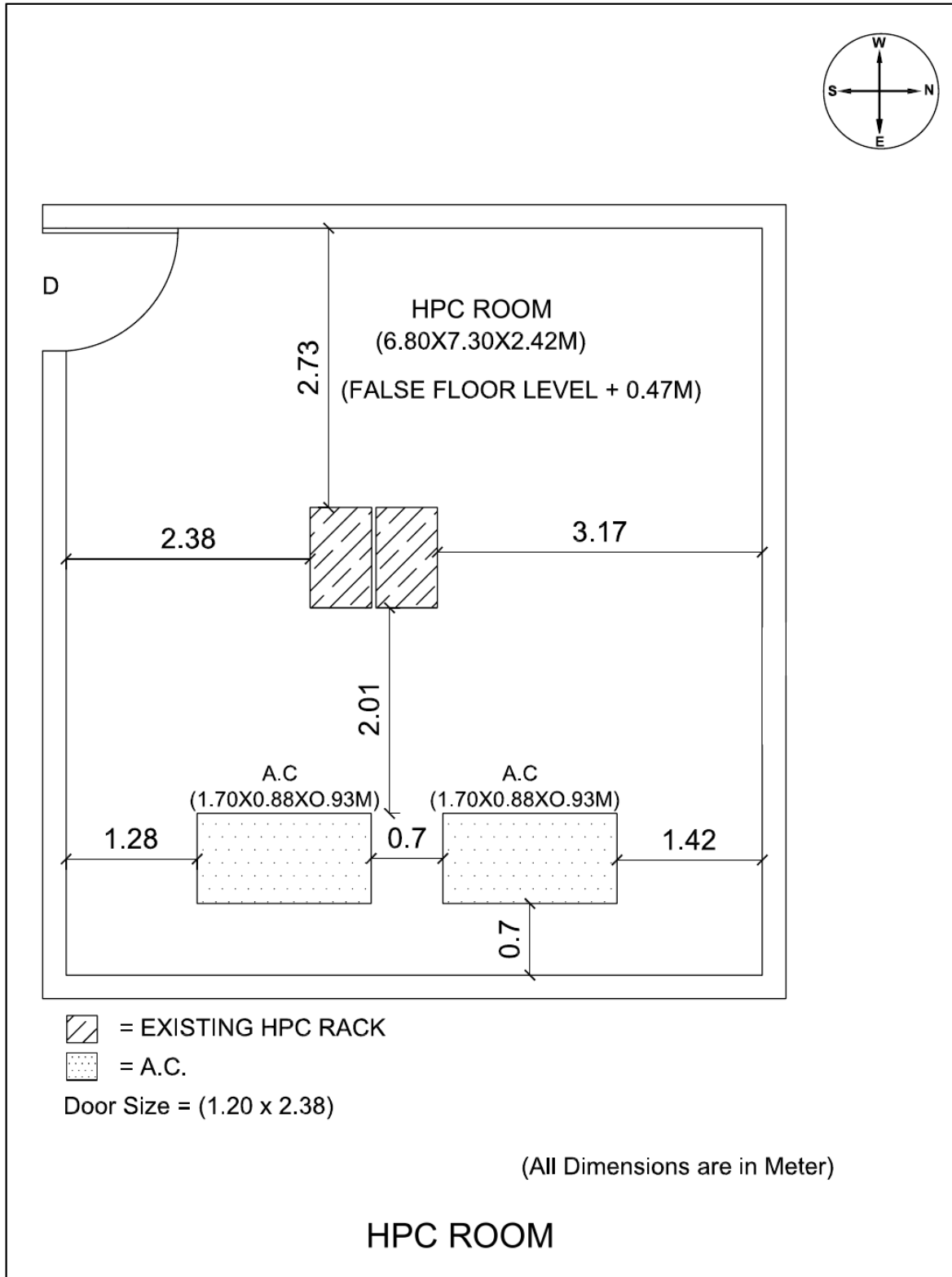|		Compliance Yes/No	Remarks
	handles and latches.		
14.22	**Ceiling Panels for Containment:** i) Ceiling panels must be thick V0 clear panels with aluminum framing, or of thick Lexan clear ribbed panels. ii) Flame spread rates: Smoke development index and flame spread index must be in compliance with UL723 or ASTM84. The nominal thickness, smoke development index, and flame spread index must be in compliance with UL723 or ASTM84. Minimum Light Transmission as per ASTM D1003 must be equal to 82% or higher		
14.23	Warranty: Comprehensive onsite warranty from the OEM as per the Terms and Conditions (item number 27).		

15. **Racks:**

Ser No	Technical Specifications Required	Compli-ance Yes/No	Remarks
15.1	42U Rack enclosure with the required accessories to fit HPC components		
15.2	The front door and rear door must have perforation pattern		
15.3	The racks must include cable manager, Earthing kit, casters and levelers, and other required accessories		
15.4	Rack must comply with the standards either UL 60950-1 or EIA-310-E		
15.5	Three phase metered PDU must include real-time monitoring of power, temperature, and humidity and must be accessible through the browser		
15.6	The PDUs and power cables must be in compliance with the industry standards		
15.7	All the power cords must be factory integrated. The racks and all other accessories must have standard comprehensive onsite warranty support (Refer Terms and Conditions item number 27)		
15.8	HPC solution must have computing servers housed in its suitable Chassis/Racks		
15.9	The proposed HPC solution must be in compliance with the layout given in Annexure I		
15.10	Appropriate number of high quality racks with accessories and metered PDUs to be provided.		
15.11	Structured power and network cabling must be done by the bidder.		
15.12	One 1U rack mount TFT with keyboard and mouse to be provided to monitor all the servers in the solution through management ports.		
15.13	Warranty: Comprehensive onsite warranty from OEM as per terms and conditions (item number 27)		

HPC ROOM

(All Dimensions are in Meter)

Legend:
- ⬚ = EXISTING HPC RACK
- ⬚ = A.C.
- Door Size = (1.20 x 2.38)

HPC ROOM
(6.80X7.30X2.42M)
(FALSE FLOOR LEVEL + 0.47M)

A.C
(1.70X0.88XO.93M)

A.C
(1.70X0.88XO.93M)

Dimensions: 2.73, 2.38, 3.17, 2.01, 1.28, 0.7, 1.42, 0.7

PHYSICAL RESEARCH LABORATORY
Annexure II: Computer Centre

ROOM
(IN USE)

UPS ROOM
(3.53X4.60)

7.98

10.28

1.60MT WIDE PASSAGE

12.30

D1

HPC ROOM
(6.80X7.30X2.42M)

(FALSE FLOOR LEVEL + 0.47M)

2.73

SERVER ROOM
(IN USE)

2.384

3.174

2.01

A.C
(1.70X0.88XO.93M)

A.C
(1.70X0.88XO.93M)

1.28

0.7

1.42

0.7

PROPOSED ROOM
FOR EXISTING HPC
MIGRATION

= EXISTING HPC RACK

= A.C.

Door Size(D1) = (1.20 x 2.38)

(All Dimensions are in Meter)

PART PLAN OF COMPUTER CENTER