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DC system and Power Electronics

10462

Refurbishment of HVDC system in India: Philosophy

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Background

- Vindhyachal Back to Back HVDC (Commissioned in 1989) & Rihand Dadri Bipole HVDC (Commissioned in 1991) have been in operation for more than 30 years
- Major constraints in proper operation of these assets were lack of spares & service support due to obsolescence in technology
- Ageing related failures have been observed after completion of 18 to 20 years of operation
- Maloperation of Control & Protection functions was a major concern due to non- availability of spare cards and lack of service support from OEM due to technological advancement
- Efficiency of Thyristor Valve cooling and Valve hall ventilation was progressively getting reduced.
- Concept behind the refurbishment was to extend useful life of HVDC system and increase its reliability

- **Thyristor Control units (TCU)**- Electronic components in TCUs have limited life and performance degrades with high temperature environment inside valve hall. Intermittent failures of TCU cards were observed in later stages of service life.



- **Light guides**- Deterioration of light guides started after 18 years of service life. OEM also recommended replacement of all the light guides.
- **Snubber Capacitor**- Snubber capacitors were oil filled. Significant increase in failure was observed after completion of 20 years of service life. Fire incidents in snubber capacitors were also observed.

System/Components

- **Thyristor Valves**- Thyristor failure caused prolonged outages in Vindhyachal HVDC. Spare thyristors were not available as it was no longer in the manufacturing line of OEM.

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- **Valve cooling system-** Originally, Valve cooling system was having raw water & fine water system and cooling of raw water was done through cooling towers. Raw water system had disadvantages such as loss of water due to evaporation, corrosion of tank, pipes, heat exchangers etc. Present day HVDC systems are equipped with dry type valve cooling system, which is closed loop deionized water circulation system.
- **Valve hall ventilation-** Some of the limitations observed in originally installed ventilation system are as follows-
 - Limitation in humidity and temperature control
 - Single filtration stage
 - Difficulty in maintaining positive pressure inside valve hall
- **HVDC Control & Protection system-** Control system was designed somewhere around 1985 and was based on 8085/8086 single board computers. Limitation in communication baud rate restricted faster controls. As per current practice, Modular I/O is used in HVDC control & protection system which is much more reliable than previously used 8085/8086 single board computers .

- **Converter transformer & smoothing reactor bushing-** Converter transformer valve side bushings had porcelain housing. As per design requirements, these bushings had long length with joints. Bushing failure from joints was reported on several times. With advancements in manufacturing technology , these bushings are manufactured with polymer housing without any joint.



Challenges and resolution

- **Rihand Dadri Bipole HVDC**
 - Design consideration for integrating new C&P system in existing panels
 - Adaptation of old C&P logic & settings in the new C&P system.
 - Use of precast foundation for installation of DC switches to reduce outage time.
 - Safe dismantling of C&P system of a pole while other pole remained in operation

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• Vindhyachal BTB HVDC

- Due to unavailability of filter rating data, AC harmonic measurements were carried out during pre & post refurbishment for validating effect of refurbishment on filters
- Unavailability of old generator data for sub synchronous resonance (SSR) studies near to the HVDC station.

Impact of cost and outage time

- Decision for going either for refurbishment or green field project was dependant on the cost involved and outage time
- In case of a green field project of same capacity as for Rihand-Dadri Bipole HVDC, it would have cost INR 15 billion and an outage time of approx. 36 months for completion. For Vindhyachal it would have been around INR 5 billion.
- Refurbishment cost of Rihand-Dadri & Vindhyachal was around INR 5.3 billion & INR 3.3 billion respectively. Outage time involved was 65 days for Rihand-Dadri & 260 days for Vindhyachal HVDC.

Conclusion

- Decision regarding replacement of various equipment of HVDC system considering non-uniform ageing of different components
- Replacement can be done in phased manner based on the operational experience, challenges and system conditions.
- Scope of work during refurbishment needs to be planned based on the available technologies and designs & better data monitoring facilities.