OPERATION & MAINTENANCE OF HVDC STATION

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POWERGRID, An OVERVIEW

- Incorporated in **1989** for transmission of Electric Power across the country.

- Central Transmission Utility - Navaratna PSU

- Asset over Rs. **56000** Crs

- World's Leading Power Transmission Utility (3rd)
POWERGRID, An OVERVIEW

- **76800** Ckt.Km line-**128** Substations
- Technology Leader in EHVAC & HVDC Transmission.
- Carries more than **50%** of Generated Power Across Country.
- **84500** MVA Transformation Capacity
- **22400** MW Interregional Capacity  Telecom NLD with **21000** Km Optical Fibre Network & Internet Service Provider
National Grid by 2012
THE POWER ‘HIGHWAY’

LEGEND
765 KV LINES
400 KV LINES
HVDC B/B
HVDC BIPOLE
EXISTING/
X PLAN
NATIONAL
GRID
XI PLAN
765 KV LINES IN XI PLAN. TO BE CHARGED AT 400KV INITIALLY
TO BE CHARGED AT 765 KV UNDER NATIONAL GRID
Existing HVDC in INDIA

1 – Rihand-Dadri (1500MW)
2 - Vindyachal (500MW)
3 - Chandrapur-Padghe (1500 MW)
4 - Chandrapur-Ramagundam (1000MW)
5 – Gajuwaka (500MW)
6 - Sasaram (500MW)
7 - Talcher-Kolar (2500MW)
8 – Ballia-Bhiwadi(2500 MW)
SALIENT FEATURES OF EXISTING & UPCOMING HVDC STATIONS
± 500 kV, 1500 MW Rihand – Dadri HVDC Project.

Approx. Value of the Contract: Rs. 457 Crore

Start date: Feb-1986
Completion date: Dec-1991

Main Data:
Power rating : 1500MW
No. of Poles : 2
AC Voltage : 400 kV
DC Voltage : ± 500 kV
Converter Transformer-
Rihand Terminal : 6 x 315 MVA
Dadri Terminal : 6 x 315 MVA
Length of over head DC line: 816 KM.
2 x 250 MW HVDC Vindhyachal Back to Back Station.

Approx. Value of the Contract: Rs. 176 Crore

Start date: Nov 1984
Completion date: April 1989

Main Data:
(i) Power rating : 2 x 250 MW.
(ii) No. of Blocks : 2
(iii) AC Voltage : 400 kV
(iv) DC Voltage : ± 70 kV
(v) Converter Transformer : 8 x 156 MVA
2 x 500 MW HVDC Chandrapur Back to Back Station.

Approx. Value of the Contract: Rs. 702.78 Crore

Start date: November 1993

Completion date: Dec 1997

Main Data:

Power rating : 2 x 500 MW.

No. of Blocks : 2

AC Voltage : 400 kV

DC Voltage : ± 205 Kv

Converter Transformer : 12 x 234 MVA
+500 kV, 2000 MW, HVDC Talchar – Kolar Transmission Line

Approx. Value of the Contract: Rs. 822.46 Crore

Start date: March 2000

Completion date: June 2003

Main Data:

Power rating : 2000 MW
No. of Poles : 2
AC Voltage : 400 kV
DC Voltage : ±500 kV

Converter Transformer:
Talcher : 6 x 398 MVA
Kolar : 6 x 398 MVA

Length of over head DC line: 1369 KM.
HVDC Talchar – Kolar link was designed for 2000 MW continuous rating with inherent short term overload capacity depending on:
- Ambient temperature
- Prevailing voltages at Talcher and Kolar
- Cooling mechanism.

Further, DC Bipole lines with quad conductor was capable to transmit 1250 MW continuously with marginal incremental loss.

The inherent overload capability was utilized to meet the system contingencies by upgradation of Talcher – Kolar HVDC link capacity from 2000 MW to 2500 MW.

This enhanced capacity is to be used only under contingency and not for increasing HVDC Capacity for firm transfer of 2500 MW.
Main objective of this HVDC project is to transfer power from Talcher Super Thermal Power Station (Eastern Region), to Kolar (Southern Region) of Indian Grid.

The most important features of the project are:

- Better over all economy as compared to AC Transmission
- Halved right-of-way requirements,
- Lower transmission loses, better stability and controllability.

This is the longest (1369 KM.) commercial HVDC link in India.
1 x 500 MW HVDC Sasaram Back to Back Station.

Approx. Value of the Contract: Rs. 204.68 Crore  
Start date: March 2000  
Completion date: Sep 2002

Main Data
(i) Power rating : 1 x 500 MW.
(ii) No. of Blocks : 1
(iii) AC Voltage : 400 kV
(iv) DC Voltage : 205 kV
(v) Converter Transformer : 6 x 234 MVA

Connects Pusauli (Eastern Region) to Sasaram (Eastern part of Northern Grid) of Indian Grid (Power Transfer mainly from ER to NR)
2 x 500 MW HVDC Gazuwaka Back to Back Station.

Approx. Value of the Contract:

**Block-1**: Rs. 209.85 Crore  
**Block-2**: Rs. 231.76 Crore

Start date:  
- **Block 1**: Dec 1994  
- **Block 2**: Sep 2002

Completion date:  
- **Block 1**: Feb 1999  
- **Block 2**: March 2005

Main Data:

(i) Power rating: 2 x 500 MW
(ii) No. of Blocks: 2
(iii) AC Voltage: 400 kV
(iv) DC Voltage: 205 kV (Block 1)  
177 kV (Block 2)
(v) Converter Transformer  
- **Block 1**: 6 x 234 MVA  
- **Block 2**: 6 x 201.2 MVA
+ 500 kV, 2500 MW HVDC Ballia – Bhiwadi Transmission Line.

Approx. Value of the Contract: Rs. 1365 Crore

Pole 1 Commissioned on 31-03-10
Pole 2: Targetted to be commissioned by 31-10-10

Main Data:
Power rating : 2500 MW
No. of Poles : 2
AC Voltage : 400 kV
DC Voltage : + 500 kV
Length of over head DC line : 780 KM.
Converter Transformer
Ballia : 8 x 498 MVA
Bhiwadi : 8 x 498 MVA
North-Eastern Region has a large quantum Hydro Electric Power potential.

Under Hydro Development program of Govt of India, this power to be evacuated to load centres of Northern and Western Regions.

POWERGRID installing +/-800 kV, 6000 MW HVDC multi-terminal system of approx length of 1728 km from North Eastern Region to Agra.
HVDC Multi Terminal System

- One Rectifier station in Biswanath Chariali (pooling station in North Eastern Region), second one in Alipurduar (pooling station in Eastern Region) and Inverter station at Agra (in Northern Region).
- Converter stations at Biswanath Chariali and Alipurduar each handles a nominal power of 3000 MW and Converter station at Agra handles nominal power of 6000 MW.
- This Transmission System originates from Assam and passes through West Bengal, Bihar and terminates in Uttar Pradesh.
Other Upcoming Projects:

- 2 x 500 MW HVDC BTB Station at Kolhapur between Kolhapur (Western Region) and Narendra (Southern Region) of Indian Grid at

Consultancy Assignment:

- 1 x 500 MW India-Bangladesh Interconnector HVDC Back To Back Station, Bheramara Bangladesh
Why O&M?

- To Run the system Smoothly to achieve highest availability and avoid outages
Operation of HVDC Station

- Preconditions of RFS / RFO
  - Circuit Breaker Is Closed
  - Cooling System is OK
  - No Alarm from Protection System
Operation of HVDC Station

- Selection of Mode of Operation
  - Joint / Separate
  - Power / Current

- Selection of Direction (Applicable for BTB)

- Setting the Ramp Rate

- Start of Block at Minimum Power Design
Operation of HVDC Station

- Selection of Mode of Operation
  - Joint / Separate
  - Power / Current

- Selection of Direction (Applicable for BTB)

- Start of Block at Minimum Power Design
BASIC HVDC Single Line Diagram

Thyristor Valves

Converter Transformer

DC Filter: DT 12/24
DT 12/36

DC OH Line

Smoothing Reactor

AC Bus

400 kV

AC Filters
Modes of Operation

Bipolar

- DC OH Line
- Transformer
- Thyristor Valves
- Smooth Reactor
- Smoothing Reactor
- Converter Transformer
- Thyristor Transformers
- AC Filters, Reactors
- 400 kV AC Bus
- Current
- Current

Diagram showing the modes of operation with highlighted components and connections.
Modes of Operation

Monopolar Ground Return

Diagram showing the modes of operation with components such as Thyristor Valves, Converter Transformer, Smoothing Reactor, DC OH Line, and AC Bus.
Modes of Operation

Monopolar Metallic Return

- Thyristor Valves
- Converter Transformer
- Smoothing Reactor
- DC OH Line
- AC Filters, Reactors
- 400 kV AC Bus
Operation of HVDC Station

- Type of Shutdowns
  - Planned / Forced / Emergency Shutdown
RPC

- Q Mode

- V Mode

- Auto / Manual
Operation of HVDC Station

- Shutdown Procedure of HVDC Station
  - Planned
  - Emergency

- Charging Procedure After Shutdown

Checking of Annunciation List Before Charging After Shutdown (Must)
Operation of HVDC Station

- Trouble Shooting
- Alarm System
- Active & Standby System of C&P
Type of Maintenance

- Preventive Maintenance
- Outage Maintenance
Major Areas Of HVDC BTB Station

- Valve Hall
- AC Switchyard Equipments
- Valve Cooling
- Auxiliaries and AC System
- AC/DC Control & Protection System
Valve Hall

- The status of the Thyristor levels in the valve hall is available online in the Control Room.
- Valve Control System monitors continuously, the healthiness of the thyristors and associated valve hall components while in service.
- Failure of thyristor is reported in the Control Room by Valve control system for the operator.
- Alarm is generated up to 2 thyristor failures in a valve and on 3rd failure, trip is generated (Redundancy of Thyristors differs from system to system).
Valve Hall – Thyristor level testing

- Failure may be in
  - Thyristor
  - Snubber capacitor
  - Snubber resistor
  - TE card

- To test the thyristor level – Thyristor Level Test Unit is used which tests thyristor and associated components

- Failure of the thyristor can be detected
Major Work During Yearly Maintenance

- Cleaning of Valve Hall
- Testing of Thyristors/Snubber Circuit
- Testing of Ground Switches
- Checking of any abnormality
- Checking of Water leakage
- Tightness Checking of Bolts
- Record of Valve Arrestor Readings
- Testing of Fire System
AC SWITCHYARD EQUIPMENTS
Converter Transformer

- Following tests are done during yearly shutdown
  - Capacitance and tan δ of the bushings
    - Used to determine the healthiness of the bushing insulation
  - Checking the operation of the buchholz relays and Pressure Relief Devices (PRD)
  - Checking of the WTI & OTI alarms and trips
  - Checking whether all the alarms are reported to HMI system
  - Checking the operation of fire fighting deluge valve system
Converter Transformer

- Replacement of the oil filters of OLTC (On-Load tap Changer) – can be replaced online when the alarm is generated
- Periodic testing of the oil – DGA – to determine the incipient internal faults of the transformer
- Testing of all the associated protection relays
Converter Transformer

- Converter Transformer OLTC – Inspection of the OLTC
-Maintenance of OLTC after every 1 lakh operations
  - Wear and tear of all mechanical & electrical parts of the OLTC to be inspected.
  - Replacement of mechanical parts with high wear & Tear.
  - Cleaning of Fixed and moving contacts.
  - Cleaning of OLTC chambers
  - Filling with fresh oil
Converter Transformer

Following Maintenance Carried Out W/SD on Monthly Basis

- Inspection of Bushing Oil Level.
- Inspection of Oil Level in Conservator.
- Inspection of Oil Level in OLTC Conservator.
- Manual Starting of Oil Pumps & Fans
- Checking of Oil Leaks
- Oil Level in Breather Oil Seal
- Condition of Silica Gel
Overhauling of OLTC
Overhauling of OLTC
AC Filter

- Maintenance of filter bay equipment includes
  - Testing of CT – C & Tan δ
  - Capacitance stack measurement and balancing if required
  - Inspection of capacitor stack for oil leakage
  - Associated breaker testing - Operation timings, alarm, lockout checks etc.
  - Measurement of resistors and reactors – for deviation
  - Testing of associated protection systems
Apart from the yearly maintenance, failure of capacitor cans calls for

- Measurement of individual capacitor stacks / cans
Current Transformer & Voltage Transformer

- Capacitance and Tan δ Measurement (S/D)
- Inspection of CT for oil leakage & Crack in Insulator
- Cleaning of MB (S/D)
- Measurement of Ratio & Secondary Resistance (SOS)
- DGA of Oil (SOS)
- Oil Parameters (SOS)
- IR Measurement (SOS)
Current Transformer & Voltage Transformer

- Voltage Transformer

- Capacitance and Tan δ Measurement (S/D)
- Inspection of oil leakage & Crack in Insulator
- Cleaning of MB (S/D)
- Measurement of Secondary Voltage
Circuit Breakers

- Timing of Main & Auxiliary Contacts (Y)
- Checking of Pressure Setting of Switches (Y)
- Checking of Pole Discrepancy (Y)
- Checking of Interlocks (Y)
- Trip / Close Coil Currents Measurement
- Maintenance of Air Compressor (In Pneumatic System)
- Cleaning of Support Insulator / PIR & Grading Capacitor / Interrupter Chamber
Circuit Breaker Contd.

- Lubrication of Chain & Gears / Checking healthiness & Cleaning of Rollers / Checking healthiness of springs and greasing if required (In Spring Operated Mechanism)
- Measurement of Static contact resistance measurement (2Y)
- Measurement of DCRM & Contact Travel (2Y)
- Capacitance & Tan Delta Measurement of Grading Capacitor (4Y)
- Dew Point Measurement of SF6 Gas (4Y)
- SF6 Gas Filling (SOS)
- Checking of Grading Capacitor Oil Leakage (M)
Valve Cooling System
Valve cooling

Maintenance of Valve Cooling

☐ Replacement of resin in the resin chamber yearly

☐ Cleaning / Painting of Cooling Towers (If available) (Y)

☐ Cleaning of Heat Exchangers (If available) (Y)
Valve Cooling

- Cleaning of Filters (SOS)
- Testing of Related Protection System (Y)
- Maintenance of Pumps (3M)
- Vibration Measurement of Pumps (3M)
- Cleaning of Electrical Contactors (3M)
Auxiliary System

- Yearly servicing of DG sets and protection relays testing
- Fire Fighting system – checking the hydrant points
- Maintenance of station batteries, chargers and UPS systems
- LT system – Relay testing & LT breaker maintenance
Maintenance of LT breakers & Relay testing
Control & Protection System

- Testing of All Control & Protection System (Y)

- Modification / Replacement / Testing of Relays & Cards (SOS)
MAJOR PROBLEMS OBSERVED DURING O&M

VALVE HALL

- Thyristor Failure (Frequency: Very Low)
- Failure of Surge Arrestor (Frequency: Very Low)
- Water Leakage from Pex Tube (Frequency: Very Low)
MAJOR PROBLEMS OBSERVED DURING O&M

- VALVE COOLING SYSTEM
  - Water Pump Motor Failure  (Frequency : Medium)
  - Valve Motor Failure  (Frequency : Very Low)
  - Makeup Water Float Failure  (Frequency : Medium)
MAJOR PROBLEMS OBSERVED DURING O&M

- Control & Protection SYSTEM
  - Failure of Control Cards
  - Stalling of Software
  - Measuring System
THANK YOU