

Prepared for the U.S. Department of Energy Under Contract DE-AC05-76RL01830 PNNL-17772

Software Verification and Validation Procedure

March 2008



DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor Battelle Memorial Institute, nor any of their employees, makes **any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or Battelle Memorial Institute. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.**

PACIFIC NORTHWEST NATIONAL LABORATORY operated by BATTELLE for the UNITED STATES DEPARTMENT OF ENERGY under Contract DE-AC05-76RL01830

Printed in the United States of America

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831-0062; ph: (865) 576-8401 fax: (865) 576-5728 email: reports@adonis.osti.gov

Available to the public from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161 ph: (800) 553-6847 fax: (703) 605-6900 email: orders@ntis.fedworld.gov online ordering: http://www.ntis.gov/ordering.htm



PNNL-17772

Software Verification and Validation Procedure

March 2008

Prepared for CH2M HILL Hanford Group, Inc. under Contract DE-AC06-76RLO 1830

Information Sciences & Engineering Pacific Northwest National Laboratory Richland, Washington 99352

Acronyms and Abbreviations

ATPR	Acceptance Test Plan and Results
CRTT	Change Request Tracking Tool
DOE	U.S. Department of Energy
IEEE	Institute of Electrical and Electronics Engineers
PNNL	Pacific Northwest National Laboratory
SSEP	Software Systems Engineering Process
TWINS	Tank Waste Information Network System

Contents

V
1
1
1
2
2
3
4
5
5
5
A.1
B .1
C.1

1.0 Purpose and Scope

This Software Verification and Validation procedure provides the action steps for the Tank Waste Information Network System (TWINS) testing process. The primary objective of the testing process is to provide assurance that the software functions as intended, and meets the requirements specified by the client. Verification and validation establish the primary basis for TWINS software product acceptance.

The TWINS project conforms to the requirements of the Pacific Northwest National Laboratory (PNNL) Information Sciences and Engineering Software Systems Engineering Process (SSEP). The SSEP has the testing process (verification and validation) integrated into its defined software lifecycle. The SSEP review and test process is defined at http://ssep.pnl.gov/VVT. The methods defined in this procedure are derived by applying a graded approach, adapting the SSEP Reviews and testing processes to the specific risks associated with the TWINS project.

This Software Verification and Validation procedure covers all software changes relating to the TWINS system. This includes web pages, scripts (server-side and client-side), code, and MS Access files (tables, reports, queries, modules).

2.0 Implementation

This procedure is effective on the Effective Date shown in the header above.

3.0 Responsibilities

Project Manager: The project manager of the TWINS project is responsible for ensuring that all aspects of this Plan are implemented. Other responsibilities are contained within Section 4.0.

4.0 Procedures

4.1 **Procedure Description**

Project Manager	1	Enter the statement of work, change order, or glitch information into the Change Request Tracking Tool (CRTT).				
Project Manager	2	Determine if the software change (prompted by a statement of work, change order or problem report) requires a formal Acceptance Test Plan and Results (ATPR) and enter the determination in the CRTT. If a formal test plan is required, skip to Step 8. If a formal test plan is not required, complete steps 3 through 7 inclusive.				
		Note: Criteria for making a formal test plan determination are found in Attachment A.				
Project Manager	3	Assign programming of the software changes to a programmer.				
Programmer	4	Complete programming and perform unit testing.				
Programmer	5	Notify the Independent Reviewer that programming and unit testing are complete.				
Independent Reviewer	6	Review each task performed by the Programmer, updating the CRTT as appropriate. Complete acceptance testing, documenting the results as indicated in Attachment B.				
Independent Reviewer	7	Enter the date of verification, verifier and the verification information of Step 6 into the appropriate place in the CRTT log. Procedure ends with this step.				
Project Manager	8	Assign programmer and Independent Reviewer to complete and unit test the changes.				
Independent Reviewer	9	Complete ATPR per template Attachment C and submit to Project Manager for approval. In the case where CH2MHill subject matter expert(s) will perform independent testing to verify results, the programmer will act as the Independent Reviewer in that he/she will document the test results in the ATPR.				
Project Manager	10	Resolve comments and concerns with Independent Reviewer and Programmer as needed and Approve ATPR.				
Programmer	11	Complete programming and unit testing of changes.				
Independent Reviewer	12	Submit ATPR and code to Tester per protocols in the Software Configuration Management Plan for acceptance testing.				
Tester	13	Complete acceptance testing and document on the ATPR form prepared in Step 9. If any tests fail, have the programmer make appropriate programming corrections, or correct test procedures, and rerun the tests. Indicate on the test forms or tables in ink the initials of the tester, the date of successful retest, and the notation that the test passed.				

Tester	14	Sign the ATPR and forward to Project Manager.
Quality Engineer	15	Review and approve the ATPR, resolving comments with the Tester as needed.
Project Manager	16	Maintain a file copy of the completed and approved ATPR.

4.2 Procedure Flow Diagram



5.0 Definitions

Acceptance Testing	Testing to ensure that the given requirements for a software change are met and that the overall system is not adversely affected by the change. Acceptance testing is performed by a person other than the developer. This type of testing is conducted at a higher conceptual level than Unit Testing and is focused on inputs and generated results at the user level. The scope of this type of testing includes:						
	1. Test cases to cover the range of possible input data, including valid and invalid values.						
	2. Ensuring that the system handles invalid input data appropriately to minimize the risk of generating inaccurate results.						
	3. Verifying the accuracy of results generated from valid input data against another trusted/verified source.						
	It is the judgment of the Independent Reviewer and ultimately the Project Manager that determine the scope and depth of coverage for Acceptance Testing.						
	If the independent testing is performed by CH2MHill subject matter expert(s), then the developer assigned to the change request or bug is responsible for documenting the test cases and results. This data will most likely be in the form of email correspondence and data dumps collected in Excel.						
Software Verification and Validation	The process of determining whether the requirements for a system or component are complete and correct, the products of each development phenomenate or conditions impressed by the pravious phase, and						
(from IEEE Std 610.12- 1990, IEEE Standard Glossary of Software Engineering Terminology)	final system or component complies with specified requirements.						
Unit Testing	Testing of individual software components (stored procedures, triggers, batch executables, queries/reports, functions, subroutines, modules, and other individual classes). This testing is carried out by the developer using their knowledge of the code details. This type of testing focuses on verifying the operation of each component separately. The items generally included in this type of testing include:						
	1. For each variable in the component:						
	a. A condition inside the variable's acceptable boundaries.						

- b. A condition outside the variable's acceptable boundaries.
- 2. Each significant logic branch or decision in the component.
- 3. Each significant operation or calculation that affects the output of the component.

It is ultimately the judgment of the developer that determines the degree of coverage for Unit Testing.

6.0 Records

Records generated by this procedure include entries into the CRTT log and the ATPR forms. Records kept prior to January 2, 2008 have been recorded in RIDS. Records after this date shall be kept in TRIM which is maintained by the Project Administrator.

7.0 References

- 1. TWINS, Software Configuration Management Plan, Revision 6, March 2008.
- 2. TRIM and Electronic Records Management http://cer.pnl.gov/records/trim/index.stm

8.0 Distribution

- 1. TWINS Project Manager
- 2. TWINS Software Developers
- 3. TWINS Project Quality Engineer

Appendix A

Appendix A Criteria for Determination of Need for a Formal Acceptance Test Plan



Probability of Failure

The above decision matrix defines the general criteria and process for determining whether or not a formal test plan is required for a given change. This matrix is utilized by the Project Manager as an aid in making that determination.

The "Probability of Failure" axis addresses how likely it is that the given change will be problematic. Issues typically considered in this area are listed below:

- Difficulty or complexity of change
- Size/scope of change
- Experience level of developers doing the change

The "Impact of Failure" axis addresses the implications if the given change does have problems. Issues typically considered in this area are listed below:

- Safety of workers or public compromised
- Regulatory compliance jeopardized
- Financial loss for PNNL and/or customer
- Lowered public image for PNNL, DOE, and customer
- Reduction of operational capability for PNNL and/or customer
- Compromised security of PNNL, DOE, or customer assets

Appendix B

Appendix B

Essential Information for Acceptance Test Plans and Results

The following information is essential for documenting acceptance testing when a formal ATPR are not required:

- CRTT identification number of the change being tested
- Name of the software and revision being tested
- Tester's name, date of test
- Any special tools, conditions, or configurations needed to perform the test
- Test case descriptions, including expected outputs
- Actual results for each test case, including a "pass/fail" notation

This information is a subset of the information contained in the ATPR template provided in Attachment C.

Appendix C

Appendix C Template for Acceptance Test Plans and Results

Bug/Change Request ID:		Bug/Change Request ID:								
Item(s) Tested:					Rev:		Da	te:		
Test Responsibilities:										
Test Environment:										
Test Data Set(Execution Log(s), s):	and								
Pass/Fail Criteria	Pas	Each test case shall have criteria to define Pass outcome for this test.							e a	
	Con Pas	ditiona s	al When all items identified as Corrective Actions have been completed and retested, the Conditiona Pass will be changed to a Pass.							
	Fai	.1	Whe	n a Pas	s or	Con	ditional	l Pass is	not rece	ived.
	Pas Fai	s after 1	Aft out out	After a Fail outcome and retest with a Pass outcome, the Fail outcome is replaced with this outcome.						chis
Test Setup	Spe for	Specific instructions regarding how to set the environment up for the testing.								
Test Procedure	spe	Specific instructions for how to perform the testing.								
Test Restart	Spe "st	Specific instructions regarding how to restart testing after a "stop", usually just "Redo Test Setup".								
Test Stop	Spe the	Specific instructions regarding when to abort the testing, in the event of a problem or failure, prior to completion.								
Test Wrap Up	Spe	Specific instructions regarding when the testing is complete.								
Test Case Log										
	Tes Cas II	st Se Test D Date	D	escript	ion		Input	Expected Result	Actual Result	Pass/ Fail
	T1 T2	L 2								<u> </u>
	ТЭ	3								
	T4	1								

Corrective Actions and Retest Criteria	Bug/ Problem ID	Test Case	Bug/I Descr	Problem	Description	Retest Outcome (Pass/Fail)			
Test Outcome	Pass	Pass 🗌 Conditional Pass 🗌 Fail 🔹 Pass After Fail							
Approvals	Approver			Name	Signature	Date			
	Tester								
	Quality Enginee:	r	Carrie	Carlson					
	Project	Manage	r Tom Olu	ind					



902 Battelle Boulevard P.O. Box 999 Richland, WA 99352 1-888-375-PNNL (7665) www.pnl.gov

