

**Standard Operating Procedure for ERDC Hydrology, Hydraulics and Coastal (HH&C) Numerical Model  
Verification & Validation (V&V) and Certification of Coastal Engineering and Planning Models  
28 November 2022**

This document provides guidelines on the process of verifying ERDC Hydrology, Hydraulics and Coastal numerical models (including both engineering and planning) as ready for official use, and when required, certifying Coastal Storm Risk Management (CSRМ) numerical models by the Planning Center of Expertise for Coastal Storm Risk Management (PCX-CSRМ).

New or updated ERDC HH&C and navigation numerical models all need to go through the seven steps outlined below to be verified as ready for use and when required also certified.

1. Step 1: Convene Coordination Meeting. ERDC, HH&C and the PCX-CSRМ will hold a meeting to discuss the level of code development, Verification and Validation (V&V), field testing, documentation, training development and certification to ensure that all parties are aligned on the approach to and timescale for new development and updates. The meeting should also cover the funding amount, source and timing; and followup coordination meetings as needed to ensure better accountability and timeliness of the HH&C numerical model V&V and Certification.
2. Step 2: Model Development Updates. Researchers develop new numerical models/tools and/or perform updates to existing versions of HH&C software. There are four categories of model development: NEW model, MAJOR updates, MINOR updates and PATCH updates to existing codes. Updates can range in complexity and effort, see section 2 for more details on what constitutes Major, Minor or Patch, but in each case, a level 1 verification and validation (Step 3) is always required.
  - a. Updates that are fixing bugs (Patch updates) still require rerunning of Level 1 V&V, and ideally should require approximately 1 week to complete.
    - i. For SMART planning use, if a software update is required during the study, then the study's Risk Register should be updated to acknowledge the recent fix and note that documentation updates, re-certification, etc. are pending
  - b. USACE funded updates addressing new capabilities based on field needs (varying time frame for completion) should be fully coordinated with and signed off by the PCX-CSRМ in conjunction with the appropriate Community of Practice leads as related to the technology being updated.
  - c. Access to code executables must be available for evaluation by the PCX-CSRМ and ACE-IT.
3. Step 3: Level 1 Verification & Validation. Developers conduct and document their model testing/verification and validation per a pre-set protocol (protocol is being developed via ERDC-CHL's Numerical Technology Modernization Strategy (NTMS) and in alignment with the HH&C Software Engineering Tools (SET) program). This protocol will be established and submitted for approval no later than January 2023. Model developers and field users will be able to contribute to the testing/V&V suite. In particular, field users will identify test cases needed for specific application/process import for their workflows.
  - a. Testing/ V&V results will be documented and posted (compare V&V results to expected test outcomes).

- b. ERDC will provide beta-release version of model to teams for field-testing, as appropriate, and establish a timeframe for providing feedback.
  - c. Externally developed/updated models and new releases of existing models similarly would conduct these tests/V&V.
  - d. Any contract actions involving ERDC codes should include requirements for the contractor to demonstrate the new code passes the test/V&V suite of cases before final work acceptance.
4. Step 4: Documentation/Training Material. All codes must have a User’s Manual or other appropriate model documentation, such as Wiki pages, websites, or videos, prior to official use status. New models and Major updates require full user manual/documentation creation or updates prior to official use status. Minor updates require user manual/documentation updates but can be in draft form and under official review while official use status of the code is being processed. This allows for potentially faster turnaround times without compromising the integrity of the code/documents. Patch updates do not automatically require updating the user manuals, but Patches are documented through the software version-control process. As part of the new HH&C SET and NTMS guidelines, training material and videos are being required for HH&C models, therefore, when New, Major, Minor updates are made, it is expected that new training material including videos will be produced within a one-year time period of the updates and made available through appropriate website and be archived.
5. Step 5: Model Certification by the PCX-CSR. For those models requiring certification, the Model Certification Lead for the PCX-CSR will be informed by the ERDC developers/model point of contacts that a new version will be available. This should be done concurrently with Steps 3 and 4 being completed. This allows time for the PCX-CSR to ensure adequate resources have been identified for the certification process. The PCX-CSR verifies that the new software version has passed Level 1 V&V (Step 3) and that documentation has been updated (Step 4) through the model certification process (provided in Figure 1).
- a. Development of a new version in and of itself does not trigger recertification. Recertification is needed when new functionality is added, or a major bug has been discovered and corrected, or no more than 5 years after the latest certification. In short, New and Major Updates will require re-certification. Documentation of code updates/bug fixes and their expected impacts need to be included in the release notes.
  - b. New models need to be certified by the appropriate PCX-CSR.
  - c. When the PCX-CSR certifies for use the new model, then the PCX-CSR approves ERDC to start the process to make the new/updated software available on the ACE-IT App Portal.

Estimated order of magnitude timeframes for certification, assuming Steps 3 and 4 are in place and code is accessible for evaluation.

- New Model – 6-14 months for certification
- Major Update – 3 months recertification
- Minor Update – 1 month recertification
- Patch Update – no recertification required

ERDC is responsible for starting the ACE-IT security process (applicable for new models, model updates, and external models) for having the software posted on the App Portal.

6. Step 6: ACE-IT Approval and Posting. The ACE-IT software request process (SRP) consists of three main phases, Phase 1- Approval, Phase 2- Acquisition/Licensing, and Phase 3- Packaging/Delivery. For this SOP, only Phase 1 and Phase 3 are involved. Phase 1 involves several steps including determining if the software will introduce any particular vulnerabilities into the USACE environment and whether the use violates any rules/regulations/guidelines. These actions can also include the ACE-IT Code Scanning team to examine the code or if the code involves a Microsoft Office plugin or macro, the Code Signing team has to perform an evaluation and signing of the code. Additional measures are involved if the code communicates via the internet either on-premise, cloud, or world. Phase 3 involves getting the code ready for posting on the portal, which may also include installers. ERDC coordinates closely with ACE-IT to ensure only approved version(s) of the software are posted/available on the App Portal.

ACE-IT posts new version on App Portal.

Estimated order of magnitude for Step 6 assuming no issues/vulnerabilities found:

- New Model/Major Update – Phase 1 is typically 3-5 business days; Phase 3 is typically 10 business days (total is 13 to 15 days)
  - Minor Update/Patch Update – Phase 1 is typically 1-2 business days; Phase 3 is typically 10 business days (total is 11 to 12 days)
7. Step 7: Communicate Release to the Field. ERDC and the PCX-CSRM (when certification is required) will announce in a joint memorandum, the release of a new model version to the District Planning and Engineering Chiefs along with an announcement utilizing the HH&C CoP and Coastal Working Group distribution mechanisms. That announcement will provide a timeline for enterprise transition including an adequate transition with both a phase-in/phase-out period. In addition to ensuring the use of the latest approved software, this process also serves to sunset older versions and prevent their use on new projects.

Notes:

- PCX-CSRM has the role to help define V&V Test cases to ensure that the scope of certification meets intent of model.
- In FY22 and FY23, ERDC-CHL's HH&C SET Lead is developing an online Model Catalog resource to provide an information source including a place for FAQs, links to model documentation, links to V&V case information to include software version results as compared to expected results for these V&V cases, tabs for notes on model updates/bug fix, and a tab with links for additional resources.

### **Versioning and Certification:**

As part of the NTMS, ERDC-CHL will establish "Semantic Versioning" specifications for all codes for which ERDC fully controls the development and release schedules. The semantic versioning protocol is widely used in the open-source community and is often actually required for use. Semantic versioning has three components to the version numbering: MAJOR.MINOR.PATCH

- MAJOR version number must be updated whenever one makes incompatible application programming interface (API) changes to the code, i.e. no backward compatibility to previous versions.
- MINOR version number must be updated when one adds functionality to the code and maintains backward compatibility. It may be incremented if substantial new functionality or improvements are introduced within the private (non-released) developmental code.
- PATCH version number must be updated when one makes backward compatible bug fixes. A bug fix is defined as an internal change that fixed incorrect behavior.

All version numbers are non-negative integers only with no alpha-numeric characters and no leading zeros included. Version numbers must increase sequentially when incrementing, no skipping numbers. When the MAJOR version number is incremented, the MINOR and PATCH versions are both reset to 0. When the MINOR version number is incremented, the PATCH version number is reset to 0. Once a version of the code is “released” only bug fixes are allowed, so only the PATCH version numbers may be incremented. After an official release, any MINOR/MAJOR level code changes must be done in a new release.

As part of the NTMS, all codes will be required to have a set of verification and validation test cases developed and used within a regression testing framework, this is the Level 1 V&V testing in this SOP. This ensures that code changes have not broken other parts of the code and that model outcomes are still as expected. All version increments must pass this Level 1 V&V regression testing, including PATCH updates. New functionality additions (MAJOR/MINOR versions) to the code will require additional V&V regression testing cases be developed and implemented. This process is performed at the developer level (ERDC) and ensures code readiness for use but does not imply in itself that a code is certified for use or that it should be posted on ACE-IT software centers. Field users may contribute to the suite of test/V&V cases.

The PCX-CSRMs should review/recertify each release version of the code. An approved/certified release version of a code is the only one that should appear on the ACE-IT software portal. A new release of code may have version numbers that are incremented in the MAJOR and/or MINOR categories. A PCX-CSRMs recertification for use is not required for PATCH versions as long as the code has passed the developer readiness regression testing.

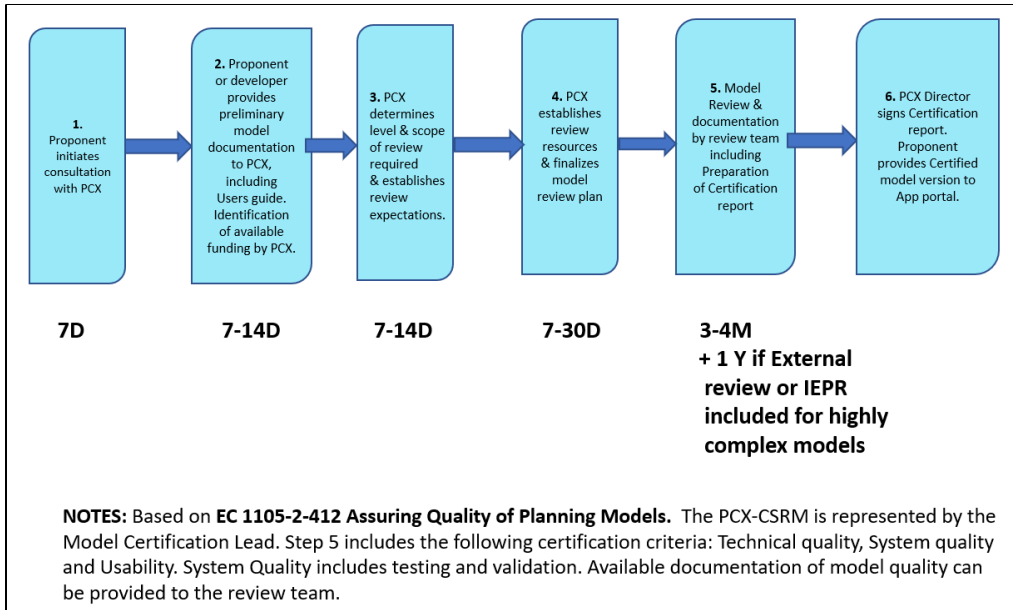


Figure 1. Coastal Storm Risk Management Planning Model Certification Timeline (courtesy PCX-CSRМ)