Dynamic pressure fluctuations and their mechanical impact on the penstock liner

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Abstract. In the beginning, a presentation of the international TS63111 Technical Specification on hydraulic transient phenomena of hydro turbines, storage pumps and pump-turbines will be done. The Specification has been submitted for comments to the IEC TC4 Countries Committees and it deals with the factors that affect the hydraulic transients, the recommend modelling, design, and the best practice for site measurement and guarantee evaluation. With respect to the pressure measurement during transient testing and the calibration of the transient modeling following the site measurement, sometimes the dynamic pressure fluctuations are not considered and only the average value is indicated. During the testing, a full attention should be given not only to the measurements conditions but also to the equipment used and not least the sampling rate used for the acquisition. The paper presents the findings of EDF-DTG during the testing performed in some power plants and the mechanical impact of high frequency pressure fluctuations on the penstock liner. During the testing, the penstock has been equipped with classic pressure transducers and with strain gauges in order to demonstrate that the high frequency pressure fluctuations have also a mechanical impact on the liner and should be considered in the evaluation of the guarantee. A comparison between the stress calculated as an effect of the pressure and the stress given by the strain gauges have been performed on the signals together with the classical Spectral analysis.

1. Introduction

In 2017 a new Working group (WG36) was created which had the mandate to provide a technical specification for turbines, storage pumps and pump-turbines in order to: (i) Aim at improving the safety of hydroelectric power plants through a better understanding of the hydraulic transient phenomenon between the different parties involved: civil work designer, equipment supplier, power network testing team and utilities; (ii) Define terms; (iii) Describe hydraulic transients and their consequences; (iv) Define parameters characterizing the phenomenon; (v) Provide a guide to select suitable modelling for different waterways and hydraulic machines and define the required input data and relevant quantities to monitor;
(vi) Define typical load cases and transient scenarios for different configurations, operating conditions and unit types; (vii) Recommend safety margin; recommendations on ways to determine uncertainty margin with respect to the project stage, modelling and computation methods and available input data will be made; (viii) Suggest ways to mitigate extreme transient values of pressure, surge tanks water levels, and hydro unit rotational speed; (ix) Define limitations of the computation methods and recommend additional means to consolidate the simulation results; (x) Address technical aspects about transient tests to be performed during the commissioning of hydro unit; (xi) Propose ways to compare on-site measurements with transient calculation results and to perform input data calibration whenever necessary; (xii) Establish