

EEMS Test Case Model Description

TC_IFREMER_MHK

1 Overview

This model replicates the test case described in the conference paper by James et al. [2], " *Verifying Marine-Hydro-Kinetic Energy Generation Simulations Using SNL-EFDC*". The objective is to use EFDC+ Explorer (EE) and EFDC+ to simulate Marine Hydrokinetic (MHK) device energy removal and its effect on the surrounding flow field. The model was originally provided by Sandia National Laboratories (SNL), who calibrated turbulence and MHK device parameters against wake data from a flume experiment reported by Myers and Bahaj [3]. This produced verified simulations of MHK-device energy removal that serve as a reliable benchmark for demonstrating EFDC+'s MHK modeling capabilities.

2 Demonstration Feature

This test case demonstrates the Marine Hydrokinetic (MHK) module in EFDC+, specifically its ability to simulate the energy extraction by in-stream turbine devices and the resulting wake effects on the surrounding flow field. MHK devices – such as horizontal axis marine current turbines – extract kinetic energy from flowing water, creating velocity deficits and turbulence in their wake that can have significant environmental and engineering implications.

By replicating the SNL-calibrated benchmark, this test case illustrates how EFDC+ can be used to:

- Model the placement and operation of MHK devices within a flow domain
- Simulate turbine wake development and velocity recovery downstream
- Calibrate turbulence parameters against physical flume experiment data
- Assess the hydrodynamic impact of MHK energy extraction on the surrounding environment

The reference paper by Roberts et al. [4], included in the **Data** folder, provides additional context and details on the modeling methodology. The theoretical foundations of EFDC+ are documented in the [EFDC+ Theory Document](#) [1].

3 Model Description

The model configuration is summarized in Table 1. The model domain, as shown in Figure 1, consists of 2,750 horizontal grid cells representing the flume geometry used in the IFREMER experiment, designed to resolve the flow field around the MHK device and its downstream wake. The following EFDC+ modules are activated in this test case:

- **Hydrodynamics** – simulates the 3D flow field within the flume domain, including velocity distribution around and downstream of the MHK device
- **Marine Hydrokinetics (MHK)** – simulates the energy extraction by the MHK turbine device and the resulting wake structure

Table 1 Model configuration summary

Dimensions	Horizontal cells	Vertical cells	Activated modules
3D	2,750 cells	• 25 layers • Using a Standard Sigma layering scheme	• Hydrodynamics • Marine Hydrokinetics (MHK)

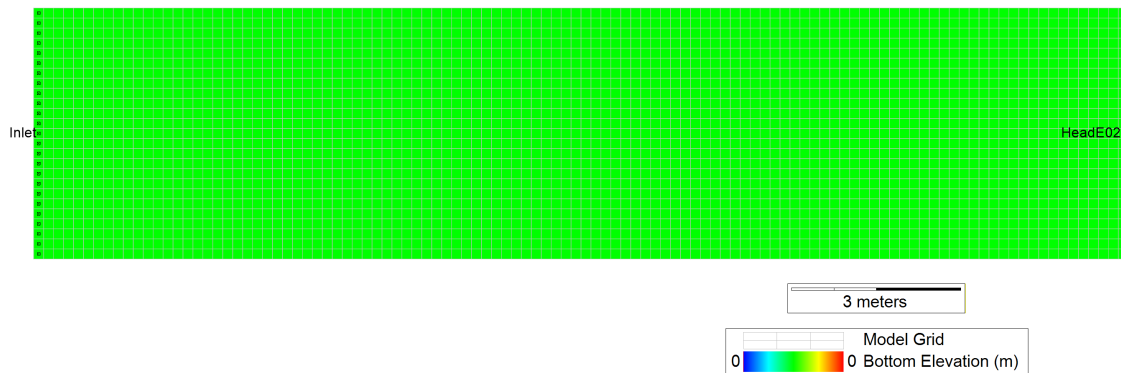


Figure 1 Model domain

4 Model Results

Figure 2 illustrates the velocity magnitude distribution across the flume domain, capturing the energy extraction effect of the MHK device and the development of the downstream wake. The velocity deficit in the wake region and the gradual velocity recovery further downstream are consistent with the patterns observed in the Myers and Bahaj [3] flume experiment, confirming the validity of the SNL-calibrated model setup.

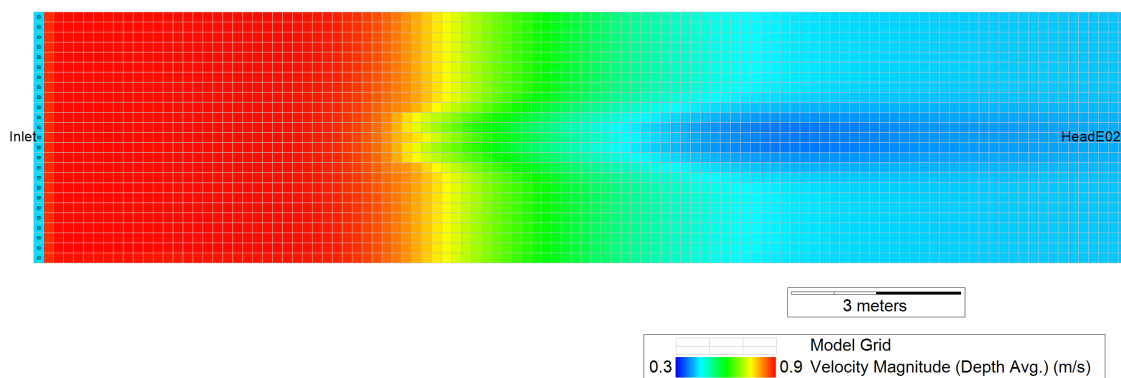


Figure 2 Simulated velocity magnitude in 2DH View

References

- [1] DSI LLC (2024). *EFDC+ Theory: Version 12*. DSI LLC, Edmonds, WA, USA. Accessed: 2026-04-06.
- [2] James, S. C., Lefantzi, S., Barco, J., Johnson, E., and Roberts, J. D. (2011). Verifying marine-hydro-kinetic energy generation simulations using snl-efdc. In *OCEANS'11 MTS/IEEE KONA*, pages 1–9. IEEE.
- [3] Myers, L. and Bahaj, A. (2009). Near wake properties of horizontal axis marine current turbines.
- [4] Roberts, J. D., Johnson, E., Barco, J., James, S. C., Jepsen, R. A., and Lefantzi, S. (2011). Flow sensitivity to mhc energy generation from currents using the snl-efdc model. Technical Report SAND2011-6261P, Sandia National Laboratories, Albuquerque, NM.

Disclaimer: This model is provided to demonstrate that EFDC+ Explorer and EFDC+ can be used to better understand how to build this kind of model. The model is running as expected; however, it should not be considered final, as it can be modified and refined to obtain improved results.