

Integration of HVDC Substation with NTAMC & RLDC.

Scope of work for Integration of HVDC Station with NTAMC/RLDC Control Centers:

1. Introduction

POWERGRID intends to Operate (Monitor and Control) the HVDC substations, auxiliaries, and its connected lines from Remote Control Centers in addition to the local HVDC substation end and Remote HVDC substation end. The Remote-Control centers are referred to as NTAMC Control Centers which comprise of 3 sets of Control Centers Namely Main NTAMC, Backup NTAMC and RTAMC.

The selected signals are to be communicated to the Regional Load Dispatch Center of Northern Region (NRLDC) and Back up RLDC for grid management purpose.

The HVDC system shall be designed to enable the remote operation from the NTAMC system and the Local terminal as well as Remote terminal stations.

2. Operation philosophy

The Operation philosophy of the HVDC substations is described below:

The control shall be mutually exclusive between the Local terminal station, Remote terminal station and the NTAMC Control Centers. Also, provision shall be made so that the control from the NTAMC Control Centers i.e. Main NTAMC, Backup NTAMC and RTAMC is mutually exclusive. However, the data of the HVDC system shall be simultaneously available to all the Control centers, irrespective of the Control Authority logic.

There shall be a Hard switch provided at the HVDC substations, which when kept in 'LOCAL' position shall allow control only from the local terminal station or Remote terminal station. When it is kept in REMOTE position, it should allow control from any of the NTAMC Control Centers (NTAMC, Backup NTAMC & RTAMC). The control from Local terminal stations shall have the highest priority.

All the signals and controls of both the Power systems, HVDC control systems, and HVDC auxiliary system including LT Supply, Air conditioning, temperatures etc. as available in the local HVDC Control system shall be communicated to the Remote Operation Control Centers.

List of signals shall be finalized during Detailed Engineering by the Employer.

3. Description of the Control Centers

The SCADA systems of the NTAMC Control Centers have two sets of communication front-end each at Main NTAMC, Back up NTAMC & RTAMC. Each communication front-end shall have a separate IP address. Hence, there shall be two sets of IP address for each control center.

The NRLDC Control Center comprises of two Control Centers, Main NRLDC and Backup NRLDC. Each of the NRLDC Control Centers comprise of two communication front ends having separate IP addresses.

These Control Centers will be communicating to the HVDC system gateways independently. The architecture is shown below in the figure 1.

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4. Communication link

The communication link for communication from HVDC system to the remote-control centers shall be provided by the Employer. The Bandwidth shall be at least 2Mbps for RLDC system and 10Mbps for NTAMC system.

5. Communication protocols

The HVDC system Gateways shall communicate to the remote-control centers of NTAMC and NRLDC using the secure IEC 60870-5-104 protocol or non-secure IEC 60870-5-104 protocol. All features of the IEC 60870-5-104 communication protocol shall be supported by the HVDC system gateway. The Employer shall provide the configuration parameters for the IEC 60870-5-104 protocols during detailed engineering. The protocol shall support the features such as Report by exception, Periodic reporting so that the data update times at the NTAMC/RLDC can be optimized.

The protocol parameters need to be configured independently for each of the Control Centers. The Contractor shall provide all the configuration tools to the Employer and the requisite training to modify, add or remove signals, modify communication protocol parameters, and IP addressing in the gateways.

The redundant Gateways are to be configured in (i.e. Active-Active / Hot-Hot mode) to allow parallel reporting of data to all remote-control centers i.e. NTAMC and RLDCs on IEC 60870-5-104 Protocol.

The HVDC system, and its associated AC system are to be integrated with RLDC for monitoring purpose only. A limited signal as per the list mentioned in RFP are required to be integrated with RLDC. All control and monitoring signals required for remote control of HVDC system, associated AC system and auxiliary system are to be configured for NTAMC system for remote control and monitoring from NTAMC, RTAMC and BNTAMC.

6. HVDC System Gateway

The HVDC station shall have Redundant Gateways based on industrial grade hardware or substation grade hardware (IEC 61850-3 compliant) for communication to NTAMC system & RLDC control centers through Secure IEC 60870-5-104 protocol.

The HVDC station gateways shall have the capability to support simultaneous communications with multiple independent remote master stations, The HVDC station shall have Ethernet ports for communication on each Gateway (two Gateways /RCI per station) as follows:

- (a) Three ports for communication with NTAMC, Backup NTAMC & RTAMC on IEC 60870-5-104 protocol.
- (b) Two ports for communication with Main RLDC & Backup RLDC on IEC 60870-5-104 protocol.

The communication interface to the Gateway/RCI shall allow scanning of defined points within the HVDC system independently for each Control Center. The HVDC Gateway shall simultaneously respond to independent scans from Control Centers i.e. NTAMC & RLDC.

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The HVDC system gateway shall be configured in redundant, Active-Active mode, and shall be designed to acquire HVDC system signals, process them and communicate to the remote-Control Centers using the IEC 6087-5-104 protocol. The processing capability, and the communication-rate shall consider the entire signals available in the HVDC system, including the auxiliaries, AC system, HVDC control system.

Each HVDC system gateway shall have separate independent physical 10/100Mbps (min) Ethernet ports for communicating to each of the Control Centers. Also, each gateway shall have redundant communication interfaces towards the HVDC system LAN side. The requirement of communication ports in the gateways is depicted in Figure 1.

No other hardware like LAN extender/ Switch / Firewall/Logical ports are to be used to multiply the single Ethernet port in RCI (Remote Communication Interface)/gateway to multiple ports for data transmission to NTAMC, RTAMC and Back up NTAMC, Main RLDC & Backup RLDC.

7. Network Equipment:

The following communication networking equipment shall also be provided for communication with the NTAMC and RLDC Control Centers

7.1 Specification for NTAMC Substation Switches:

The bidder shall also provide 2 Nos. managed Ethernet switches with at least 16 copper 10/100 Mbps RJ45 ports on each switch to form managed "Redundant System LAN" for connecting different HVDC equipment/devices (RCI/ Gateways, Cameras, NVR, VOIP, router cum firewall etc.) which will communicate to the NTAMC Control Centers as per system architecture attached as Annexure-1.

There will be separate switches and router cum firewall for NTAMC Control Centers and separate router cum firewall for RLDC Control Centers as per the architecture.

These Substation Ethernet Switches mentioned here are specified exclusively for NTAMC & RLDC data communication only and are in addition to any other Ethernet switches required for HVDC system for local/internal communication. These switches shall be suitable for substation environment and shall comply with the requirements of IEC 61850-3 standard for EMI/EMC and environmental conditions.

These LAN switches shall have the following compliance and functional features:

- a) Support SNMPv3 (Full SNMP support including Traps)
- b) Web based GUI or CLI based with HTTPS/HTTP and SSH/ Telnet support.
- c) Support for IPv4 and IPv6 switching simultaneously.
- d) Layer 3 Static routing functionality
- e) Syslog facility for local as well as remote server
- f) Support for remote management
- g) LED indication for port status/supply etc.
- h) Shall support VLAN IEEE 802.1Q
- i) IGMP snooping
- j) Spanning tree protocol IEEE 802.1d or RSTP IEEE 802.1w

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- k) Shall support SNTP
- l) Port based Network Access Control (IEEE 802.1x)
- m) Quality of Service (IEEE 802.1p)
- n) Shall support unicast as well as multicast IP traffic
- o) SNTP time synchronization
- p) Shall support Mac Binding
- q) Fanless design

7.2 Specification for Firewall cum Router

There shall be two sets of Firewall cum Routers which shall be connected to a LAN. One set shall be for communication to the RLDC Control Centers and one set shall be communication to the NTAMC Control Centers as per the architecture. These Substation Firewall -cum- Router mentioned here are in addition to any other Routers, Firewalls required for HVDC & SAS system for local/internal communication and are specified exclusively for NTAMC & RLDC data communication only. The substation firewall and router shall be suitable for the substation environment and shall comply with the requirements for IEC 61850-3.

The substation firewall cum router shall have the following features:

- a) Shall be Next Generation Firewall supporting Firewalls, Access control, features such as Address/port inspection and filtering
- b) Shall be stateful firewall.
- c) Shall have deep packet inspection.
- d) Shall support up to 8 Ethernet **interfaces** 10/100 Mbps.
- e) Shall support IPv4 and Ipv6.
- f) Shall have IP sec/VPN with 3DES/AES encryption with each of the control centers.
- g) Shall have NAT support.
- h) Shall have syslog capability.
- i) Shall have hot- standby operation with similar Firewall cum router.
- j) Shall support VRRP or Clustering features for High Availability configuration.
- k) Shall support SNTP & SNMPv3 protocols.
- l) Routing protocols such as OSPF and support for Ipv4 and Ipv6.
- m) Support IEEE 802.3u, 802.1p, 802.1Q, 802.1d, 802.1w.
- n) Traffic prioritization for routed IP flows/ports.
- o) Shall support local log storing capacity for at least 30 days.
- p) Shall support SCADA protocol of IEC 60870-5-104 for Application control/Firewall rules configuration
- q) Shall have feature to update its signature in an offline mode as well as online mode.

Offline Mode: In offline mode, the signatures/updates shall be downloaded on a separate system connected to the Internet and then applied to the firewall.

Online Mode: In online mode, the signatures/updates shall be downloaded directly by the firewall through Internet or through centralized management console.

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- r) Shall have subscription for the NGFW services (IPS, Antivirus, at least 5 years from the date of Factory acceptance test.

8. Testing and Validation:

It shall be the responsibility of contractor to successfully validate all the signals functionality in coordination with Employer's NTAMC deptt / RLDC for completion of scope of works. All support needed from Contractor, shall be extended to Employer in this regard.

9. Testing of failover of network devices:

It shall be the responsibility of contractor to successfully demonstrate the continuity of data through failovers of Substation Switches and Router cum Firewall without interrupting the SCADA communication between HVDC Gateway and Control Centre.

10. Cyber Security:

It shall be the responsibility of contractor to ensure the latest firmware in Substation switches and Router cum Firewall during hand-over of the system.

Operating System supplied in HVDC gateways shall also be updated with latest security patches. Anti-Virus shall be installed, activated and updated with latest signature patterns. It shall be provisioned to offline update the anti-virus security patches. System hardening shall also be done by contractor to ensure blocking of CD/USB access, unwanted protocols and ports, processes and services. Local windows firewall shall also be configured for enabling communication with required system and blocking all other communication.

11. Control Authority Logic

Both the HVDC Gateways shall be configured to report independently to three Control Centers of NTAMC system (Main NTAMC, Backup NTAMC & RTAMC) simultaneously. There shall be a Control Center Authority Transfer scheme implemented such that at a time, only one Control Center shall be able to Control the Substation. Any Control Center shall be able to takeover supervisory control authority from the HVDC gateway for either/ both main system / auxiliary system after substation is manually put in remote mode from local station. The information regarding which Control Center is having the control authority shall be known to all the other control centers. Each signal in the HVDC substation will be categorized in two Groups, either as "POWER" or "AUXILLIARY". The Control Authority transfer to a Control Center shall be possible for any of the groups i.e. POWER or AUXILIARY or both. This takeover control logic shall be implemented in the HVDC Gateway.

12. Local Remote Logic

There shall be a Hard switch provided at the HVDC substations, which when kept in 'LOCAL' position shall allow control only from the local terminal station or Remote terminal station. When it is kept in REMOTE position, it should allow control from any of the NTAMC Control Centers. The control from Local terminal stations shall have the highest priority.

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13. Typical Architecture Diagram:

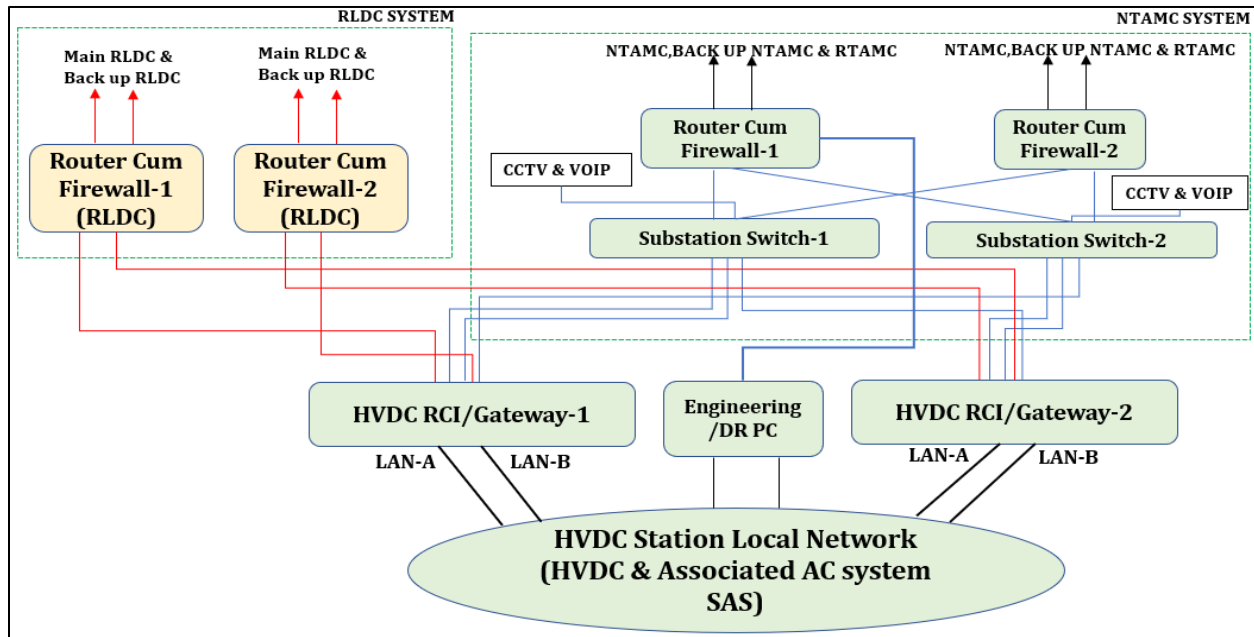


Figure-1: Typical Architecture for NTAMC & RLDC Communication

Note: The above architecture is typical, however if any contractor offers slightly modified architecture based on their standard practice without compromising the working, the same shall be subject to approval during detailed engineering.

14. BOQ for Integration of HVDC station with NTAMC & RLDC Control Centers:

Sr.no	Item Description	Unit	Qty
	SUPPLY PART		
1	Router Cum Firewall	Nos	4
2	NTAMC System Substation Switches	Nos	2
	MANDATORY SPARE		
1	Router Cum Firewall	Nos	1
2	NTAMC System Substation Switches	Nos	1
	SERVICES PART		
1	Integration with NTAMC, RTAMC & Back up NTAMC	Lot	1
2	Integration with RLDC & Back Up RLDC	Lot	1

Note: The above BOQ shall be considered for both terminals

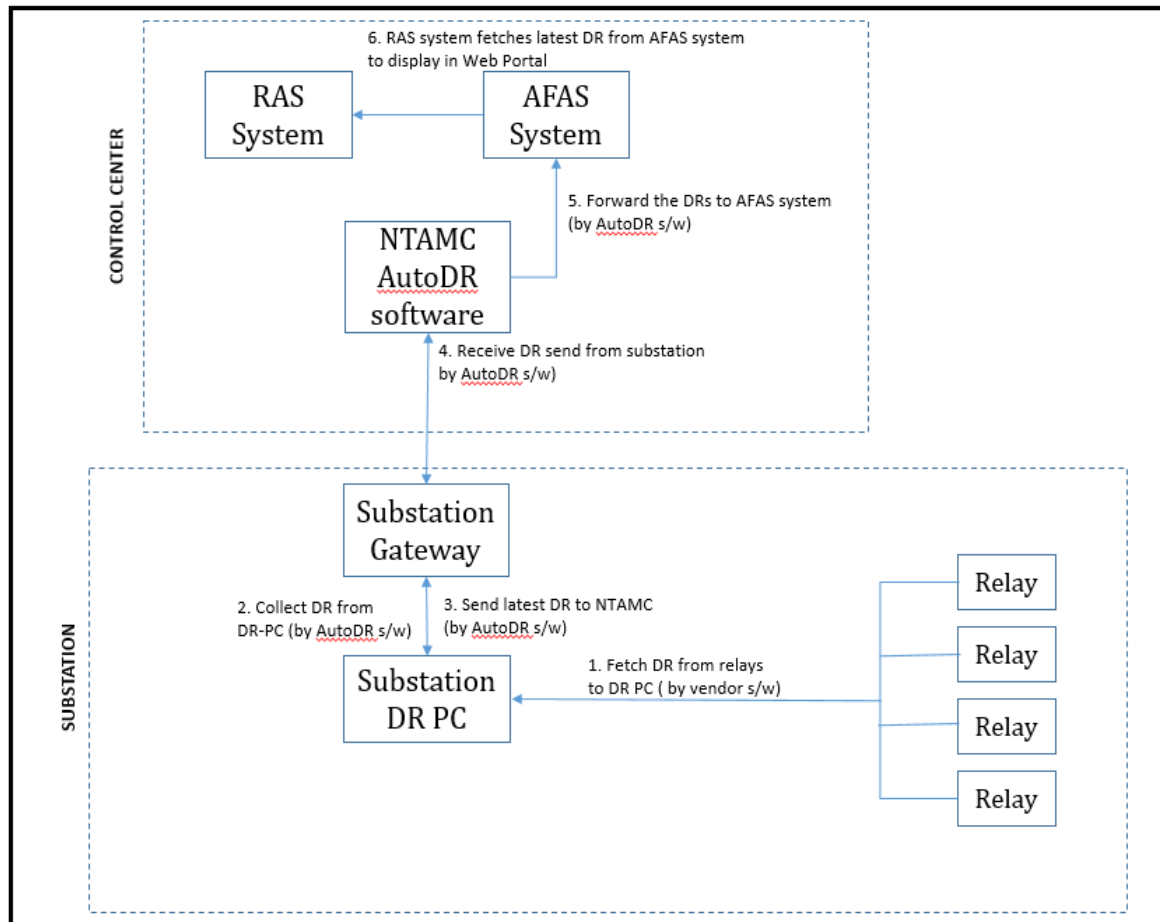
15. Integration of HVDC Substations in NTAMC Remote Accessibility System (RAS):

The AutoDR system for sending of Disturbance Record files (fault records) to NTAMC & Backup NTAMC is envisaged for integration of HVDC substations in RAS. The DR shall be fetched to DR PC/ engineering PC automatically from IEDs/TFRs by the software to be provided by the HVDC supplier.

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The AutoDR software, supplied by POWERGRID, which shall be hosted in HVDC RCI/ gateway will fetch the DR from Engineering PC, rename them as per NTAMC naming convention and send to Control Center servers.

The AutoDR software application is designed to run on Microsoft Windows OS.



AutoDR Generic Communication Architecture

To integrate HVDC substations in NTAMC RAS system, the following requirements shall be fulfilled:

- i. DR (TFR, TW) from each relay/TFR is stored in a separate folder (in a single parent folder of a PC) and folder name is configured with relay name.
- ii. Each DR consists of at least .cfg and .dat files.
- iii. DR is collected to DR PC immediately after trigger.
- iv. The DR shall be accessible from DR PC to substation gateway
- v. The substation gateway shall be accessible from NTAMC through remote desktop.
- vi. File transfer from substation gateway to NTAMC shall be through https protocol by enabling port 443.
- vii. Vendor specific software to read the TW and generate the fault location shall be provided for Control Centre.