ORNL/TM-2011/360

Environmental Science Division

Reference Inflow Characteristics for River Resource Reference Model: Reference Model 2 (RM2)

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Date Published: October 2011

Prepared by
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managed by
UT-BATTELLE, LLC
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-00OR22725

ABSTRACT

Sandia National Laboratory (SNL) is leading an effort to develop reference models for marine and hydrokinetic technologies and wave and current energy resources. This effort will allow the refinement of technology design tools, accurate estimates of a baseline levelized cost of energy (LCoE), and the identification of the main cost drivers that need to be addressed to achieve a competitive LCoE. As part of this effort, Oak Ridge National Laboratory was charged with examining and reporting reference river inflow characteristics for reference model 2 (RM2). Published turbulent flow data from large rivers, a water supply canal and laboratory flumes, are reviewed to determine the range of velocities, turbulence intensities and turbulent stresses acting on hydrokinetic technologies, and also to evaluate the validity of classical models that describe the depth variation of the time-mean velocity and turbulent normal Reynolds stresses. The classical models are found to generally perform well in describing river inflow characteristics. A potential challenge in river inflow characterization, however, is the high variability of depth and flow over the design life of a hydrokinetic device. This variation can have significant effects on the inflow mean velocity and turbulence intensity experienced by stationary and bottom mounted hydrokinetic energy conversion devices, which requires further investigation, but are expected to have minimal effects on surface mounted devices like the vertical axis turbine device designed for RM2. A simple methodology for obtaining an approximate inflow characterization for surface deployed devices is developed using the relation $u_{max}=(7/6)V$ where V is the bulk velocity and u_{max} is assumed to be the near-surface velocity. The application of this expression is recommended for deriving the local inflow velocity acting on the energy extraction planes of the RM2 vertical axis rotors, where $V=Q/A$ can be calculated given a USGS gage flow time-series and stage vs. cross-section area rating relationship.