

Office of Civilian Radioactive Waste Management

QA: QA

PROCEDURE

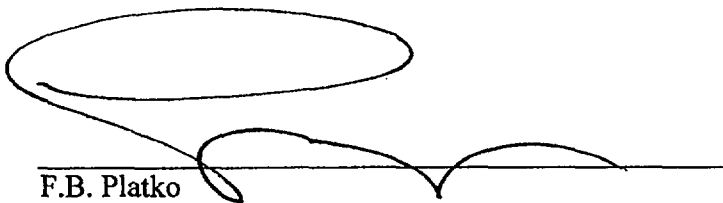
SOFTWARE INDEPENDENT VERIFICATION AND VALIDATION

AP-SI.3Q

Revision 1 ICN 0

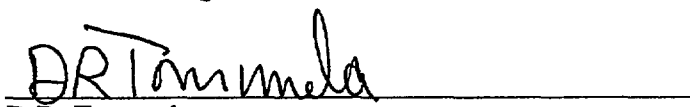
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Preparer:


F.B. Platko

4/22/03
Date

Approval:


D.R. Tommela
Chief Information Officer

4/22/03
Date

Approved 8/1/03

CHANGE HISTORY

<u>Revision Number</u>	<u>Interim Change No.</u>	<u>Effective Date</u>	<u>Description of Change</u>
0	0	01/13/2003	Initial issue
1	0	04/23/2003	Complete revision to address consolidation of Level A software activities from AP-SI.1Q, <i>Software Management</i> , to AP-SI.2, <i>Qualification of Level A Software</i> ; rework process flows to address organizational hand-off issues, role responsibilities, and provide clearer definition of work products; remove use of AP-2.14Q, <i>Review of Technical Products and Data</i> for comment resolution activities; used the Institute of Electrical and Electronic Engineers standards as guidance for development of this procedure rather than as a reference for conducting independent verification and validation activities; and address the following Document Action Requests: D6455, D6456, D6457, D6459, D6460, D6461, D6462, D6463, D6464, D6467, D6468, D6469, D6470, D6523, D6525, D6590, and D6591.

1.0 PURPOSE

The purpose of this procedure is to provide the methodology for performing the independent verification and validation (IV&V) processes throughout the software life cycle.

2.0 APPLICABILITY

This procedure shall only be used as part of AP-SI.1Q, *Software Management*. This procedure applies to software that is subject to the *Quality Assurance Requirements and Description*, DOE/RW-0333P; individuals within Bechtel SAIC Company, LLC; the National Laboratories; the U.S. Geological Survey; Bechtel SAIC Company, LLC subcontractors; and other contractors who acquire, develop, control, or manage software, or who submit software for use by the Office of Civilian Radioactive Waste Management Program.

3.0 DEFINITIONS

- 3.1 ***Configuration Audit*** (Physical and Functional)–The process performed to verify that all software configuration items required to correctly install and operate (and build, if required) the software are present and/or identified in the physical configuration audit. The functional configuration audit is the process performed to verify that these configuration items are properly configured. The configuration items include, but are not limited to, source files, executables, parameter files, input files, security devices/constraints, compilers, utilities, commands, options, settings, and other software.
- 3.2 ***Control Point A Traceability Analysis***–The process performed, during the Control Point A review, to validate the relationship between each requirement, design element, and test case. The draft Requirements Traceability Matrix (RTM) is verified to ensure that each and every requirement is mapped to a design element(s) and test case(s), and that each and every design element is mapped to a requirement(s) and test case(s).
- 3.3 ***Control Point B Traceability Analysis***–The process performed during the Control Point B review to validate the relationship between each requirement; design element, if applicable; test case; and user manual section, if applicable. The final RTM is verified to ensure that each and every requirement is mapped to a design element(s), if applicable; test case(s); and user manual section, if applicable, and that each and every test case is mapped to a requirement(s) and design element(s), if applicable.
- 3.4 ***Document Adequacy Evaluation***–The process performed to verify that all necessary and sufficient information has been included in the documentation to fully define the nature, function, complexity, and detail of the software, as specified by the governing procedure.
- 3.5 ***Document Verification Check***–The process performed to verify that software documentation was produced in accordance with the governing procedure. Each document is checked to verify that all sections have been addressed.

- 3.6 ***Independent Verification and Validation (IV&V)***—The office, position, or organization assigned responsibility for the software verification and validation processes that fall under the scope of this procedure.
- 3.7 ***Installation Test Process Evaluation***—The process performed to verify that the installation documentation addressed all necessary installation components.
- 3.8 ***Integrity Level***—A denotation of a range of values of the property of an item necessary to maintain system risks within acceptable limits. For items that perform mitigating functions, the property is the reliability with which the item must perform the mitigating function. For items whose failure can lead to a threat, the property is the limit on the frequency of that failure.
- 3.9 ***Inventory***—The process performed to verify that the items identified on the Software Configuration Control Request (SCCR) are received at the appropriate check point in the verification and validation process.
- 3.10 ***Media Adequacy Evaluation***—The process performed to verify that all necessary information has been included on the media to fully describe the software and operating environment.
- 3.11 ***Media Verification Check***—The process performed to verify that the software media was produced in accordance with the governing procedure. The media is checked to verify that the identified configuration items have been addressed.
- 3.12 ***Software Design Evaluation***—The process performed to verify the design for correctness, consistency, completeness, accuracy, readability, and testability. The design is verified to determine if it satisfies the requirements within the stated assumptions and constraints; complies with any stated standards, references, regulations, policies, physical laws, and business rules; any accuracy issues have been addressed; and there are objective acceptance criteria for verifying each and every design element.
- 3.13 ***Software Requirements Evaluation***—The process performed to verify the requirements for correctness, consistency, completeness, accuracy, readability, and testability. The requirements are verified to determine if they have been fully described, including data usage and format; compliance with any stated standards, references, regulations, policies, physical laws, and business rules; conflicting, incompatible, inconsistent, or ambiguous requirements; accuracy can be satisfied in the system requirements; and objective acceptance criteria for validating each and every requirement.
- 3.14 ***Source Code Evaluation***—The process performed to verify that the requirements and design elements have been implemented into the source code. The source code is evaluated for consistency and traceability to applicable documentation.
- 3.15 ***Testing***—The activity of conducting tests in an operational environment. Testing includes, but is not limited to, integration, installation, regression, and system.

- 3.16 User Documentation Evaluation**—The process performed to verify the user documentation for correctness, consistency, and completeness against the stated requirements. The user documentation is evaluated for readability and effectiveness with respect to requirements for user interface and functionality that may be invoked by the user.
- 3.17 Validation Test Process Evaluation**—The process performed to verify the validation documentation for test completeness and requirement, design, and test coverage. Completeness is assessed by evaluating the extent that the software is to be exercised. Coverage is assessed by verifying that the set of inputs used during the test(s) is a representative sample from the set of all possible inputs to the software, every requirement (and design element, if applicable) has been tested, and boundary condition inputs and invalid inputs are included.
- 3.18 Validation**—The test and evaluation of completed software to ensure compliance with software requirements. (QARD)
- 3.19 Verification**—The process of determining whether or not the products(s) of a given phase of the software development lifecycle fulfills the requirements imposed by the previous phase. (QARD)

4.0 RESPONSIBILITIES

- 4.1** The Chief Information Officer is responsible for the preparation, change, and approval of this procedure.
- 4.2** The following organizations or positions are responsible for activities identified in Section 5.0 of this procedure:

IV&V

5.0 PROCESS

Quality related software developed and/or maintained by the Office of Civilian Radioactive Waste Management is required to meet the quality assurance (QA) standards as defined by the QARD. Verification and validation demonstrates the operational integrity of software programs.

The Institute of Electrical and Electronic Engineers, Inc., Std 1012-1998, *IEEE Standard for Software Verification and Validation*, was used as guidance to develop the verification and validation reviews incorporated into this procedure. IEEE standard software integrity level 3 (major) is equivalent to Level A in this procedure. IEEE standard software integrity level 2 (moderate) is equivalent to Level B in this procedure. Software integrity levels denote a range of software criticality values necessary to maintain risks within acceptable limits. These software properties may include safety, security, software complexity, performance, reliability, or other characteristics. Critical, high-integrity software typically requires a larger set and more rigorous application of verification and validation tasks. There are overlaps between the software integrity levels to allow for individual interpretations of acceptable risk depending on the application.

A functional process flow of this procedure is depicted in Attachment 1, AP-SI.3Q Flowchart. Acronyms and abbreviations used in this procedure are defined in Attachment 2, Acronyms and Abbreviations, and/or in the flowchart legend.

PROCESS OUTLINE

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5.1 GENERAL

The verification and validation process will be performed at the appropriate control points for the level of software submitted.

5.2 VERIFICATION AND VALIDATION FOR CONTROL POINT A

Control Point A review activities are only performed for Level A, developed software.

All necessary documentation will be provided so that IV&V can perform the required Control Point A review activities. If documentation is modified after passing this control point, based on the IV&V evaluation of the modified documentation, verification and validation activities described within Control Point A review shall be repeated in Control Point B, if required.

Control Point A package is:

- Requirements Document (RD)
- Design Document (DD)
- Validation Test Process (VTP)
- Copy of RTM
- RD Verification Report
- DD Verification Report.

5.2.1 Initiate Control Point A Review

5.2.1.1 IV&V:

- a) Receive Control Point A package from the Software Coordinator.
- b) Perform an inventory of the Control Point A package. If any items are unaccounted for, contact the Software Coordinator for resolution.

- c) Upon final resolution of the Control Point A inventory, initiate a Control Point A Report, including the results from the following activities:
 - 1) Document Verification Check of all received Control Point A documentation
 - 2) Document Adequacy Evaluation
 - 3) Software Requirements Evaluation
 - 4) Software Design Evaluation
 - 5) Validation Test Process Evaluation
 - 6) Control Point A Traceability Analysis.
- d) Submit any comments to the Software Coordinator for resolution. Comments and comment resolution shall be documented E-mail may be used for comments.
- e) If there are no comments, submit a "No Comments on Control Point A" comment to the Software Coordinator.

5.2.2 Complete Control Point A Review

5.2.2.1 IV&V:

- a) Receive all final Control Point A documentation from the Software Coordinator.
- b) Check resolution of comments and any modified documentation for completeness.
- c) Sign and date the RD, DD, and VTP as "Verified By:."
- d) Attach all comment resolution documentation used in this control point review process to the Control Point A Report.
- e) Finalize and sign the Control Point A Report.
- f) Notify the Software Coordinator that Control Point A is complete.
- g) Submit the Control Point A records package to Software Configuration Management (SCM).

5.3 VERIFICATION AND VALIDATION FOR CONTROL POINT B

All necessary documentation and software code(s) will be provided by the software coordinator so that IV&V can perform the required Control Point B activities. Proceed to Paragraph 5.3.1 for Level A developed software, Paragraph 5.3.2 for Level A acquired software, and Paragraph 5.3.3 for Level B software.

5.3.1 Control Point B for Level A, Developed Software

Activities defined within the Control Point A review shall be repeated in Control Point B, if required, based on the IV&V evaluation of any modified Control Point A documentation. The implementation phase and testing phase verification reviews are conducted in Control Point B for Level A, developed software.

Control Point B package for Level A, developed software is:

- Any changed or modified Control Point A documentation
- SCCR, page 3
- Installation Test Process (ITP)
- Finalized RTM
- Users Manual (UM)
- Validation Test Report (VTR)
- Software media.

5.3.1.1 Initiate Control Point B Review for Level A, Developed Software

IV&V:

- a) Receive Control Point B package from the Software Coordinator.
- b) Perform an inventory of the Control Point B package. If any items are unaccounted for, contact the Software Coordinator for resolution.
- c) Upon final resolution of the Control Point B inventory, initiate a Control Point B Report, including the results from the following activities:
 - 1) Any Control Point A review activities, if required
 - 2) Document Verification Check of all received Control Point B documentation
 - 3) Media Verification Check
 - 4) Document Adequacy Evaluation
 - 5) Media Adequacy Evaluation

- 6) Configuration Audit
- 7) Source Code Evaluation
- 8) Installation Test Process Evaluation
- 9) User Documentation Evaluation
- 10) Control Point B Traceability Analysis
- 11) Testing.

The following activities are performed using the executable provided and with the executable generated from the source code compilation.

a. Installation Checkout

1. Execute the ITP.
2. Verify that the software initializes, executes, and terminates, as specified.
3. Validate that the test results map to the test case(s).
4. Compare the generated results to the VTR.
5. Document the results and any discrepancies between the actual and expected test results using a test log.
6. Upon failure, skip the Validation and Uninstall tests and proceed to Step 5.3.1.1d).

b. Validation Test

1. Execute the VTP.
2. Verify that the software initializes, executes, and terminates as specified.
3. Validate that the test results map to the test case(s).
4. Compare the generated results to the VTR.
5. Document the results and any discrepancies between the actual and expected test results using a test log.

c. Uninstall Test

1. Uninstall the software per the provided instructions.
 2. Validate that the software can be successfully removed from the system without affecting the functionality of the remaining system components.
 3. Document the results and any discrepancies between the actual and expected test results using a test log.
- d) Submit any comments to the Software Coordinator for resolution. Comments and comment resolution shall be documented. E-mail may be used for comments.
- e) If there are no comments, submit a "No Comments on Control Point B" comment to the Software Coordinator.

5.3.1.2 Complete Control Point B Review for Level A, Developed Software

IV&V:

- a) Receive all final Control Point B documentation from the Software Coordinator.
- b) Check final resolution of comments and any modified documentation and/or media for completeness.
- c) Re-execute any tests that may have been affected by the comment resolution activity.
- d) Sign and date the ITP, VTR, and UM as "Verified By:."
- e) Attach all comment resolution documentation used in this control point review process to the Control Point B Report.
- f) Finalize and sign the Control Point B Report.
- e) Notify the Software Coordinator that Control Point B is complete.
- f) Submit the Control Point B records package and media to SCM.

5.3.2 Control Point B for Level A, Acquired Software

For Level A acquired software, the two software life cycle phases are Requirements and Testing. Verification and validation reviews for the Testing life cycle phase are conducted in Control Point B for Level A, acquired software.

Control Point B package for Level A, acquired software is:

- SCCR, page 3
- RD
- VTP, if it is required
- ITP
- RTM
- UM
- VTR
- RD Verification Report
- Software media.

5.3.2.1 Initiate Control Point B Review for Level A, Acquired Software

IV&V:

- a) Receive Control Point B package from the Software Coordinator.
- b) Perform an inventory of the Control Point B package. If any items are unaccounted for, contact the Software Coordinator for resolution.
- c) Upon final resolution of the Control Point B inventory, initiate a Control Point B Report, including the results from the following activities:
 - 1) Document Verification Check of all received Control Point B documentation
 - 2) Document Adequacy Evaluation
 - 3) Media Adequacy Evaluation
 - 4) Configuration Audit
 - 5) Software Requirements Evaluation
 - 6) Installation Test Process Evaluation
 - 7) Validation Test Process Evaluation
 - 8) User Documentation Evaluation
 - 9) Control Point B Traceability Analysis

10) Testing.

The following activities are performed using the executable provided.

a. Installation Checkout

1. Execute the ITP.
2. Verify that the software initializes, executes, and terminates, as specified.
3. Validate that the test results map to the test case(s).
4. Compare the generated results to the VTR.
5. Document the results and any discrepancies between the actual and expected test results using a test log.
6. Upon failure, skip the Validation and Uninstall tests and proceed to Step 5.3.2.1d).

b. Validation Test—if software was acquired through a quality procurement (i.e., no VTP required), proceed to Step 5.3.2.1c).

1. Execute the VTP.
2. Verify that the software initializes, executes, and terminates, as specified.
3. Validate that the test results map to the test case(s).
4. Compare the generated results to the VTR.
5. Document the results and any discrepancies between the actual and expected test results using a test log.

c. Uninstall Test

1. Uninstall the software per the provided instructions.
2. Validate that the software can be successfully removed from the system without affecting the functionality of the remaining system components.
3. Document the results and any discrepancies between the actual and expected test results using a test log.

- d) Submit any comments to the Software Coordinator for resolution. Comments and comment resolution shall be documented. E-mail may be used for comments.
- e) If there are no comments, submit a "No Comments on Control Point B" comment to the Software Coordinator.

5.3.2.2 Complete Control Point B Review for Level A, Acquired Software

IV&V:

- a) Receive all final Control Point B documentation from the Software Coordinator.
- b) Check final resolution of comments and any modified documentation and/or media for completeness.
- c) Re-execute any tests that may have been affected by the comment resolution activity.
- d) Sign and date the RD, ITP, VTR, and UM, as well as the VTP, if the VTP is required, as "Verified By:."
- e) Attach all comment resolution documentation used in this control point review process to the Control Point B Report.
- f) Finalize and sign the Control Point B Report.
- g) Notify the Software Coordinator that Control Point B is complete.
- h) Submit the Control Point B records package and media to SCM.

5.3.3 Control Point B for Level B Software

The requirements phase, design phase, implementation phase, and testing phase reviews are conducted in Control Point B for Level B software.

Control Point B package for Level B software is:

- SCCR, page 3
- Software Management Report (SMR)
- Software media
- SMR Verification Report.

5.3.3.1 Initiate Control Point B Review for Level B Software

IV&V:

- a) Receive Control Point B package from the Software Coordinator.
- b) Perform an inventory of the received Control Point B package. If any items are unaccounted for, contact the Software Coordinator for resolution.
- c) Upon final resolution of the Control Point B inventory, initiate a Control Point B Report, including the results from the following activities:
 - 1) Document Verification Check of all received Control Point B documentation
 - 2) Media Verification Check
 - 3) Document Adequacy Evaluation
 - 4) Media Adequacy Evaluation
 - 5) Configuration Audit
 - 6) Software Requirements Evaluation
 - 7) Source Code Evaluation, if the software is developed
 - 8) Installation Test Process Evaluation
 - 9) Validation Test Process Evaluation
 - 10) Control Point B Traceability Analysis
 - 11) Testing.

The following activities are performed using the executable provided and again with the executable generated from the source code compilation, if the software is developed

a. Installation Checkout

1. Execute the installation instructions.
2. Verify that the software initializes, executes, and terminates, as specified.
3. Validate that the test results map to the test case(s).

4. Document the results and any discrepancies between the actual and expected test results using a test log.
5. Upon failure, skip the Validation test and proceed to Step 5.3.3.1d).

b. Validation Test

1. Execute the validation test(s).
 2. Verify that the software initializes, executes, and terminates, as specified.
 3. Validate that the test results map to the test case(s).
 4. Document the results and any discrepancies between the actual and expected test results using a test log.
- d) Submit any comments to the Software Coordinator for resolution. Comments and comment resolution shall be documented. E-mail may be used for comments.
- e) If there are no comments, submit a "No Comments on Control Point B" comment to the Software Coordinator.

5.3.3.2 Complete Control Point B Review for Level B Software

IV&V:

- a) Receive all final Control Point B documentation from the Software Coordinator.
- b) Check final resolution of comments and any modified documentation and/or media for completeness.
- c) Re-execute any tests that may have been affected by the comment resolution activity.
- d) Sign and date the SMR as "Verified By:."
- e) Attach all comment resolution documentation used in this control point review process to the Control Point B Report.
- f) Finalize and sign the Control Point B Report.
- g) Notify the Software Coordinator that Control Point B is complete.
- h) Submit the Control Point B records package and media to SCM.

5.4 VERIFICATION AND VALIDATION FOR OPERATING SYSTEM CHANGE

Verification and validation review activities for operating system changes will only be performed for changes in operating system within the same platform and operating system series (e.g., SUN Solaris 5.6 to SUN Solaris 5.7).

5.4.1 IV&V:

- a) Receive the SUR, software package, and supporting documentation from the Software Coordinator.
- b) Obtain a verification copy of the software media from SCM.
- c) Perform an inventory of the Operating System Change package. If any items are unaccounted for, contact SCM for resolution.
- d) Initiate an Operating System Change Report upon final resolution of the Operating System Change package inventory.
- e) Perform an installation checkout including the results from the following activities and document the results in the Operating System Change Report:
 - 1) Execute the installation test(s) on the newly identified operating system.
 - 2) Verify that the software initializes, executes, and terminates, as specified.
 - 3) Validate the test results against the acceptance criteria.
 - 4) Document the results and any discrepancies between the actual and expected results using a test log.
 - 5) Upon failure, proceed to Step 5.4.1h).
- f) Perform a validation test, including the results from the following activities, and document the results in the Operating System Change Report:
 - 1) Evaluate the software to determine if validation testing is necessary to mitigate any risk of functionality impact.
 - 2) Determine and document if validation testing is necessary.
 - 3) If validation testing is not necessary, proceed to Step 5.4.1g).

- 4) If it is determined that validation testing is necessary:
 1. Execute the validation test(s).
 2. Verify that the software initializes, executes, and terminates, as specified.
 3. Validate the test results against the acceptance criteria.
 4. Document the results and any discrepancies between the actual and expected test results using a test log.
- g) Perform an uninstall test, including the results from the following activities, and document the results in the Operating System Change Report:
 - 1) Determine and document if uninstall instructions were provided.
 - 2) If uninstall instructions were not provided, proceed to Step 5.4.1h).
 - 3) If uninstall instructions were provided:
 1. Uninstall the software per the provided instructions.
 2. Validate that the software can be successfully removed from the system without affecting the functionality of the remaining system components.
 3. Document the results and any discrepancies between the actual and expected results using a test log.
- h) Finalize and sign the Operating System Change Report.
- i) Submit the Operating System Change records package, software package received from the Software Coordinator, and the verification copy of the software media to SCM.

6.0 RECORDS

The records listed in Subsection 6.1 shall be collected. The records are submitted to the RPC in accordance with AP-SI.1Q and AP-SI.2Q, *Qualification of Level A Software*, as appropriate.

6.1 QA RECORDS

Control Point A Records Package:

RD
RD Verification Report
DD

DD Verification Report
VTP
Control Point A Report

Control Point B Records Package for Level A, Developed Software:

SCCR
Any modified Control Point A Documentation
ITP
UM
RTM
VTR
Control Point B Report

Control Point B Records Package for Level A, Acquired Software:

SCCR
RD
RD Verification Report
VTP, if it is required
ITP
UM
RTM
VTR
Control Point B Report

Control Point B Records Package for Level B Software:

SCCR
SMR
SMR Verification Report
Control Point B Report

Operating System Change Package:

SUR
Supporting Documentation
Operating System Change Report

6.2 NON-QA INCLUSIONARY RECORDS

None

6.3 NON-QA EXCLUSIONARY RECORDS

None

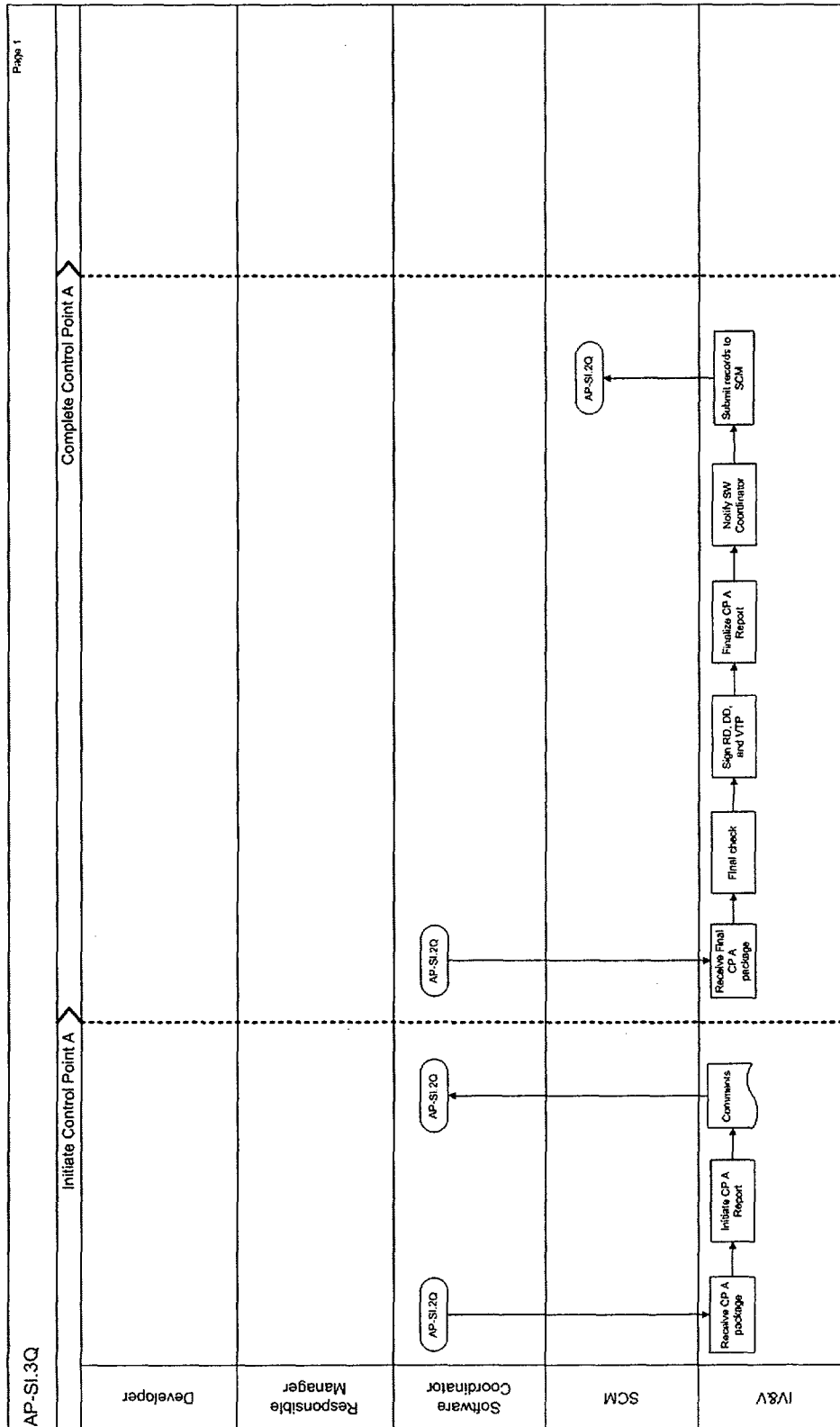
7.0 REFERENCES

- a) *Quality Assurance Requirements and Description*, DOE/RW-0333P
- b) AP-SI.1Q, *Software Management*
- c) AP-SI.2Q, *Qualification of Level A Software*
- d) Institute of Electrical and Electronic Engineers, Inc., Std 1012-1998, *IEEE Standard for Software Verification and Validation*

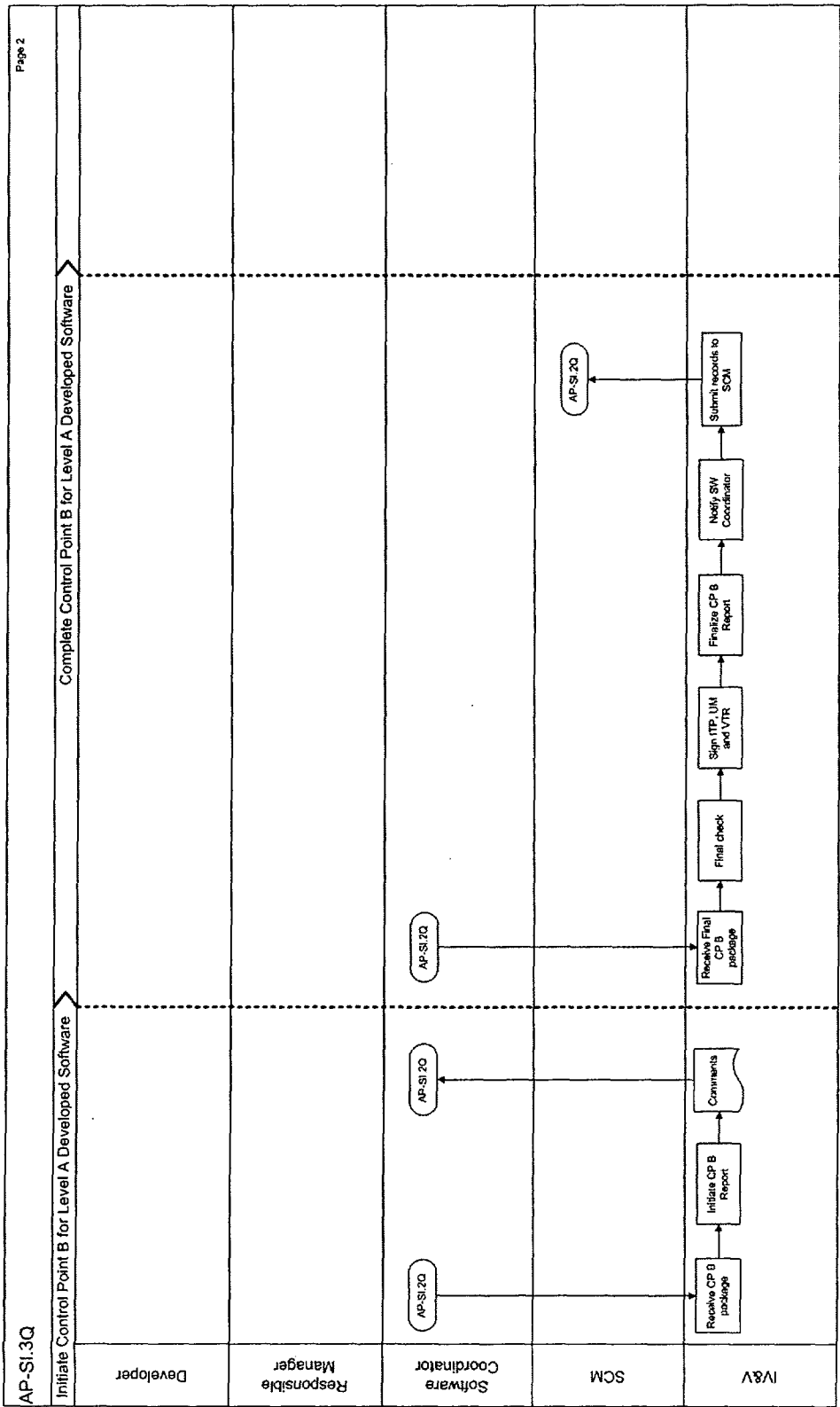
8.0 ATTACHMENTS

Attachment 1 - AP-SI.3Q Process Flowchart

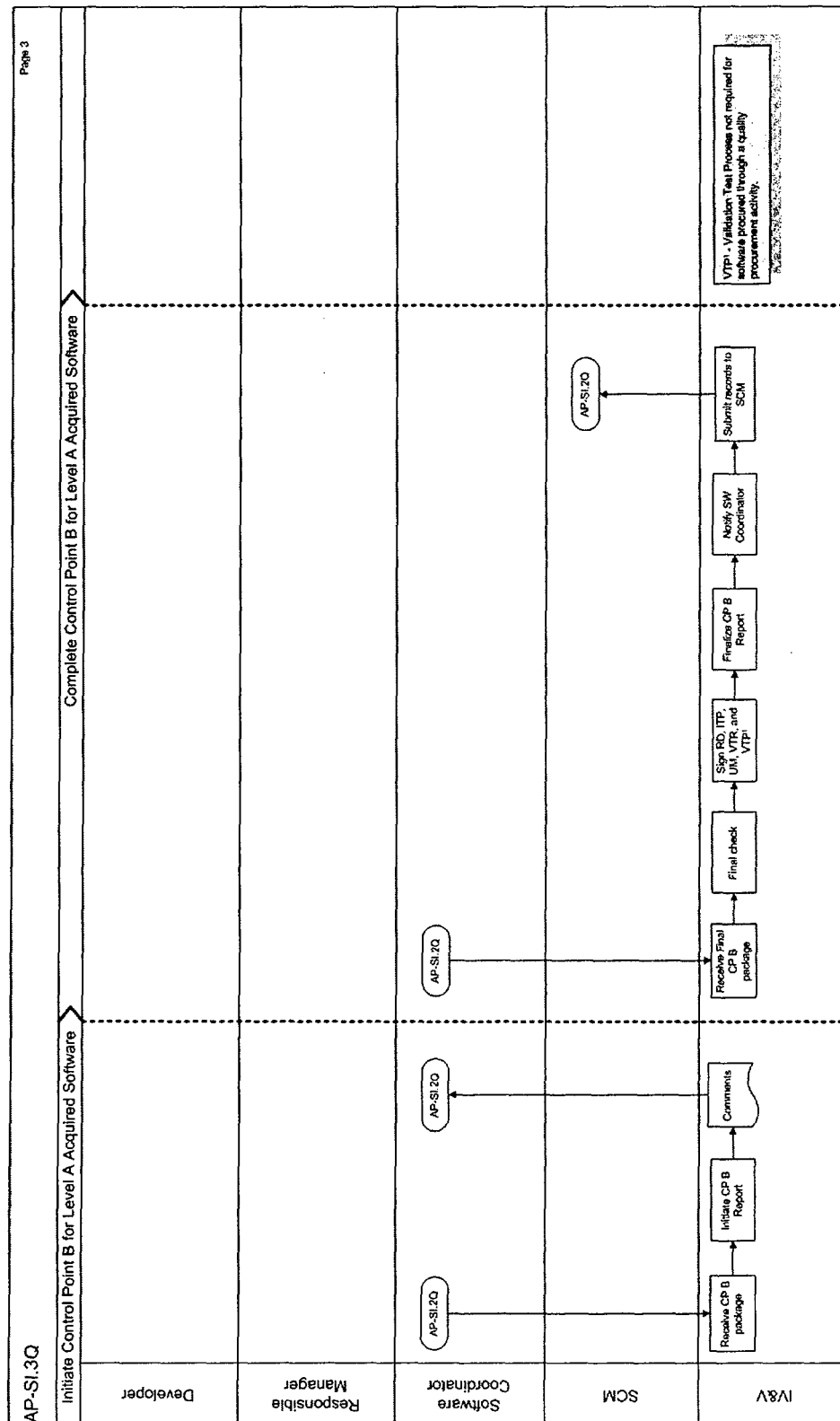
Attachment 2 - Acronyms and Abbreviations



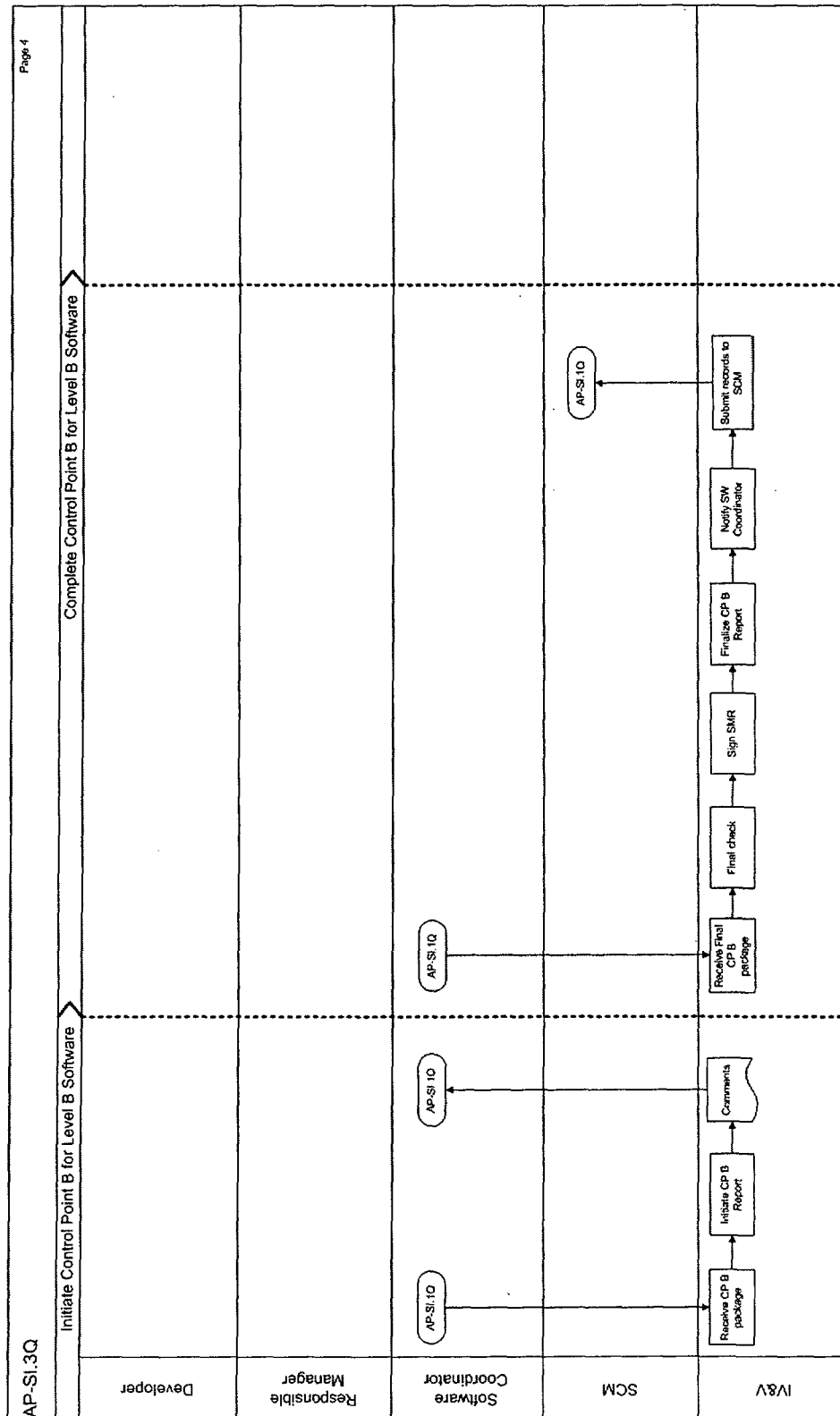
Attachment 1 - AP-SI.3Q Process Flowchart



Attachment 1 - AP-SI.3Q Process Flowchart (Continued)



Attachment 1 - AP-SI.3Q Process Flowchart (Continued)



Attachment 1 - AP-SI.3Q Process Flowchart (Continued)

DD	Design Document
ITP	Installation Test Process
IV&V	Independent Verification and Validation
QA	Quality Assurance
QARD	Quality Assurance Requirements and Description
RD	Requirements Document
RTM	Requirements Traceability Matrix
SCCR	Software Configuration Control Request
SCM	Software Configuration Management
SMR	Software Management Report
UM	Users Manual
VTP	Validation Test Process
VTR	Validation Test Report