

## **Flow Measurements for Efficient Operation**

### **Publications, Reports, and Presentations**

March, P., and P. Wolff, *Quantifying the Potential Value of Unit Characteristics Based on Field Efficiency Tests and Archival Data Analyses*, Doylestown, Pennsylvania: Hydro Performance Processes Inc., Final Report FR2101, November 2021.

March, P., and P. Wolff, *Operation Efficiency and Generating Scheduling Analyses for Reclamation's Palisades Dam and Powerplant*, Doylestown, Pennsylvania: Hydro Performance Processes Inc., Technical Memorandum TM2102, October 2021.

March, P., and P. Wolff, *Implementing Identified Opportunities for Generation Improvements at Reclamation's Flaming Gorge Dam and Powerplant*, Doylestown, Pennsylvania: Hydro Performance Processes Inc., Technical Memorandum TM2101, September 2021.

March, P., and P. Wolff, *Operation Support Tool for Ontario Power Generation's Sir Adam Beck Project*, Palo Alto, California: Electric Power Research Institute, Report No. 3002019413, April 2020.

March, P., P. Wolff, E. Foraker, and S. Durham, "Quantifying the Potential Value of Unit Characteristics Based on Field Efficiency Tests and Archival Data," *Proceedings of HydroVision International 2019*, Tulsa, Oklahoma: PennWell Corporation, July 2019.

March, P., and P. Wolff, *Quantification of Optimization Benefits from Detailed Unit Performance Testing at Multiunit Hydropower Facilities, Phase 2: Case Study for Palisades*, Oak Ridge, Tennessee: Oak Ridge National Laboratory, ORNL Draft Report, July 2017.

March, P., P. Wolff, E. Foraker, and S. Hulet, "Quantification of Optimization Benefits from Detailed Unit Performance Testing at Multiunit Hydropower Facilities," *Proceedings of HydroVision International 2017*, Tulsa, Oklahoma: PennWell Corporation, July 2017.

March, P., P. Wolff, and S. Rosinski, "Evaluating the Effects of Uncertainty in Unit Characteristics on the Operation and Optimization of Francis, Diagonal Flow, Fixed Propeller, and Kaplan Hydroplants," *Proceedings of HydroVision International 2016*, Tulsa, Oklahoma: PennWell Corporation, July 2016.

March, P., and P. Wolff, *Quantification of Optimization Benefits from Detailed Unit Performance Testing at Multiunit Hydropower Facilities, Phase 1: Case Study for Flaming Gorge*, Oak Ridge, Tennessee: Oak Ridge National Laboratory, ORNL Draft Report, May 2016.

March, P., and P. Wolff, *Evaluating the Effects of Uncertainty in Unit Characteristics on the Operation and Optimization of Francis, Diagonal Flow, Fixed Propeller, and Kaplan Hydroplants*, Palo Alto, California: Electric Power Research Institute, Report No. 3002006158, December 2015.

March, P., and P. Wolff, *Evaluating the Effects of Uncertainty in Unit Characteristics on the Operation and Optimization of Multiunit Hydroplants*, Palo Alto, California: Electric Power Research Institute, Report No. 3002003700, December 2014.

March, P. A., P. Wolff, P. O'Connor, and B. Smith, "Developing and Verifying a Hydroplant Performance Calculator," *Proceedings of HydroVision International 2014*, Tulsa, Oklahoma: PennWell Corporation, July 2014.

March, P., P. Wolff, J. Zhu, R. Fremming, and T. Key, "Using ADCP-Based Flow Monitoring to Improve Operations at Niagara," *Hydro Review*, October 2012.

March, P., *Evaluation and Application of Radar-Based Water Level Sensors, New York Power Authority's Niagara Project*, Palo Alto, California: Electric Power Research Institute, Report No. 1023419, August 2011.

March, P., and J. Zhu, *Application of an Acoustic Doppler Current Profiler to Measure Hydro Plant Diversion Flows, New York Power Authority's Niagara Project*, Palo Alto, California: Electric Power Research Institute, Report No. 1023420, August 2011.

March, P., P. Wolff, J. Zhu, R. Fremming, T. Key, "Using an ADCP-Based Flow Monitoring System to Improve Operation of the New York Power Authority's Niagara Project," *Proceedings of HydroVision 2011*, Tulsa, Oklahoma: PennWell Corporation, July 2011.

Wolff, P. J., P. A. March, T. Key, and J. Zhu, "Using Operational Data to Determine Pumped-Storage Unit Characteristics in Generating Mode and Pumping Mode," *Proceedings of HydroVision 2010*, Tulsa, Oklahoma: PennWell Corporation, July 2010.

Wolff, P. J., and P. A. March, *Improved Lewiston Unit Characteristics from Operational Data, New York Power Authority's Niagara Project*, Nashville, Tennessee: Hydro Performance Processes Inc., Report 10.02, March 2010.

March P. A., and P. J. Wolff, *Diversion Flow Comparisons, New York Power Authority's Niagara Project*, Nashville, Tennessee: Hydro Performance Processes Inc., Report 10.01, March 2010.

March, P. A., "Supplement to Volume 1: Turbine Performance and Air Admission Tests, Osage Plant Units 1 and 7," Nashville, Tennessee: Hydro Performance Processes, June 2009.

Wolff, P. J., and P. A. March, *Extraction of Lewiston Unit Characteristics from Operational Data, New York Power Authority's Niagara Project*, Nashville, Tennessee: Hydro Performance Processes Inc., Report 0803, December 2008.

March, P. A., *Hydropower Technology Roundup Report - Case Study on Hydro Performance Best Practices*, Palo Alto, California: Electric Power Research Institute, Report No. 1015807, December 2008.

March, P. A., "Improving Flow Measurements in Short, Converging Intakes," Electric Power Research Institute Collaborative Project Meeting, Waterpower XV, July 2007.

March, P. A., B. T. Smith, A. W. Wilson, and F. Sotiropoulos, "Achieving Improved Flow Measurements for the Hydroelectric Power Industry," *Proceedings of HydroVision 2006*, Kansas City, Missouri: HCI Publications, August 2006.

Almquist, C. W., and P. A. March, "Turbine Performance and Air Admission Tests, Osage Plant Units 3 and 6," Nashville, Tennessee: Principia Research Corporation and Hydro Performance Processes Inc., Revision B, March 2006.

March, P. A., "Progress and Recommendations of the HPLIG Flow Measurement Working Group," Canadian Electricity Association Technologies Inc. - Hydraulic Plant Life Interest Group (CEATI/HPLIG), Chattanooga, Tennessee, February 2006.

March, P. A., "Improved Flow Measurements for the Hydroelectric Power Industry: Experience and Recommendations of the CEATI-HPLIG Flow Measurement Working Group," CEATI Report No. T052700-0330, Montreal, Canada: CEA Technologies Inc., January 2006.

Wolff, P. J., P. A. March, R. K. Jones, and D. B. Hansen, "Structuring a Hydroturbine Testing Program to Measure and Maximize Benefits," *Proceedings of Waterpower XIV*, Kansas City, Missouri: HCI Publications, July 2005.

Almquist, C. W., T. A. Brice, J. S. Adams, and P. A. March, "Economical Flow Measurement for Optimal Dispatch," *Proceedings of Waterpower XIV*, Kansas City, Missouri: HCI Publications, July 2005.

March, P. A., "Observations and Recommendations Based on Site Visits to Meridian Energy Ltd.'s Offices and Hydroelectric Projects," Norris, Tennessee: Hydro Resource Solutions LLC, HRS Report 0301, October 2003.

March, P. A., "Why Measure Flow?," Flow Measurement Forum, Waterpower XII, Salt Lake City, Utah, July 2001.

Lemon, D., C. Almquist, W. Cartier, P. March, and T. Brice, "Measuring Turbine Flow with an Acoustic Scintillation Flow Meter," *Hydro Review*, April 1999.

Lemon, D. D., C. W. Almquist, W. W. Cartier, P. A. March, and T. A. Brice, "Comparison of Turbine Discharge Measured by Current Meters and Acoustic Scintillation Flow Meter at Fort Patrick Henry Power Plant," *Proceedings of HydroVision 98*, Reno, Nevada, August 1998.

Wolff, P. J., P. A. March, and C. W. Almquist, "Old Problems, New Techniques: Using Computational Fluid Dynamics to Find the Missing Flow," *Proceedings of Waterpower 97*, August 1997.

Almquist, C. W., P. A. March, and H. W. Franseen, "The Sliding Gate Method: A Better Way of Turbine Efficiency Testing," *Hydro Review*, May 1997.

Almquist, C.W., D.B. Hansen, and P.A. March, "Evaluation of the Ultrasonic Time-of-Travel and Pressure-Time Methods for Measuring Flow in Main River Hydroplants," Norris, Tennessee: Tennessee Valley Authority, Engineering Laboratory Report No. WR28-1-900-276, February 1996.

Almquist, C.W., and P.A. March, "Hydroturbine Efficiency and Vibration Tests at the Santeetlah Development," Report TAP.SNT.ET.01, January 1996.

March, P.A., and C.W. Almquist, "Flow Measurement Techniques for the Efficient Operation of Hydroelectric Power Plants," National Institute of Standards and Technology, Metrology for the Americas Conference, Miami, FL, November 1995.

March, P.A., "Proposal to Develop a Turbine Module for Hydro Condition Monitoring," MCM Consortium, October 1995.

Wolff, P.J., D.B. Hansen, C.W. Almquist, and P.A. March, "An Improved System for Hydroturbine Index Testing," *Proceedings of Waterpower 95*, July 1995.

March, P.A., and R.K. Jones, "Hydroturbine Condition Monitoring System," Norris, Tennessee: Tennessee Valley Authority, Engineering Laboratory Misc. Paper No. 95-1, July 1995.

Almquist, C.W., D.B. Hansen, G.A. Schohl, and P.A. March, "Pressure-Time Flow Rate in Low Head Hydro Plants," *Proceedings, ASCE National Hydraulic Eng. Conference*, August 1994.

Almquist, C.W., and P.A. March, "Hydroturbine Efficiency and Vibration Tests, Chilhowee Hydro Plant," Report 94-1, March 1994.

Rizk, T.J., P.A. March, and C.W. Almquist, "Numerical and Physical Modeling for Condenser Flow Measurement," *Proceedings of the ASME Forum on Industrial and Environmental Applications of Fluid Mechanics*, New York: American Society of Mechanical Engineers, November 1992.

Almquist, C.W., and P.A. March, "Hydroturbine Efficiency and Vibration Tests, Calderwood Hydro Plant" Report 92-1, March 1992.

Jones, R.K., and P.A. March, "Efficiency and Cavitation Effects of Hydroturbine Venting," *Proceedings of the ASCE National Hydraulic Engineering Conference*, Nashville, TN, August 1991.

Almquist, C.W., P.A. March, and J.F. Kirkpatrick, "Modernizing the Gibson Method of Flow Measurement," *Hydro Review*, June 1990, pp. 86-91.

Schohl, G.A., and P.A. March, "Theoretical and Numerical Analysis of the Pressure-Time Flow Measurement Method," Norris, Tennessee: Tennessee Valley Authority, Engineering Laboratory Report No. WR28-1-900-244, June 1990.

Giles, J.E., R.K. Jones, P.A. March, H. Armour, and J.M. Epps, "Microcomputer-Aided Planning at a Hydro Control Centre," *International Water Power and Dam Construction*, January 1990.

March, P.A., "Preliminary Recommendations for Efficiency Improvements at Tapoco Hydroplants," Report No. 89-2, July 1989.

Jones, R.K., P.A. March, and J.M. Epps, "Monitoring Hydroturbines for Efficiency and Cavitation," *Hydro Review*, June 1989, pp. 72-79.

March, P.A., and C.W. Almquist, "New Techniques for Monitoring Condenser Flow Rate and Fouling," *Power*, March 1989, pp. 73-76.

March, P.A., and C.W. Almquist, "Techniques for Monitoring Flowrate and Hydraulic Fouling of Main Steam Condensers," *Proceedings of the Electric Power Research Institute Condenser Technology Symposium*, CS-5942-SR, September 1988.

Jones, R.K., and P.A. March, "Hydroturbine Efficiency and Cavitation Monitoring," *Proceedings of the 1988 ASCE Hydraulics Division Specialty Conference*, Colorado Springs, Colorado, August 1988.

March, P.A., "On the Use of Laser Velocimetry for Performance Evaluation of Cooling Towers," ASME Winter Annual Meeting, Boston, Mass., December 1987.

March, P.A., J.R. Missimer, A. Voss, and H.S. Pearson, "Comparison of Acoustic and Conventional Flow Measurement Techniques at the Raccoon Mountain Pumped- Storage Plant," EPRI Report No. AP-4713, Palo Alto, California: Electric Power Research Institute, August 1987.

Missimer, J.R., P.A. March, and A.W. Voss, "A Comparison of Flow Measurements Using Acoustic and Volumetric Techniques," *Proceedings of the Fourth International Symposium on Hydro Power Fluid Machinery*, FED-Vol. 43, New York: American Society of Mechanical Engineers, December 1986.

March, P.A., and C.W. Almquist, "New Techniques for Monitoring Condenser Flow Rate and Hydraulic Fouling," Norris, Tennessee: Tennessee Valley Authority, Engineering Laboratory Report No. WR28-1-41-106, December 1986.

Almquist, C.W., J.F. Kirkpatrick, and P.A. March, "Microcomputer-Based Index Testing of Hydroturbines," *Proceedings of the 1985 ASCE Hydraulics Division Specialty Conference*, August 1985.

Harshbarger, E. D., P. A. March, and S. Vigander, "The Effect of Hydro Turbine Air Venting on Generating Efficiency, Dissolved Oxygen Uptake, and Turbine Vibrations," *Proceedings of the Symposium on Hydraulic Machinery in the Energy-Related Industries*, Stirling, Scotland, August 1984.

Smith, M.N., P.A. March, and S. Vigander, "On the Use of Acoustic Flowmeters for Feedwater Flowrate Measurement in Nuclear Plants," Norris, Tennessee: Tennessee Valley Authority, Engineering Laboratory Report No. WR28-1-900-111, April 1983.

March, P.A., "Comparison of Volumetric, Ultrasonic, and Winter-Kennedy Flow Measurement Methods," *Water Power*, October 1982.

### **Contact information:**

Patrick A. March  
President and Principal Consultant  
Hydro Performance Processes Inc. (EIN 20-1959788)  
98 Steeplechase Dr., Doylestown, Pennsylvania 18901-5717  
[pamarch@hydroppi.com](mailto:pamarch@hydroppi.com); [pamarch@gmail.com](mailto:pamarch@gmail.com)  
Cell Phone: 1.865.603.0175