

# Hydraulic Transient Analysis of Surge Tanks: Case Study of Satpara and Golen Gol Hydropower Projects in Pakistan

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## Abstract

*Surge tanks are used for dissipate the water hammer pressure in high head hydropower project. Commonly used surge tanks have one surge chamber. A double chamber surge tanks were introduced in two high head hydropower projects in Pakistan. In the present study hydraulic design of surge tanks for the two potential sites in Pakistan were analyzed for surge wave height and time to dissipate. Surge tanks designed for Golen Gol hydropower project and Satpara hydropower project were analyzed for the hydraulic transient under the two operational scenarios i.e. complete closure and complete opening. It was concluded that for Satpara hydropower plant, surge tank without chamber and surge tank with two chambers produces high range of surges to cause undesirably heavy governor movement. While surge tank with lower chamber produces the minimum surge height as compared to other types, so the hydraulic behavior of surge tank with lower chamber is more stable than other types of surge tanks. Similarly for Golen Gol hydropower plant surge tank with two chambers produces better surge protection as compared to surge tank with single chamber and no chamber.*

**Key Words:** Hydraulic Transient, Hydropower, Surge Chamber, High Head Hydropower, Pressure Conduit.

## 1. Introduction

The surge tank or surge tower is an essential part of with high head hydropower to protect the low-pressure conduit system from high internal pressure. The surge tank is also useful to minimize the possible danger due to water hammer due to pressure change in closed pipes caused when flowing water in pipes is accelerated or decelerated by closing or opening a valve or changing the velocity of water rapidly in some other mean. Whenever there is an abrupt load rejection by the power system, the mass of water in the conveyance system in turn get suddenly decelerated, this process gives rise to water hammer phenomenon. The purpose of the surge tank is to intercept and dampen these high-pressure waves and not allow them in the low-pressure system. Its operation benefits in three different ways.

1. It shortens the distance between the turbine inlet and the nearest free water surface, and thereby greatly reduces the intensity of the water hammer waves.
2. With a reduction of turbine load, the water level in the chamber rises until it exceeds the level in the main reservoir, thus retarding the main conduit flow and absorbing the surplus kinetic energy.
3. In case of increase of turbine load, the chamber act as a reservoir which will provide sufficient water to enable the turbine to pick up their new load safely and quickly and to keep them running at the increased load until the water level in the surge chamber has fallen below its original level. Sufficient head is thereby created to accelerate the flow of water in the conduit until it meets the new demand.

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