**Validation**

Purpose: the purpose of Validation is to demonstrate that a product or product component fulfils its intended use when placed in its intended environment.

SG1: **prepare** for validation

**Selection** **products** and **product components** for **establish** and **maintain** the **validation environment**, **procedures**, and **criteria**. Items selected for validation can include only the product or it can include appropriate levels of product components used to build the product. The **environment** required validating the product or product component is prepared. The environment can be purchased or can be **specified**, **designed**, and **built**. Environments used for product integration and verification can be considered in collaboration with the validation environment to **reduce cost** and **improve efficiency or productivity**.

SP 1.1 **selects** products for validation

**Select** **products** and **product components** to be **validated** and **validation** **methods (with equipment, facilities, environment)** to be used. Products and product components are selected for validation based on their **relationship** to end user needs. For each product component, the **scope** of the **validation** should be **determined**. (Product and product component requirements and designs, product and product components, user interfaces, user manuals, training materials, process documentation, access protocols, and data interchange reporting formats)

Result: the validation approach and needs can **result** in the **generation** of **lower level product component** requirements that are handled by the requirements development process.

Validation methods: 1) discussions with end users, perhaps in the context of a formal review 2) prototype demonstrations 3) functional demonstrations 4) pilots of training materials 5) tests of products and product components by end users and other relevant stakeholders 6) incremental delivery of working and potentially acceptable product 7) analyses of product components.

Practices: identify the key **principles**, **features**, and phases for product or product component validation throughout the life of the project. **Determine** which categories of **end user needs** are to be validated. Select the product and product components to be validated. Select the product and product components to be validated. Select the evaluation methods for product or product component validation. **Review** the validation **selection**, **constraints**, and methods with **relevant stakeholders**.

SP 1.2 establish the validation environment

**Establish** and **maintain** the **environment** needed to support validation. The **requirements** for the validation environment are driven by the **product** or product components selected, by the type of the work products, and by the **methods** of validation. These selections can **yield** **requirements** for the purchase or **development** of **equipment**, **software**, or other **resources**. These requirements are provided to the requirements **development** **processes** for development. The validation environment can include the reuse of existing **resources**. In this case, arrangements for the use of these resources should be made. (test tools interfaced with the product being validate, temporary embedded test software, recording tools for dump or further analysis and replay, simulated subsystems or components, simulated interfaced systems, real interfaced systems, facilities and customer supplied products, skilled people to operate or use all preceding elements, dedicated computing or network test environment)

Early selection of products or product components to be validated, work products to be used in validation, and validation methods is needed to ensure that the validation environment will be available when necessary. The validation **environment** should be carefully **controlled** to provide for **replication**, **results** **analysis**, and **revalidation** of **problem** **areas**.

Practices: **identify** **requirements** for the validation **environment**, **identify** customer supplied **products**, **identify** test **equipment** and **tools**, and identify validation **resources** that are available for reuse and **modification**, **plan** the availability of **resources** in detail.

SP 1.3 establish validation procedures and criteria

**Establish** and **maintain** **procedures** and **criteria** for **validation**. Validation procedures and criteria are defined to **ensure** the product or product component will fulfil its **intended** **use** when placed in its intended environment. **Test cases and procedures** for acceptance testing can be used for validation procedures. The validation procedures and criteria include **test** and **evaluation** of **maintenance** **training**, and **support services**. (Product and product component requirements, standards, customer acceptance criteria, environmental performance, thresholds of performance deviation)

Practices: **review** the product **requirements** to ensure that issues affecting validation of the product or product component are **identified** and **resolved**. Document the environment, operational scenario, procedures, inputs, outputs, and criteria for the validation of the selected product or product component. Assess the design as it matures in the context of the validation environment to identify validation issues.

SG 2 validate product or product components

The **product** or product components are validated to ensure they are **suitable** for use in their **intended operating environment**. The validation methods, procedures, and criteria are used to validate the selected products and product components and any associated maintenance, training, and support services using the appropriate validation environment. **Validation** **activities** are **performed** throughout the **product** **lifecycle**.

SP 2.1 perform validation

**Perform** **validation** on selected products and product components. To be **acceptable** to **stakeholders**, a product or product component should perform as expected in its intended operational environment. Validation activities are performed and the **resulting** **data** are **collected** according to **established** **methods**, **procedures**, and **criteria**. The as-run validation procedures should be **documented** and the **deviations** **occurring** during the **execution** should be noted as appropriate. (Validation report, validation results, validation cross reference matrix, as-run procedures log, operational demonstrations)

SP 2.2 analyse validation results

The **data** resulting from **validation** **tests**, **inspections**, **demonstrations**, or **evaluations** are analysed against **defined** **validation** **criteria**. Analyses reports indicate whether **needs** were **met**. In the case of deficiencies, these reports document the **degree** of **success** or **failure** and categorize **probable** **causes** of **failure**. The collected test, inspection, or review results are compared with established evaluation criteria to determine whether to **proceed** or to **address** **requirements** or **design** issues in the requirements development or technical **solution** **processes**. Analysis reports or as-run validation documentation can also indicate that **bad** **test** **results** are due to a **validation** **procedure** **problem** or a **validation** **environment** problem. (Validation deficiency reports, validation issues, procedure change request)

Practices: **compare** actual **results** to **expect** **results**, **based** on the established **validation** **criteria**, **identify** products and product components that do **not** perform **suitably** in their intended operating environments, or identify **problems** with methods, criteria, or the environment. **Analyse** validation data for **defects**, **record** **results** of the analysis and identify **issues**. **Use** validation **results** to **compare** actual **measurements** and **performance** to the intended use or operational need. Provide **information** on how **defects** can be **resolved** and **initiate** **corrective** **action**.

**Verification**

The purpose of verification is to ensure that selected work products meet their specified requirement. Peer reviews are an important part of verification and are **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 that **defects** can be **prevented** and process **improvement** opportunities can be **identified**. Peer reviews involve a **methodical** **examination** of work products by the producers; peers to identify defects and other changes that are needed (inspections, structured walkthroughs, deliberate refactoring, pair programming).

SG1 prepare for verification

**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 the **selection**, **inspection**, **testing**, **analysis**, and **demonstration** of work products. Methods of verification includes, but are not limited to, inspections, peer reviews, audits, walkthroughs, analyses, architecture evaluations, simulations, testing, and demonstration. Practices related to peer reviews as a specific verification method are included in specific goal 2. Preparation also entails the definition of support tools, test equipment and software, simulations, prototypes, and facilities.

SP 1.1 select work products for verification

Work **products** are selected based on their **contribution** to **meeting** project **objectives** and **requirements**, and to addressing project **risks**. The work products to be verified can include the ones associated with maintenance, training, and support services. The work product requirements for verification are included with the **verification** **methods**. The verification methods address the **approach** to work product verification and the specific approaches that will be used to verify that specific work products **meet** their **requirements**. (software architecture evaluation and implementation conformance evaluation, path coverage testing, load, stress and performance testing, decision table based testing, functional decomposition based testing, test case reuse, acceptance testing, continuous integration)

Selection of verification methods typically begins with the **definition** of product component **requirements** to ensure that the requirements are **verifiable**. **Re**-**verification** should be addressed by verification methods to ensure that rework performed on work products does **not** **cause** **unintended** **defects**. **Suppliers** should be involved in this selection to ensure that the project’s methods are **appropriate** for the supplier’s **environment**.

Practices: identify work **products** for **verification**. Identify **requirements** to be **satisfied** by each selected work product. Identify verification **methods** available for **use**. **Define** verification **methods** to be used for each selected work product. 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.

SP 1.2 establish the verification environment

An **environment** should be established to **enable** **verification** to take place. The verification environment can be **acquired**, **developed**, **reused**, **modified**, or obtained using a combination of these activities, **depending** on the **needs** of the project. The type of environment required **depends** on the work **products** selected for verification and the verification **methods** used. A **peer** **review** can **require** little more than a **package** of **materials**, reviewers, and a room. A **product** **test** can **require** **simulators**, **emulators**, **scenario** **generators**, **data** **reduction** tools, **environmental** **controls**, and **interfaces** with other system.

Practices: **identify** verification **environment** **requirements**; **identify** verification **resources** that are available for **reuse** or **modification**. **Identify** verification **equipment** and **tools**. **Acquire** verification support **equipment** and an **environment**.

SP 1.3 establish verification procedures and criteria

**Verification** **criteria** are **defined** to ensure that work **products** **meet** their **requirements**.

Practices: **generate** a set of **comprehensive**, **integrated** **verification** **procedures** for work products and commercial off-the-shelf products, as necessary. **Develop** and **refine** verification **criteria** as necessary. **Identify** the expected **results**, **tolerances** **allowed**, and other **criteria** for **satisfying** the **requirements**. **Identify** **equipment** and environmental **components** **needed** to support **verification**.

SG 2 perform peer reviews

**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. The peer review is an important and effective verification method implemented via **inspections**, **structured** **walkthroughs**, or a **number of other collegial review methods**. 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.

SG 2.1 prepare for peer review

**Preparation** activities for **peer** **reviews** typically **include** **identifying** the **staff** to be **invited** to **participate** in the peer review of each work product; **identifying** **key** **reviewers** who should participate in the peer review; **preparing** and **updating** **materials** to be used during peer reviews, such as checklists and review criteria and scheduling peer reviews. (peer review schedule, peer review checklist, entry and exit criteria for work products, criteria for requiring another peer review, peer review training material, selected work products to be reviewed)

Practices: **determine** the **type** of **peer** **review** to be conducted. **Define** **requirements** for **collecting** **data** during the peer review. **Establish** and **maintain** **entry** and **exit** **criteria** for the peer review. **Establish** and **maintain** **criteria** for **requiring** another peer review. **Establish** and **maintain** checklists to ensure that work products are **reviewed** **consistently**. **Develop** a detailed peer review **schedule**, including the dates for peer review training and for when materials for peer reviews will be available. **Ensure** that the work **product** **satisfies** the peer review entry criteria prior to distribution. **Distribute** the work **product** to be **reviewed** and **related** **information** to participants early enough to enable them to **adequately** prepare for the peer review. **Assign** **roles** for the peer review as **appropriate**. **Prepare** for the peer review by reviewing the work **product** prior to **conducting** the peer review.

SP 2.2 conduct peer review

One of the purposes of conducting a peer review is to **find and remove defects early**. Peer reviews are **performed incrementally** as **work products** and **being developed**. These reviews are structured and are not management reviews. Peer reviews can be performed on key work products of specification, design, test, and implementation activities and specific planning work products. The **focus** of the peer review should be on the **work product** in review, **not** **on** the **person** who produced it. When **issues** **arise** during the peer review, they should be **communicated** to the **primary** **developer** of the work product **for** **correction**. Peer reviews should address the following guidelines: there should be **sufficient** **preparation**, the conduct should be **managed** and **controlled**, **consistent** and **sufficient** **data** should be **recorded**, and **action** items should be **recorded**.

Practices: perform the **assigned** **roles** in the peer review. **Identify** and document **defects** and other issues in the work product. **Record** **results** of the peer review, including **action** items. **Collect** peer review **data**. **Identify** **action** items and communicate issues to **relevant** **stakeholders**. Conduct an **additional** **peer** **review** if needed. **Ensure** that the exit criteria for the peer review are **satisfied**.

SP 2.3 analyse peer review data

Analyse data about the preparation, conduct, and results of the peer reviews. (peer review data, peer review action items data)

Practices: **record** **data** related to the **preparation**, **conduct**, and **results** of the peer reviews. **Store** the data for **future** **reference** and **analysis**. **Protect** the **data** to **ensure** that peer review data are **not** used **inappropriately**. Analyse the peer review data (phase defect was injected, preparation time or rate versus expected time or rate, number of defects versus number expected, types of defects detected, causes of defects, defect resolution impact, user stories or case studies associated with a defect, the end users and customers who are associated with defects.).

SG 3 verify select work products

**Verification methods, procedures, and criteria** are used to **verify** selected **work** products and associated maintenance, training, and support services using the **appropriate** **verification** **environment**. **Verification** **activities** should be **performed** **throughout** the product **lifecycle**.

SG 3.1 perform verification

**Verifying products** and work **products** **incrementally** **promotes** **early** **detection** of **problems** and can result in the **early** **removal** of **defects**. The **results** of verification **save** the **considerable** **cost** of **fault** **isolation** and **rework** associated with **troubleshooting** **problems**. (Verification results, verification reports, demonstrations, as-run procedures log)

Practices: **perform** the **verification** of selected work products **against** their **requirements**. **Record** the **results** of **verification** **activities**. **Identify** **action** items **resulting** from the verification of work products. **Document** the “as-run” **verification** **method** and **deviations** from available **methods** and procedures **discovered** during its **performance**.

SG 3.2 analyse verification results

**Actual result** should be **compared** to **established** **verification** criteria to **determine** **acceptability**. The **results** of the **analysis** **recorded** as **evidence** that **verification** was **conducted**. For each work product, all available **verification** **results** are **incrementally** **analysed** to **ensure** that **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 verification results are analysed **sufficiently**. Analysis **reports** or “**as**-**run**” **method** documentation can also **indicate** that **bad** **verification** **results** are due to method **problems**, criteria problems, or a verification environment problem. (Analysis report, trouble reports, change requests for verification methods, criteria, and the environment)

Practices: **compare** actual results to expected result. Based on the established verification criteria, **identify** products that do **not** **meet** their **requirements** or identify problems with methods, procedures, criteria, and the verification environment. **Analyse** **defect** **data**. **Record** all **results** of the **analysis** in a report. Use **verification** **results** to **compare** **actual** **measurements** and **performance** to technical performance parameters. Provide **information** on **how** **defects** can be **resolved.**