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Modified Design of Hydroturbine Wicket Gates to Include Liquid Control Jets[1] BRYAN LEWIS, JOHN CIMBALA, ALEX WOUDEN, Penn State University — With the ever-increasing penetration of alternative electricity generation, it is becoming more common to operate hydroturbines under off-design conditions in order to maintain stability in the electric power grid. Improving the off-design performance of these turbines is therefore of significant importance. As the runner blades of a Francis hydroturbine pass though the wakes created by the upstream guide vanes (wicket gates and stay vanes), they experience significant changes in the instantaneous values of absolute velocity, flow angle, and pressure. The concept of adding water jets to the trailing edge of the guide vanes is proposed as a method for reducing the dynamic load on the hydroturbine runner blades, as well as modifying the flow angle of the water entering the runner to improve turbine efficiency during off-design operation. In order to add water jets that are capable of turning the flow, a modified beveled trailing edge design is presented. Computational experiments show that a $\pm 5^\circ$ change in swirl angle is achievable with the new design, as well as up to 4% improvement in turbine efficiency during off-design operation. This correlates to an overall improvement in machine efficiency of up to 2%, when the losses through the jet channels are taken into account.

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Bryan Lewis
Penn State University

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