

## Case Study

# Hydro generator protection retrofit at 4,888 MW dam

**Client:** Tarbela Hydro Power Plant, Water & Power Development Authority (WAPDA).  
**Level:** 500 kV  
**Commissioned:** 2014  
**Scope:** Turnkey

### Introduction

Built between 1968 and 1976, Pakistan's Tarbela Dam is an engineering marvel. It's the world's largest earth-filled dam, a behemoth taming the Indus River with a height of 470 feet. This titan not only creates a massive reservoir for crucial irrigation and flood control but also houses a powerhouse generating a whopping 4,888 MW of hydroelectric power. With a planned addition of 1,530 MW in the coming years, the capacity will increase to 6,418 MW. Imagine a wall of earth and rock stretching nearly 3 miles wide, holding back enough water to fill 11.6 million acre-feet – that's Tarbela's impressive capacity! The hydro complex consists of four tunnels equipped with 14 generating units of 175 MW, 432 MW, and 470 MW. Power evacuation is carried out by several 500 kV and 220 kV transmission lines from a double bus substation.

### Problem Statement

The aging Tarbela Dam generators were facing issues with their old electro-mechanical protection relays. This was critical as the dam forms the backbone of the power infrastructure of an energy-strapped country. Any downtime during times of need invites the wrath of the general populace and the power network regulator. As hopes for further spares and support faded after 40 years of operation, it became necessary to upgrade.

### Solution

EPENAM provided a state-of-the-art, turnkey solution with a wire-to-wire match. The scope included the preparation of complete vendor analysis, schematic drawings, relay setting calculations, site modifications, installation, testing,

commissioning, and training documentation. The site originally featured GEC make DDG 31A biased differential relays, which were later retrofitted with upgraded DTH-31 generator-transformer differential relays. Additionally, the anti-motoring relays also needed replacement. The old relays installed at the site were WCD type relays made by English Electric and later few were replaced with PM2g90 by Brown, Boveri & Company, Ltd. The relays were originally installed in 1974 by Merlin Gerin, with retrofits performed during the 1990s. To upgrade the system into the modern numerical era, EPENAM offered a solution based on GE UR relay type G30, as it met all the requirements specified by the customer for generator-transformer protection. In addition to wiring and scheme modifications for the existing generator protection switchgear, EPENAM also provided customized relay settings, including a custom differential curve to match the old DTH-31 curve as required by the customer. For anti-motoring (reverse power) protection, EPENAM provided GE's MIWII relays with settings matched to the reverse power pickup settings of the previously installed electro-mechanical relays.

### Conclusion

Tarbela Hydro Power Plant holds strategic importance in Pakistan's power infrastructure. Recognizing this, EPENAM executed the retrofit under significant time constraints. We compressed the retrofit plan to ensure the successful commissioning within a single energization of the powerhouse, thus minimizing downtime for this critical facility. This retrofit extended the protection life of the hydro generators by a couple of decades.



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