

## VERIFICATION

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Maturity Level 3

### Purpose

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The purpose of Verification is to ensure that selected work products meet their specified requirements. [PA150]

### Introductory Notes

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The Verification process area involves the following: verification preparation, verification performance, and identification of corrective action. [PA150.N101]

Verification includes verification of the product and intermediate work products against all selected requirements, including customer, product, and product-component requirements. [PA150.N102]

Verification is inherently an incremental process because it occurs throughout the development of the product and work products, beginning with verification of the requirements, progressing through the verification of the evolving work products, and culminating in the verification of the completed product. [PA150.N103]

The specific practices of this process area build upon each other in the following way: the Select Work Products for Verification specific practice enables the identification of the work products to be verified, the methods to be used to perform the verification, and the requirements to be satisfied by each selected work product. The Establish the Verification Environment specific practice enables the determination of the environment that will be used to carry out the verification. The Establish Verification Procedures and Criteria specific practice then enables the development of verification procedures and criteria that are aligned with the selected work products, requirements, methods, and characteristics of the verification environment. The Perform Verification specific practice conducts the verification according to the available methods, procedures, and criteria. [PA150.N110]

Verification of work products substantially increases the likelihood that the product will meet the customer, product, and product-component requirements. [PA150.N104]

The Verification and Validation process areas are similar, but they address different issues. Validation demonstrates that the product, as provided (or as it will be provided), will fulfill its intended use, whereas verification addresses whether the work product properly reflects the specified requirements. In other words, verification ensures that “you built it right;” whereas, validation ensures that “you built the right thing.”

[PA150.N105]

Peer reviews are an important part of verification and are a proven mechanism for effective defect removal. An important corollary is to develop a better understanding of the work products and the processes that produced them so defects can be prevented and process-improvement opportunities can be identified. [PA150.N106]

Peer reviews involve a methodical examination of work products by the producers' peers to identify defects and other changes that are needed.

[PA150.N107]

Examples of peer review methods include the following: [PA150.N109]

- Inspections
- Structured walkthroughs

## Related Process Areas

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*Refer to the Validation process area for more information about confirming that a product or product component fulfills its intended use when placed in its intended environment. [PA150.R102]*

*Refer to the Requirements Development process area for more information about the generation and development of customer, product, and product-component requirements. [PA150.R103]*

*Refer to the Requirements Management process area for more information about managing requirements. [PA150.R104]*

## Specific and Generic Goals

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### SG 1 Prepare for Verification [PA150.IG101]

***Preparation for verification is conducted.***

### SG 2 Perform Peer Reviews [PA150.IG102]

***Peer reviews are performed on selected work products.***

**SG 3 Verify Selected Work Products** [PA150.IG103]

***Selected work products are verified against their specified requirements.***

**GG 3 Institutionalize a Defined Process** [CL104.GL101]

***The process is institutionalized as a defined process.***

**Practice-to-Goal Relationship Table**

**SG 1 Prepare for Verification** [PA150.IG101]

- SP 1.1 Select Work Products for Verification
- SP 1.2 Establish the Verification Environment
- SP 1.3 Establish Verification Procedures and Criteria

**SG 2 Perform Peer Reviews** [PA150.IG102]

- SP 2.1 Prepare for Peer Reviews
- SP 2.2 Conduct Peer Reviews
- SP 2.3 Analyze Peer Review Data

**SG 3 Verify Selected Work Products** [PA150.IG103]

- SP 3.1 Perform Verification
- SP 3.2 Analyze Verification Results and Identify Corrective Action

**GG 3 Institutionalize a Defined Process** [CL104.GL101]

- GP 2.1 (CO 1) Establish an Organizational Policy
- GP 3.1 (AB 1) Establish a Defined Process
- GP 2.2 (AB 2) Plan the Process
- GP 2.3 (AB 3) Provide Resources
- GP 2.4 (AB 4) Assign Responsibility
- GP 2.5 (AB 5) Train People
- GP 2.6 (DI 1) Manage Configurations
- GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders
- GP 2.8 (DI 3) Monitor and Control the Process
- GP 3.2 (DI 4) Collect Improvement Information
- GP 2.9 (VE 1) Objectively Evaluate Adherence
- GP 2.10 (VE 2) Review Status with Higher Level Management

**Specific Practices by Goal**

**SG 1 Prepare for Verification**

***Preparation for verification is conducted.*** [PA150.IG101]

Up-front preparation is necessary to ensure that verification provisions are embedded in product and product-component requirements, designs, developmental plans, and schedules. Verification includes selection, inspection, testing, analyses, and demonstration of work products. [PA150.IG101.N101]

Methods of verification include, but are not limited to, inspections, peer reviews, audits, walkthroughs, analyses, simulations, testing, and demonstrations. [PA150.IG101.N102]

Preparation also entails the definition of support tools, test equipment and software, simulations, prototypes, and facilities. [PA150.IG101.N103]

## SP 1.1 Select Work Products for Verification

**Select the work products to be verified and the verification methods that will be used for each.** [PA150.IG101.SP101]

Work products are selected based on their contribution to meeting project objectives and requirements, and to addressing project risks.

[PA150.IG101.SP101.N104]

The work products to be verified may include those associated with maintenance, training, and support services. The work product requirements for verification are included with the verification methods. The verification methods address the technical approach to work product verification and the specific approaches that will be used to verify that specific work products meet their requirements.

[PA150.IG101.SP101.N102]

### *For Software Engineering*

*Examples of verification methods include the following:*

[PA150.IG101.SP101.N102.AMP101]

- *Path coverage testing*
- *Load, stress, and performance testing*
- *Decision-table-based testing*
- *Functional-decomposition-based testing*
- *Test-case reuse*
- *Acceptance tests*

Selection of the verification methods typically begins with involvement in the definition of product and product-component requirements to ensure that these requirements are verifiable. Re-verification should be addressed by the verification methods to ensure that rework performed on work products did not cause unintended defects. [PA150.IG101.SP101.N103]

### *For Integrated Product and Process Development*

*The verification methods should be developed concurrently and iteratively with the product and product-component designs.* [PA150.IG101.SP101.N103.AMP101]

### Typical Work Products

1. Lists of work products selected for verification [PA150.IG101.SP101.W101]
2. Verification methods for each selected work product  
[PA150.IG101.SP101.W102]

### Subpractices

1. Identify work products for verification. [PA150.IG101.SP101.SubP102]
2. Identify the requirements to be satisfied by each selected work product. [PA150.IG101.SP101.SubP103]

*Refer to the Maintain Bidirectional Traceability of Requirements specific practice in the Requirements Management process area to help identify the requirements for each work product.*

[PA150.IG101.SP101.SubP103.R101]

3. Identify the verification methods that are available for use.  
[PA150.IG101.SP101.SubP104]
4. Define the verification methods to be used for each selected work product. [PA150.IG101.SP101.SubP105]
5. Submit for integration with the project plan the identification of work products to be verified, the requirements to be satisfied, and the methods to be used. [PA150.IG101.SP101.SubP106]

*Refer to the Project Planning process area for information on coordinating with project planning.* [PA150.IG101.SP101.SubP106.R101]

## SP 1.2 Establish the Verification Environment

***Establish and maintain the environment needed to support verification.*** [PA150.IG101.SP102]

An environment must be established to enable verification to take place. The verification environment may be acquired, developed, reused, modified, or a combination of these, depending on the needs of the project. [PA150.IG101.SP102.N101]

The type of environment required will depend on the work products selected for verification and the verification methods used. A peer review may require little more than a package of materials, reviewers, and a room. A product test may require simulators, emulators, scenario generators, data reduction tools, environmental controls, and interfaces with other systems. [PA150.IG101.SP102.N102]

### Typical Work Products

1. Verification environment [PA150.IG101.SP102.W102]

#### Subpractices

1. Identify verification environment requirements. [PA150.IG101.SP102.SubP101]
2. Identify verification resources that are available for reuse and modification. [PA150.IG101.SP102.SubP102]
3. Identify verification equipment and tools. [PA150.IG101.SP102.SubP103]
4. Acquire verification support equipment and an environment, such as test equipment and software. [PA150.IG101.SP102.SubP104]

### SP 1.3 Establish Verification Procedures and Criteria

***Establish and maintain verification procedures and criteria for the selected work products.*** [PA150.IG101.SP103]

#### *For Integrated Product and Process Development*

*The verification procedures and criteria should be developed concurrently and iteratively with the product and product-component designs.* [PA150.IG101.SP103.AMP101]

Verification criteria are defined to ensure that the work products meet their requirements. [PA150.IG101.SP103.N101]

Examples of sources for verification criteria include the following: [PA150.IG101.SP103.N102]

- Product and product-component requirements
- Standards
- Organizational policies
- Test type
- Test parameters
- Parameters for tradeoff between quality and cost of testing
- Type of work products

#### Typical Work Products

1. Verification procedures [PA150.IG101.SP103.W101]
2. Verification criteria [PA150.IG101.SP103.W102]

#### Subpractices

1. Generate the set of comprehensive, integrated verification procedures for work products and any commercial off-the-shelf products, as necessary. [PA150.IG101.SP103.SubP101]
2. Develop and refine the verification criteria when necessary.  
[PA150.IG101.SP103.SubP102]

3. Identify the expected results, any tolerances allowed in observation, and other criteria for satisfying the requirements. [PA150.IG101.SP103.SubP104]
4. Identify any equipment and environmental components needed to support verification. [PA150.IG101.SP103.SubP105]

## SG 2 Perform Peer Reviews

***Peer reviews are performed on selected work products.*** [PA150.IG102]

Peer reviews involve a methodical examination of work products by the producers' peers to identify defects for removal and to recommend other changes that are needed. [PA150.IG102.N101]

The peer review is an important and effective engineering method implemented via inspections, structured walkthroughs, or a number of other collegial review methods. [PA150.IG102.N102]

Peer reviews are primarily applied to work products developed by the projects, but they can also be applied to other work products such as documentation and training work products that are typically developed by support groups. [PA150.IG102.N103]

### SP 2.1 Prepare for Peer Reviews

***Prepare for peer reviews of selected work products.*** [PA150.IG102.SP101]

Preparation activities for peer reviews typically include identifying the staff who will be invited to participate in the peer review of each work product, identifying the key reviewers who must participate in the peer review, preparing and updating any materials that will be used during the peer reviews (such as checklists and review criteria), and scheduling peer reviews. [PA150.IG102.SP101.N101]

#### Typical Work Products

1. Peer review schedule [PA150.IG102.SP101.W101]
2. Peer review checklist [PA150.IG102.SP101.W102]
3. Entry and exit criteria for work products [PA150.IG102.SP101.W103]
4. Criteria for requiring another peer review [PA150.IG102.SP101.W104]
5. Peer review training material [PA150.IG102.SP101.W105]
6. Selected work products to be reviewed [PA150.IG102.SP101.W106]

### Subpractices

1. Determine what type of peer review will be conducted.

[PA150.IG102.SP101.SubP101]

Examples of types of peer reviews include the following: [PA150.IG102.SP101.SubP101.N101]

- Inspections
- Structured walkthroughs
- Active reviews

2. Define requirements for collecting data during the peer review.

[PA150.IG102.SP101.SubP102]

*Refer to the Measurement and Analysis process area for information on identifying and collecting data.*

[PA150.IG102.SP101.SubP102.R101]

3. Establish and maintain entry and exit criteria for the peer review.

[PA150.IG102.SP101.SubP103]

4. Establish and maintain criteria for requiring another peer review.

[PA150.IG102.SP101.SubP104]

5. Establish and maintain checklists to ensure that the work products are reviewed consistently. [PA150.IG102.SP101.SubP105]

Examples of items addressed by the checklists include the following:

[PA150.IG102.SP101.SubP105.N102]

- Rules of construction
- Design guidelines
- Completeness
- Correctness
- Maintainability
- Common defect types

The checklists are modified as necessary to address the specific type of work product and peer review. The peers of the checklist developers and potential users review the checklists. [PA150.IG102.SP101.SubP105.N101]

6. Develop a detailed peer review schedule, including the dates for peer review training and for when materials for peer reviews will be available. [PA150.IG102.SP101.SubP106]

7. Ensure that the work product satisfies the peer review entry criteria prior to distribution. [PA150.IG102.SP101.SubP107]

8. Distribute the work product to be reviewed and its related information to the participants early enough to enable participants to adequately prepare for the peer review. [PA150.IG102.SP101.SubP108]
9. Assign roles for the peer review as appropriate. [PA150.IG102.SP101.SubP109]

Examples of roles include the following: [PA150.IG102.SP101.SubP109.N101]

- Leader
- Reader
- Recorder
- Author

10. Prepare for the peer review by reviewing the work product prior to conducting the peer review. [PA150.IG102.SP101.SubP110]

## SP 2.2 Conduct Peer Reviews

***Conduct peer reviews on selected work products and identify issues resulting from the peer review.*** [PA150.IG102.SP102]

One of the purposes of conducting a peer review is to find and remove defects early. Peer reviews are performed incrementally, as work products are being developed. These reviews are structured and are not management reviews. [PA150.IG102.SP102.N101]

Peer reviews may be performed on key work products of specification, design, test, and implementation activities and specific planning work products. [PA150.IG102.SP102.N102]

The focus of the peer review should be on the work product in review, not on the person who produced it. [PA150.IG102.SP102.N103]

When issues arise during the peer review, they should be communicated to the primary developer of the work product for correction. [PA150.IG102.SP102.N104]

*Refer to the Project Monitoring and Control process area for information about tracking issues that arise during a peer review.*

[PA150.IG102.SP102.N104.R101]

Peer reviews should address the following guidelines: there must be sufficient preparation, the conduct must be managed and controlled, consistent and sufficient data must be recorded (an example is conducting a formal inspection), and action items must be recorded.

[PA150.IG102.SP102.N105]

#### Typical Work Products

1. Peer review results [PA150.IG102.SP102.W101]
2. Peer review issues [PA150.IG102.SP102.W102]
3. Peer review data [PA150.IG102.SP102.W103]

#### Subpractices

1. Perform the assigned roles in the peer review. [PA150.IG102.SP102.SubP101]
2. Identify and document defects and other issues in the work product. [PA150.IG102.SP102.SubP102]
3. Record the results of the peer review, including the action items. [PA150.IG102.SP102.SubP103]
4. Collect peer review data. [PA150.IG102.SP102.SubP104]

*Refer to the Measurement and Analysis process area for more information on data collection.* [PA150.IG102.SP102.SubP104.R101]

5. Identify action items and communicate the issues to relevant stakeholders. [PA150.IG102.SP102.SubP105]
6. Conduct an additional peer review if the defined criteria indicate the need. [PA150.IG102.SP102.SubP106]
7. Ensure that the exit criteria for the peer review are satisfied. [PA150.IG102.SP102.SubP107]

### SP 2.3 Analyze Peer Review Data

**Analyze data about preparation, conduct, and results of the peer reviews.** [PA150.IG102.SP103]

*Refer to the Measurement and Analysis process area for more information about obtaining and analyzing data.* [PA150.IG102.SP103.R101]

#### Typical Work Products

1. Peer review data [PA150.IG102.SP103.W101]
2. Peer review action items [PA150.IG102.SP103.W102]

#### Subpractices

1. Record data related to the preparation, conduct, and results of the peer reviews. [PA150.IG102.SP103.SubP101]

Typical data are product name, product size, composition of the peer review team, type of peer review, preparation time per reviewer, length of the review meeting, number of defects found, type and origin of defect, etc. Additional information on the work product being peer reviewed may be collected, such as size, development stage, operating modes examined, and requirements being evaluated. [PA150.IG102.SP103.SubP101.N101]

2. Store the data for future reference and analysis. [PA150.IG102.SP103.SubP102]
3. Protect the data to ensure that peer review data are not used inappropriately. [PA150.IG102.SP103.SubP103]

Examples of inappropriate use of peer review data include using data to evaluate the performance of people and using data for attribution. [PA150.IG102.SP103.SubP103.N101]

4. Analyze the peer review data. [PA150.IG102.SP103.SubP104]

### SG 3 Verify Selected Work Products

***Selected work products are verified against their specified requirements.***  
[PA150.IG103]

#### SP 3.1 Perform Verification

***Perform verification on the selected work products.*** [PA150.IG103.SP101]

Verifying products and work products incrementally promotes early detection of problems and can result in the early removal of defects. These results of verification save considerable cost of fault isolation and rework associated with troubleshooting problems. [PA150.IG103.SP101.N101]

(For users of the continuous representation, this is a capability level 1 specific practice. Verification processes at capability level 1 or 2 may not include procedures and criteria, which are created in the Establish Verification Procedures and Criteria specific practice at capability level 3. When there are no procedures or criteria established, use the methods established by the Select Work Products for Verification specific practice to accomplish capability level 1 performance.)

[PA150.IG103.SP101.N102]

##### Typical Work Products

1. Verification results [PA150.IG103.SP101.W101]
2. Verification reports [PA150.IG103.SP101.W102]
3. Demonstrations [PA150.IG103.SP101.W103]
4. As-run procedures log [PA150.IG103.SP101.W104]

### Subpractices

1. Perform verification of selected work products against their requirements. [PA150.IG103.SP101.SubP102]
2. Record the results of verification activities. [PA150.IG103.SP101.SubP103]
3. Identify action items resulting from verification of work products. [PA150.IG103.SP101.SubP104]
4. Document the “as-run” verification method and the deviations from the available methods and procedures discovered during its performance. [PA150.IG103.SP101.SubP105]

## SP 3.2 Analyze Verification Results and Identify Corrective Action

**Analyze the results of all verification activities and identify corrective action.** [PA150.IG103.SP102]

Actual results must be compared to established verification criteria to determine acceptability. [PA150.IG103.SP102.N101]

The results of the analysis are recorded as evidence that verification was conducted. [PA150.IG103.SP102.N102]

For each work product, all available verification results are incrementally analyzed and corrective actions are initiated to ensure that the requirements have been met. Since a peer review is one of several verification methods, peer review data should be included in this analysis activity to ensure that the verification results are analyzed sufficiently. Analysis reports or “as-run” method documentation may also indicate that bad verification results are due to method problems, criteria problems, or a verification environment problem.

[PA150.IG103.SP102.N103]

*Refer to the corrective action practices of Project Monitoring and Control process area for more information on implementing corrective action.* [PA150.IG103.SP102.N103.R101]

### Typical Work Products

1. Analysis report (such as statistics on performances, causal analysis of nonconformances, comparison of the behavior between the real product and models, and trends) [PA150.IG103.SP102.W101]
2. Trouble reports [PA150.IG103.SP102.W102]
3. Change requests for the verification methods, criteria, and environment [PA150.IG103.SP102.W103]
4. Corrective actions to verification methods, criteria, and/or environment [PA150.IG103.SP102.W104]

### Subpractices

1. Compare actual results to expected results. [PA150.IG103.SP102.SubP101]
2. Based on the established verification criteria, identify products that have not met their requirements or identify problems with the methods, procedures, criteria, and verification environment.  
[PA150.IG103.SP102.SubP102]
3. Analyze the verification data on defects. [PA150.IG103.SP102.SubP103]
4. Record all results of the analysis in a report. [PA150.IG103.SP102.SubP104]
5. Use verification results to compare actual measurements and performance to technical performance parameters.  
[PA150.IG103.SP102.SubP105]
6. Provide information on how defects may be resolved (including verification methods, criteria, and verification environment) and formalize it in a plan. [PA150.IG103.SP102.SubP106]

## GG 3 Institutionalize a Defined Process [CL104.GL101]

***The process is institutionalized as a defined process.***

### Commitment to Perform

#### GP 2.1 (CO 1) Establish an Organizational Policy

***Establish and maintain an organizational policy for planning and performing the verification process.*** [GP103]

Elaboration:

This policy establishes organizational expectations for establishing and maintaining verification methods, procedures, criteria, verification environment, performing peer reviews, and verifying selected work products. [PA150.EL101]

### Ability to Perform

#### GP 3.1 (AB 1) Establish a Defined Process

***Establish and maintain the description of a defined verification process.*** [GP114]

**GP 2.2 (AB 2) Plan the Process**

***Establish and maintain the plan for performing the verification process.*** [GP104]

Elaboration:

Typically, this plan for performing the verification process is included in (or referenced by) the project plan, which is described in the Project Planning process area. [PA150.EL102]

**GP 2.3 (AB 3) Provide Resources**

***Provide adequate resources for performing the verification process, developing the work products, and providing the services of the process.*** [GP105]

Elaboration:

Special facilities may be required for verifying selected work products. When necessary, the facilities required for the activities in the Verification process area are developed or purchased. [PA150.EL110]

Certain verification methods may require special tools, equipment, facilities, and training (e.g., peer reviews may require meeting rooms and trained moderators; certain verification tests may require special test equipment and people skilled in the use of the equipment).

[PA150.EL104]

Examples of other resources provided include the following tools: [PA150.EL103]

- Test management tools
- Test-case generators
- Test-coverage analyzers
- Simulators

**GP 2.4 (AB 4) Assign Responsibility**

***Assign responsibility and authority for performing the process, developing the work products, and providing the services of the verification process.*** [GP106]

**GP 2.5 (AB 5) Train People**

***Train the people performing or supporting the verification process as needed.*** [GP107]

Elaboration:

Examples of training topics include the following: [PA150.EL105]

- Application domain
- Verification principles, standards, and methods (e.g., analysis, demonstration, inspection, test)
- Verification tools and facilities
- Peer review preparation and procedures
- Meeting facilitation

## **Directing Implementation**

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### **GP 2.6 (DI 1) Manage Configurations**

***Place designated work products of the verification process under appropriate levels of configuration management.*** [GP109]

Elaboration:

Examples of work products placed under configuration management include the following: [PA150.EL106]

- Verification procedures and criteria
- Peer review training material
- Peer review data
- Verification reports

### **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

***Identify and involve the relevant stakeholders of the verification process as planned.*** [GP124]

Elaboration:

Select relevant stakeholders from customers, end users, developers, producers, testers, suppliers, marketers, maintainers, disposal personnel, and others who may be affected by, or may affect, the product as well as the process. [PA150.EL113]

Examples of activities for stakeholder involvement include the following: [PA150.EL114]

- Selecting work products and methods for verification
- Establishing verification procedures and criteria
- Conducting peer reviews
- Assessing verification results and identifying corrective action

## GP 2.8 (DI 3) Monitor and Control the Process

***Monitor and control the verification process against the plan for performing the process and take appropriate corrective action.***

[GP110]

Elaboration:

Examples of measures used in monitoring and controlling include the following:

[PA150.EL107]

- Verification profile (e.g., the number of verifications planned and performed, and the defects found; perhaps categorized by verification method or type)
- Number of defects detected by defect category
- Verification problem report trends (e.g., number written and number closed)
- Verification problem report status (i.e., how long each problem report has been open)

## GP 3.2 (DI 4) Collect Improvement Information

***Collect work products, measures, measurement results, and improvement information derived from planning and performing the verification process to support the future use and improvement of the organization's processes and process assets.***

[GP117]

## Verifying Implementation

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### GP 2.9 (VE 1) Objectively Evaluate Adherence

***Objectively evaluate adherence of the verification process against its process description, standards, and procedures, and address noncompliance.*** [GP113]

Elaboration:

Examples of activities reviewed include the following: [PA150.EL109]

- Selecting work products for verification
- Establishing and maintaining verification procedures and criteria
- Performing peer reviews
- Verifying selected work products

Examples of work products reviewed include the following: [PA150.EL112]

- Verification procedures and criteria
- Peer review checklists
- Verification reports

**GP 2.10 (VE 2) Review Status with Higher Level Management**

***Review the activities, status, and results of the verification process with higher level management and resolve issues.*** [GP112]