HARDWARE REQUIREMENTS FOR SCADA/DMS

5.0 Introduction

This section articulates the hardware requirements for the SCADA/DMS system . The conceptual hardware configuration diagram of SCADA/DMS control centre is indicated in **Figure-1 of section 1 chapter1**. The bidders are encouraged to optimise the hardware for servers where SCADA, DMS & ISR applications can be combined or distributed in any combination with adequate redundancy. However quantity of servers shall be as per detailed bill of quantities for SCADA/DMS defined in **section 8**. Bidder shall assess the adequacy of hardware specified in the BOQ & if any additional hardware is required to meet all the requirements of the technical specifications, the same shall also be included in the offer. The Bidder shall offer the minimum hardware configuration as specified here for various equipment, however if required, higher end hardware configurations shall be offered to meet all the requirements of the technical specification. The redundant hardware such as servers (Except DTS, development server) , CFE, etc shall work in hot standby manner. I f the SCADA/DMS control centre is collocated with R-APDRP DC/DR centre, then IT infrastructure under R-APDRP such as LAN/WAN security & networking hardware shall be used. However, it is necessary to ensure that the functional requirements , availability & performance aspects are met as per SCADA/DMS system specification of R-APDRP

5.1 General Requirements for Hardware

All hardware shall be manufactured, fabricated, assembled, finished, and documented with workmanship of the highest production quality and shall conform to all applicable quality control standards of the original manufacturer and the Contractor. All hardware components shall be new and suitable for the purposes specified. All hardware such as computers, computer peripherals/accessories etc. and networking products proposed and implemented shall conform to latest products based on industry standard. All hardware shall be of reputed make.

All servers and workstations shall include self-diagnostic features. On interruption of power they shall resume operation when power is restored without corruption of any applications.

The hardware shall be CE/FCC or equivalent international standard compliance . The specification contains minimum hardware requirement. However, the contractor shall provide hardware with configuration equal or above to meet the technical functional & performance requirement . Any hardware /software that is required to meet functional , performance & availability requirement shall be provided by Contractor & the same shall be mentioned in the BOQ at the time of bid . If not mentioned at the time of bid, contractor shall provide the same without any additional cost to the owner

The proposed system shall be designed for an open & scalable configuration, to ensure the inter-compatibility with other systems of the Utility, the future smooth expansion as well as the easy maintainability. The proposed hardware configuration should be extended by adding either CPU processors / memory boards / disks etc in delivered units or additional units for capacity extension.

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The configuration of the SCADA/DMS shall comprise a distributed computing environment with an open systems architecture. The system architecture shall be open internally and externally to hardware or application software additions, whether supplied by the original supplier of the SCADA/DMS or obtained from third party vendors, both for capacity expansion and for upgrading functionality, without affecting existing SCADA/DMS components or operation.

To be recognized as a true open computer system, all internal communications among the SCADA/DMS Servers and all external communications between the SCADA/DMS and other computer systems shall be based on widely accepted and published international or industry standards which are appropriate and relevant to the open systems concept or should have a field proven acceptance among utilities. This applies to the operating system, database management system, and display management system, as well as to APIs providing standardized interfacing between System software and application software.

The contractor should ensure that at the time of final approval of hardware configuration/BOQ, all the above hardware are current industry standard models and that the equipment manufacturer has not established a date for termination of its production for said products. Any hardware changes proposed after contract agreement shall be subject to the following: -

a)   Such changes/updates shall be proposed and approval obtained from Employer alongwith the approval of Drawings/documents.

b)   The proposed equipment shall be equivalent or with better features than the equipment offered in the Contract.

c)   Complete justification alongwith a comparative statement showing the original and the proposed hardware features/parameters including technical brochures shall be submitted to the Employer for review and approval.

d) Changes/updates proposed will be at no additional cost to the Employer.

5.2 Hardware Configuration

In this technical specification all hardware has been broadly classified as server and Peripheral device. The term "server" is defined as any general-purpose computing facility used for hosting SCADA, DMS & ISR application functions as defined in the specification. The servers typically serve as the centralized source of data, displays and reports. The term "Peripheral Device" is used for all equipment other than servers. Peripheral device includes Operator Workstations, WAN router, LAN, Printer, , Time and Frequency system, External Auto loader, External Cartridge Magnetic tape drive, VPS, RTU/FRT U etc.

5.2.1 Servers

The OEM of servers shall be member of TPC/SPECMARK . can be broadly classified into the following categories:

A) Application server
- SCADA/DMS
- ISR
- NMS
- Web server

B) Communication server
- Front –End server (Communication Front End) FEP(CFE)
- ,ICCP /Inter control centre communication server

C) De –militarized server (DMZ)
- web server with load balancing

D) Training & development system server
- DTS #
- Developmental server #

E) Data recovery
- DR/ Communication server ^

The minimum hardware configuration of the servers shall be:

- 2.4 GHZ each processor (in case the offered server is RISC & EPIC based processor speed shall be at least 1.2GHz)
- Minimum 2 Processors
- 8GB Main memory (RAM) For all servers .
- 216 GB Auxiliary memory (Hard disk drive) For all servers .
- 160/320GB Cartridge magnetic tape drive (DAT) or MO disk
- CD R/W drive
- 19" TFT colour monitor
- Keyboard & Mouse
- Dual 10/100/1000Mbps Ethernet ports (Single for DTS & Developmental server #)
- One hot pluggable port for external Cartridge magnetic tape drive
- TPC/ Spec mark performance compliance
- redundant power supply
- redundant fan

SCADA/DMS and other servers shall be RISC (Reduced Instruction Set for Computation) or Non RISC e.g. EPIC/CISC etc.

Contractor shall provide cubicle mounted servers. The main & standby servers shall be provided with separate cubicles where each cubicle can be provided with one set of TFT monitor, keyboard, and mouse through KVM switch with retraceable tray.

5.2.1.1 Application servers

Redundant SCADA/DMS servers shall house SCADA/DMS application. Redundant ISR application shall be provided with common external memory for mass historical data storage and retrieval. The external memory shall comprise of multiple hot pluggable type hard disks configured in RAID configuration. (Except RAID-0) The external memory shall be connected either directly to the ISR server through SCSI /SAS interface or directly on the LAN (Network Attached Storage). Alternatively, the bidder may offer RAID with each server to meet the mass storage requirement in place of common external memory.. The minimum requirement for external RAID for ISR servers is as below. The SCADA shall include historical data storage configured to store historical data at the storage rates, for the required period of time, and for the Ultimate historical database sizes given in section 8.

- Storage Array
- Controller Cache: 512 MB per controller standard
- Integrated RAID controller with an LCD/LED status display and 256 MB read/write battery-backed cache (expandable to 512 MB per controller).
- Host Interface: Fibre Channel connection per controller from the host side
- Host Ports per Controller: Dual 2 Gb/s
- RAID Levels(EXCEPT RAID 0)
- Redundant Controller: Yes

Redundant Web / Active Directory Services Server shall host Web Applications for SCADA/DMS LAN and the DNS configuration

Redundant NMS server shall be provided to host NMS application

5.2.1.2 Communication Servers:

5.2.1.2.1 FEP(CFE) Server

The redundant FEP server shall be a functional unit that offloads the task of communication & pre processing between RTUs/FRTUS/FPIs & SCADA/DMS servers. All RTUs/FRTUs/FPIs shall be connected to CFE through IEC 60870-5-104/101 link.. For any existing RTUs/FRTU/FPI that are to be integrated, interface must be available to use existing protocols. Free slots shall be made available inside the FEP server, so as additional communication boards can be plugged-in to meet the network future expansion. Each channel shall be assigned a different protocol and the front-end shall be able to manage several protocols in parallel.

The redundancy of front-end servers shall allow handling of RTUs/FRTUs/FPIs connected either through single channel or redundant channels. In both cases, one FEP server shall be able to take control of all RTUs/FRTUs/FPIs channels. In order to meet network's expansion behind the full capacity of a pair of FE servers, it shall be possible to connect additional FE servers' pairs to the LANs. Each communication line shall be able to support its own communication protocol. The CFE shall comply VPN / SSL based security for

connecting with IEC 60870-5-104 &101 nodes on public networks. Further the nodes and CFE shall be self certified by manufacturers as NERC/CIP compliant to comply with future smart grid requirements.

All FEPs shall not have open ports other than needed for protocol traffic / SCADA traffic, and shall have an audit trace of all login attempts / connection attempts. This FEP shall exchange data through secured SSL / VPN and encryption of protocol traffic whether it is a is public network or a dedicated one. The equipment should take control command from designated Master IP address only and no other IP.

All RTU/FRTU/FPI shall be connected to the SCADA/DMS Control Center.

RTU Communication Card / Module shall support VPN / SSL Security / Encryption of data coming to it through Public network, and then send over private & secure Utility network to the SCADA Control Center.

The Communication Servers shall be able to process time – stamped data and can be directly connected to GPS device for time synchronization

5.2.1.2.2 ICCP Server /inter control centre communication server

Depending upon the protocol i.e ICCP o other interco0ntrol centre protocol used as permissible as per this specification for , the server shall be called as ICCP or inter control centre communication server. The redundant ICCP//*inter control centre communication server* servers shall be installed at each SCADA/DMS control centres of eligible towns of the state and DR centre & shall be used to retrieve, transmit and process data to and from remote sources i.e. remote control centres. Data retrieved and processed from remote sources may be stored in communication servers, which then distributes the data to other servers periodically or on demand. The server may also be used by utility to exchange data with State Load Dispatch Centres (SLDC) of the state where scheme will be implemented for exchange of scheduling data.

5.2.1.2.3 Network Management System (NMS) servers

Redundant NMS servers shall be used for configuration management, fault management & performance monitoring of servers, workstations, routers & LAN equipments etc. Part of the above functions may be performed by other servers as per the standard design of offered product.

5.2.1.2.4 Web servers with Active directory :

Redundant Web servers with active directory LDAP , DNS shall be provided.

5.2.1.3 Demilitarized/ Security servers

5.2.1.3.1 Web servers with Firewalls and IPS:

Redundant Web servers shall be provided to allow the access of SCADA/DMS system data, displays by outside users. One router shall be provided which shall be connected to the external LAN/WAN communicating SCADA/DMS system. The external LAN/WAN users shall be able to access SCADA/DMS data through the Web server system through this router.

Web servers shall also be provided with host based Intrusion prevention & detection system (IPS). The host-based IPS will be installed in both the Web-servers. The Network based IPS shall be supplied for both the SCADA/DMS dual LAN and DMZ dual LAN.

All necessary hardware & software for Web Servers with firewalls and IPS shall be supplied by the contractor.

5.2.1.3.2 Firewall:

Two firewalls shall be provided, one between Web servers & SCADA/DMS dual LAN and another between Web servers & W eb server dual LAN.   Specification of the firewall is given in the chapter for software requirements.

Contractor shall provide equivalent tools such as Apache etc for Web servers if UNIX or LINUX O/s is used to meet the security requirement as envisaged in the specification.

5.2.1.4 Training & development system server

5.2.1.4.1   DTS server ;

A non - redundant server to host DTS applications shall be provided to impart the training.

5.2.1.4.2 Development server

A non- redundant server to host Developmental applications shall be provided

5.2.1.5 Data recovery cum communication server

Redundant DR server shall be provided with common external memory for mass historical data storage and retrieval. The external memory shall comprise of multiple hot pluggable type hard disks configured in RAID configuration. (Except RAID-0) The external memory shall be connected either directly to the ISR server through SCSI /SAS interface or directly on the LAN (Network Attached Storage). Alternatively, the

bidder may offer RAID with each server to meet the mass storage requirement in place of common external memory.. The minimum requirement for external RAID for ISR servers is as below. The SCADA shall include historical data storage configured to store historical data at the storage rates, for the required period of time, and for the Ultimate historical database sizes given section 8.

- Storage Array
- Controller Cache: 512 MB per controller standard
- Integrated RAID controller with an LCD/LED status display and 256 MB read/write battery-backed cache (expandable to 512 MB per controller).
- Host Interface: Fibre Channel connection per controller from the host side
- Host Ports per Controller: Dual 2 Gb/s FC enabled
- RAID Levels(EXCEPT RAID 0)
- Redundant Controller: Yes

5.2.2   Operator Workstations

The operator Workstation console shall be used as a Man Machine Interface (MMI) by despatcher for interacting with all SCADA/DMS system. Operator Workstation consoles shall also be used as development console to take up developmental/ maintenance activities such as generation/updation of database, displays etc & to impart training through DTS workstation consoles.

Each workstation shall consist dual monitors & single keyboard and a cursor positioning device/mouse.

Workstation consoles for development system shall also be available with single TFT monitor Operator workstation consists of a console driving single/ dual monitors as defined in the BOQ.

The user shall be able to switch the keyboard and cursor-positioning device as a unit between both monitors of console. The minimum hardware configuration of operator workstation shall be:

- 2.4 GHz processor (in case RISC & EPIC it shall be at least 1.2GHz)
- 2 GB Main memory (RAM)
- 144 GB Auxiliary memory (Hard disk drive)
- 48x24x48 CD-R/W drive
- 21" TFT colour monitors
- Graphic adaptor cards
- Two speakers for audible alarms with configurable tones
- Keyboard & Mouse
- Dual 10/100/1000Mbps Ethernet ports
- One hot pluggable for external Cartridge magnetic tape drive
- Parallel, serial and USB (2.0) ports to accommodate printers, mouse and other peripherals

The specification of Remote VDU is same as of workstation for SCADA/DMS system mentioned above, except, it shall have suitable software & hardware to facilitate remote VDU user to monitor remotely , the real time power system from SCADA/DMS system & have facility to generate report. The additional associated hardware is mentioned in the BOQ.

5.2.3 TFT colour monitor

The TFT monitor shall have flat panel colour screen. The following is the minimum characteristics of TFT colour monitors

S. No	Specification	For 19" monitor	For 21"monitor
1	Diagonal Viewable size	19"	21"
2	Viewing angle	Sufficiently wide horizontal & vertical viewing angles	Sufficiently wide horizontal & vertical viewing angles
3	Dot Pitch	0.294 mm	0.28 mm
4	Resolution	1280x1024 minimum	1280x1024 minimum
5	Colour support	16 million	16 million
6	Refresh rate	Minimum 75Hz	Minimum 75Hz
7	On screen control	Yes	yes
8	Anti glare & anti static	Yes	yes
9	Tilt , Swivel	yes	yes

5.2.4 WAN router

Wan router shall be required for data exchange of SCADA /DMS control centres with DR centre , their respective IT system of R-APDRP system (IT Data centre, ITDR centre)
, remote VDUs and LDMS & SLDC optional. The data exchange between the two centres shall be over TCP/IP using Ethernet based communication network on various mediums viz FO , radio etc . The router shall have the following features:
- support the OSI and TCP/IP protocols
- support X.21/V.35/G.703 interface for interfacing communication links

WAN Routers shall be required for data exchange of SCADA/DMS control centres with RTUs at various locations in the respective town, SCADA/DMS DR centre, LDMS & SLDC ,Utility's respective IT system of R-APDRP system (Data centre, DR centre, customer care centre, Utility's Head Quarter and various other offices), remote VDUs etc. The data exchange between the two centres shall be primarily over MPLS based secured network using TCP/IP on various mediums as per the requirement and availability in the respective project area viz FO, radio, V-SAT etc . The router shall support the OSI and TCP/IP protocols.

The Routers shall be compatible with Owners existing MPLS based Wide Area Network created/ to be created under RAPDRP IT infrastructure. The Wide Area Links are planned for 2Mbps or higher Bandwidth capacity from ISPs (BSNL, MTNL or any other ISP)

The Router offered shall deliver high performance IP/MPLS features and shall support Layer 3 MPLS VPN connection. It shall support PPP/Frame Relay transport over MPLS.

The Routers shall be configurable and manageable through local console port, http interface, NMS software and as well through Telnet.

The Router shall provide built-in monitoring and diagnostics to detect failure of hardware. The Router shall be provided with LED/LCD indication for monitoring the Operational status.

The configuration changes on the Router should take effect without rebooting the router or modules.

1)   Memory
Flash: Minimum 8MB and upgradable upto 72MB
SDRAM: Minimum 64MB and upgradable upto 320MB

2)   Console Port: 01 No. for configurations and diagnostic tests

3)   LAN/WAN Port: The router shall support variety of interfaces as per the concerned utility's requirement at site like V.24, V.35, E1, Channelized E1 etc. along with following minimum number of ports :

  - Two fixed 10/100M high speed Ethernet ports
  - Two fixed Serial ports with synchronous speed up to 2 Mbps and with interface support for V.35, V.24 ports
  - Two fixed ports of G.703 E1 (2 Mbps) interface
  - One AUX port

 Total no of ports shall be determined by the connectivity requirement.

All the interface cables for interconnecting all LAN/WAN ports as well as connection to SCPC/MCPC/ leased E1 – V.35 ports etc. shall be in the scope of bidder.

4)   Scalability: Should have provision of atleast 100% additional number of free ports for future scalability

5)   Network Protocol: TCP/IP and support for IP version 6 . Shall provide IP address Management

6)   Routing Protocols:

RIP v1 (RFC 1058), RIPv2 (RFC 1722 AND 1723), OSPFv2 (RFC1583 & RFC 2328), OSPF on demand (RFC 1793), BGP4 with CIDR implementation as per RFC 1771. The implement should be compliant as per RFC1745 that describes BGP4/IDRP IP OSPF interaction. It shall provide Policy routing to enable changes to normal routing based on characteristics of Network traffic. IS-IS protocol support (RFC 1195).

7) WAN Protocols:
Frame Relay(LMI & Annex.D & ITU Annex A), PPP (RFC1661), Multi-link PPP (RFC1717), HDLC/LAPB, Frame Relay support shall include Multi-protocol encapsulation over Frame relay based on RFC1490, RFC 1293 for Inverse ARP/IP, DE bit support

8) High Availability :

Shall support redundant connection to LAN
For high availability, the router should support the standards based RFC 2338 Virtual Router redundancy Protocol (VRRP) or equivalent

9) Network Management:

SNMP, SNMPv2 support with MIB-II and SNMP v3 with Security authentication. Implementation control configuration on the Router to ensure SNMP access only to SNMP Manager or the NMS work Station.

- RMON 1 & 2 support using service modules for Events, Alarms, History.
- Should have accounting facility.
- Shall support multilevel access.
- Shall be Manageable from any Open NMS platform.
- Shall support for telnet,ftp,tftp and http & https enabled Management.
- Should have debugging facility through console.
- AAA Authentication support shall be provided via RADIUS (Remote Authentication Dial-IN User Service) and/or TACACS, PAP/CHAP authentication for P-to-P links, 3DES/IPsec encryption with hardware based encryption services.

10) Optimization feature:

Data Compression for both header and payload to be supported for Frame Relay and Leased/Dial-up WAN Links. Dial restoral on lease link failure Dial on demand or congestion, Load Balancing.

Support for S/W downloads and quick boot from onboard Flash. Online software re-configuration to implement changes without rebooting. Should support Network Time Protocol for easy and fast synchronization of all Routers.

11) QOS Support:

RSVP (Resource Reservation Protocol as per RFC 2205), IGMP v1, v2 (InterGroup Management Protocol Version 2 as per RFC 2236), Multicast Routing support like PIM-SM (RFC 2362), PIM-DM etc.,

Policy based routing (It shall be possible to affect the normal routing process for specific mission critical traffic through specified alternate routes in the network).

A class based scheduling, Priority Queuing mechanism that shall provide configurable minimum Bandwidth allocation to each class and IP Precedence.

Congestion Avoidance – Random Early Detection (RED). Support for Differentiated Services as per RFCs 2474, 2475, 2598 & 2597.

12)   Switching Performance: 200 Kpps or higher as per utility requirement at site

The following routers will be required as minimum, The minimum port requirement is specified above . However, bidder shall determine no. of ports requirement on the basis the interface & performance, availability & functional requirements & shall provide additional features/ ports over and above minimum requirement specified:

- SCADA/DMS router
- Intranet router at/DMZ
- DR router
- Router at S/S & remote VDUs locations

5.2.5 Local Area Network (LAN) and Device Interfaces

Servers, consoles and devices are connected to each other on a local area network (LAN), which allows sharing of resources without requiring any physical disconnections & reconnections of communication cable. Four LAN shall be formed namely SCADA/DMS, DTS, developmental system & DMZ. Dual LAN is envisaged each for the SCADA /DMS system & DMZ system & Single LAN is envisaged each for DTS & development system. At DR centre also redundant LAN is envisaged. LAN shall have the following characteristics:

- shall conform to the ISO 8802 or IEEE 802 series standards.
- shall preclude LAN failure if a server, device, or their LAN interface fails.
- shall allow reconfiguration of the LAN and the attached devices without disrupting operations
- shall be either controlled LAN such as Token passing or uncontrolled LAN such as CSMA/CD
- shall have minimum of fourtyeight (48) ports of 10/100/1000Mbps per LAN switch   for SCADA/DMS LAN & (24)ports be considered for DMZ system, DTS & development system & DR system each,)

5.2.6 Printers

Except for the output capabilities unique to any printer type (such as extended character sets, graphic print and colouring features), there shall be no limitations on the use of any printer to perform the functions of any other printer. All the SCADA/DMS system printers except Logger shall have dual LAN interface either directly or through internal/external print servers. Printers for DTS & development system shall have single LAN interface. The characteristics for each type of printer are described below:

a) Colour inkjet printer

Colour inkjet printer shall be used to take colored hardcopy printout. The Printer shall have the following features:

- shall be suitable for printing on A4 & A3 size normal paper.
- the printout shall match to object/content to be printed in colour & size.
- shall have resolution of at least 1200 X 1200 dots per inch.
- print time shall be less than 60 seconds per page for a coloured printout in normal mode for A4 size of printing.
- shall have suitable port for connectivity with Remote VDU.
- shall have input & output trays
- shall have landscape and portrait print orientation

B) Black & White Laser Printer

It is a multipurpose printer used to take prints of displays, reports etc. The laser printer shall have the following features:

- shall be black & white laser printer
- have speed of at least 17 pages per minute
- Minimum resolution of 1200 dots per inch
- Landscape and portrait output orientation
- Memory buffer of at least 48 Mbyte
- Shall be suitable for A4 size normal paper

C) Colour Laser Printer

It is a multipurpose printer used to take prints of displays, reports etc . The colour laser printer shall have the following features:

- shall be colour laser printer
- have speed of at least 10 pages per minute for A3 & 17 pages for A4 in color
- 600 X 600 dpi
- Landscape and portrait output orientation

- Duplex printing
- Memory buffer of at least 128 Mbyte

5.2.7 Time and Frequency system

GPS based time facility, using Universal Time Coordination (UTC) source, shall be provided for time synchronization of computer system at SCADA/DMS control centre. The time receiver shall include an offset adjustment to get the local time. It shall have propagation delay compensation to provide an overall accuracy of ±1.5microsec. The GPS system shall have dual 10/100/1000Mbps LAN interface. The GPS receiver shall be provided in redundant configuration

The time receiver shall detect the loss of signal from the UTC source, which shall be suitably indicated. Upon loss of signal, the time facility shall revert to its internal time base. The internal time base shall have a stability of 2ppm or better.

The GPS system shall include digital displays for time and date in the format DDD:HH:MM:SS (the hour display shall be in 00 to 23 hour format)

GPS system shall also be used to drive separate time , day & date indicators which shall be wall mounted type. The display for time shall be in the 24-hour, HH:MM:SS format. The display for the day & date shall be xxx format (MON through SUN) & DD:MM:YYYY respectively. .

Contractor shall provide wall mounted type digital display units for time, day, date & frequency indication. The display of frequency shall be in the xx.xx Hz format. The frequency shall be derived from 230V AC supply.

Each digit on the time, day and frequency indicators shall be at least 7.5 cm in height and shall be bright enough for adequate visibility in the control room from a distance of 15 meters.

The offered GPS clock shall also provide at least one 2 MHz (75 ohm interface confirming to ITU-T G.703) synchronization interface to meet the time synchronization requirement of the communication system   This interface shall confirm to the requirements specified in ITU-T G.811 for accuracy, jitter, wander etc. Alternatively, a separate GPS clock for synchronization of communication system is also acceptable.

5.2.8 External Cartridge Magnetic tape drive

One external 4mm DAT,160/320 GB Cartridge magnetic tape drive shall be supplied for taking Backups and performing restores of the Hard disks of any computer. The external tape drive shall have hot-pluggable port for connection to any computer. Bidder may also provide equivalent Magneto Optical (MO)   –disk in place for DAT drive (Cartridge magnetic tape drive)

5.2.9 Digital Light Processing (DLP) based Video Projection System

The contractor shall provide a video projection system based on modular DLP (Digital Light Processing) technology. All the screen modules of the VPS system, shall be suitable to form combined high resolution projection images. The VPS system will be used to project displays of SCADA/DMS system independently of workstation console monitors. All the operations envisaged from workstation console (dispatcher) shall be possible from VPS also.

The Contractor shall supply all necessary hardware and software, including the multi-screen drivers, adapters and memory to seamlessly integrate the video projection system with the user interface requirements described in the specification.

The video projection systems shall be rear projection systems and shall be complete with all projection modules, supporting structures and cabling. Design & installation of the video projection systems shall be coordinated with the Employer during project implementation. The requirement for each modular video display system include:

a) VPS screen with 2x3 matrix with each module minimum 67" diagonal

b) VPS screen shall form a seamless rectangular array, using modules. (0.5mm) max

c) VPS Graphics controller shall be interfaced to the SCADA/DMS system through dual LAN connectivity.

d) Each projector shall provide a minimum resolution of 1024X768 pixels per module. The rear projection screens shall be capable of displaying full resolution of the source.

e) The VPS shall be capable of supporting multiple display modes in which one or more modules show one or more SCADA/DMS displays concurrently as selected by the user.

f) This system shall provide the same functional display capability as the full graphics workstations.

g) The VPS shall have a horizontal & vertical viewing angle of approximately 160 degrees. The half gain angle shall be at least 40 degrees with a tolerance of ± 5 degrees for both horizontal & vertical directions.

h) The overall brightness of individual projector shall be at least 550 ANSI lumens. The luminance measured at the screen shall be minimum 100 candelas/sqm.

i) The projection bulb (lamp) shall have an average operating life of 9,000 hours (typical).

J) Centre to corner brightness shall be generally uniform.

K) The configuration of the VPS (no. of screens and size of each screen) is defined in the

BOQ.

L) The VPS controller shall have audio-video signal input module to interface with video conferencing equipment, CCTV, VCD/DVD players. The VPS controller shall support three types of video signal inputs (PAL, SECAM. NTSC).

5.2.10 Furniture

Utility shall provide necessary furniture & shall look aesthetically pleasing. It is not in the scope of contractor.

5.3 Auxiliary Power Supply for Computer systems

The computer system should be suitable for operation with single-phase, $230 \pm 10\%$ Vac, $50 \pm 5.0\%$ Hz power supply. To ensure uninterrupted & regulated power supply to computer system, suitable rating UPS are envisaged under auxiliary power supply specification. All cables supply, laying & their termination between UPS panel & computer system shall be in the scope of contractor.

The input circuit breakers are provided in the UPS for protection against short circuits, any additional fuses, switches and surge protection if necessary to protect the hardware shall also be supplied by the Contractor.

The auxiliary power to all computer system hardware shall be fed from parallel operating UPS system. On interruption of input AC power to UPS, the load shall be fed through UPS inverter through it's batteries. In case of battery capacity low conditions (due to prolonged failure of input supply to UPS), the computer system shall go for orderly shutdown to avoid corruption of any applications. The orderly shutdown of computer system can be implemented either through RTU (where UPS alarms shall be wired to RTU) or through suitable interface with UPS Supplier software.

5.4 Environmental Conditions

Equipment to be located in the SCADA/DMS control centre building shall operate over an ambient temperature range of 16°C to 32°C, with a maximum rate of change of 5°C per hour. Relative humidity will be less than 80% non-condensing..

5.5 Acoustic Noise Level

The noise level of any equipment located in the control room shall not exceed 60dbA measured at three feet from equipment especially for the printers.

5.6 Construction Requirements of panels

In case the equipments are mounted in panel type of enclosures, then such enclosures shall meet the following requirements:

a)   shall be free-standing, floor mounted and shall not exceed 2200 mm in height.

(b)   Enclosures shall be floor mounted with front and rear access to hardware and wiring through lockable doors.

(c)   Cable entry shall be through the bottom. No cables shall be visible, all cables shall be properly clamped, and all entries shall be properly sealed to prevent access by rodents.

(d)   The safety ground shall be isolated from the signal ground and shall be connected to the ground network Each ground shall be a copper bus bar. The grounding of the panels to the owner's grounding network shall be done by the contractor.

(e)   All enclosures shall be provided with, 230 VAC 15/5A duplex type power socket & switch for maintenance purpose.

(f)   All panels shall be provided with an internal maintenance lamp and space heaters, gaskets.

(g)   All panels shall be indoor, dust-proof with rodent protection, and meet IP41 class of protection.

(h)   There shall be no sharp corners or edges. All edges shall be rounded to prevent injury.

(i)   Document Holder shall be provided inside the cabinet to keep test report, drawing, maintenance register etc.

(j)   Cooling air shall be drawn from the available air within the room.

(k)   All materials used in the enclosures including cable insulation or sheathing, wire troughs, terminal blocks, and enclosure trim shall be made of flame retardant material and shall not produce toxic gasses under fire conditions.

(l)   Suitable sized terminal blocks shall be provided for all external cablings.

5.7   Assembly and Component Identification

Each assembly in the system, to the level of printed circuit cards, shall be clearly marked with the manufacturer's part number, serial number, and the revision level. Changes to assemblies shall be indicated by an unambiguous change to the marked revision level. All printed circuit card cages and all slots within the cages shall be clearly labelled. Printed circuit cards shall be keyed for proper insertion orientation.

5.8 Interconnections

All signal cabling between component units of the computer systems shall be supplied by the Contractor. Plug-type connectors shall be used for all signal interconnections. The connectors shall be polarized to prevent improper assembly. Each end of each interconnection cable shall be marked with the cable number and the identifying number and location of each of the cable's terminations. Each cable shall be continuous between components; no intermediate splices or connectors shall be used. Terminations shall be entirely within the enclosures.

5.9 Consumables

The Contractor shall supply, at its own expense, all consumables required for use during all phases of the project through completion of the system availability test. The consumable items shall include as minimum :
(a)   Magnetic cartridges (DAT)/ MOdisks
(b)   Printer paper
(c)   Printer toner, ink. Ribbons and cartridges
(d)   Special cleaning materials
(e)   CDs/DVDs

5.10   Certain criteria for Hardware /Configuration

1. Each state can have maximum 1 DTS.
2. Each state can have maximum 1 common DR centre
3. One operator workstation shall be considered per 10 S/S at SCADA/DMS control centres. However, for locations less than 20 S/S shall have 2 operator workstation as minimum.
4. Remote VDUs shall be required at one each at HQ , Division, IT office & LDMS at S/S

Refer section 1 chapter 1 for configuration for the hardware configuration of the SCADA/DMS system.