**Deployment Package**

**Verification and Validation (V&V)**

**Systems Engineering Basic Profile**

**Notes:**

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The processes described in this Deployment Package are not intended to preclude or discourage the use of additional processes that Very Small Entities may find useful.

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Abbreviations/Acronyms

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| --- | --- |
| **Abre./Acro.** | **Definitions** |
| DP | Deployment Package - a set of artifacts developed to facilitate the implementation of a set of practices, of the selected framework, in a Very Small Entity. |
| VSE | Very Small Entity – an enterprise, organization, department or project having up to 25 people. |
| VSEs | Very Small Entities |
| V&V | Verification and Validation |
| ISO | International Organization for Standardization,  <http://www.iso.org> |
| INCOSE | International Council on Systems Engineering, <http://www.incose.org/> |
| PMBOK | Project Management Body of Knowledge, <http://www.pmi.org/> |
| *<details>* | *<details>* |
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# 1. Technical Description

## Purpose of this document

A Deployment Package (DP) is a set of artifacts developed to facilitate the implementation of a set of practices in a Very Small Entity (VSE). A DP is not a process reference model (i.e. it is not prescriptive). The elements of a typical DP are: roles and products, description of processes, activities, tasks, template, checklist, reference to standards, etc.

This Deployment Package (DP) supports the Basic Profile as defined in ISO/IEC TR 29110-5-6-2, the Management and engineering guide [ISO/IEC 29110]. The Basic Profile is one profile of the Generic profile group. The Generic profile group is applicable to VSEs that do not develop critical systems. The Generic profile group is composed of 4 profiles: Entry, Basic, Intermediate and Advanced. The Generic profile group does not imply any specific application domain. The Basic profile is targeted to VSEs working on one project at a time.

The Basic profile is composed of two processes: the Project Management Process and the System Definition and Realization Process.

The processes, activities and tasks described in this DP are consistent with those listed in ISO/IEC TR 29110 5-6-2 Systems Engineering — Lifecycle Profiles for Very Small Entities (VSEs) — Part 5-6-2: Management and engineering guide – Generic profile group: Basic profile.

The INCOSE Systems Engineering Handbook [INCOSE] has been used to develop this DP. The INCOSE Handbook is consistent with ISO/IEC 15288:2008 – *Systems and software engineering – System life cycle processes* [ISO 15288].

Information contained in this DP is applicable to VSEs that do not develop critical products that require intense verification and validation (V&V) activities. Those projects could use of the appropriate standards and guides (e.g. ANSI/GEIA EIA-632, MIL-STD-499, etc.)

This document is intended to be used by a VSE to establish processes to implement any development approach or methodology including, e.g., agile, evolutionary, incremental, test driven development, etc. based on the organization or project needs of a VSE.

The content of this document is entirely *informative*.

Once published by ISO, ISO/IEC TR 29110-5-6-2 will be available at no cost on the following ISO site: <http://standards.iso.org/ittf/PubliclyAvailableStandards/index.html>

## Why is Systems Engineering important?

The way to effective Systems Engineering (SE) is not “in the direction of formal, formidable, massive documentation” [Chase]. Systems Engineering is a perspective, a process, and a profession [INCOSE]. SE has an iterative nature that supports learning and continuous improvement. SE has a horizontal orientation which means SE is a mechanism to establish agreements for the creation of products and services in a web of contractors and subcontractors. Therefore SE is the link between contractors, and PM, and the organizational parts of enterprises and single technical disciplines (e.g. Software, mechanics, HMI, EMC, etc.).

## Why is cooperation between Systems Engineering and Project Management important?

Systems engineers and program managers bring unique skills and experiences to the programs on which they work. There is also a “shared space” (PM/SE) where program managers and systems engineers collaborate to drive the program team’s performance and success. Therefore they have to collaborate.

Figure 1 shows a concept how systems engineering (SE) and project management (PM) might relate to each other. The basis for this concept is the project lifecycle as proposed by *ISO 21500 – Guidance on project management*. But it’s too simple just to consider the pure project time span for a product development. SE has to consider the whole life cycle of a product in the product concepts until product disposal. Therefore SE has to contribute in all project control activities and provide relevant inputs.



Figure 1 Overview of a concept for SE – PM cooperation

Because a deployment package is not a complete process reference model a VSE might need guidance about how they might perform a project.

To consider the idea for the ISO/IEC TR 29110 simplified technical processes have been defined (see the 9 coloured blocks in Figure 2). Each of these blocks consists of business aspects and technical aspects. Just the degree of involvement for PM and SE changes. Interface management or requirements engineering are commonly understand as SE activities. But they are also influenced by business aspects, enterprise interests or simply by available resources which are more in the PM domain. Therefore the addressed technical processes in Figure 2 might be understood as common (PM&SE) activities.

Configuration management (CM) might be understood as an enterprise oriented task and used in every project. The activities of CM should start with the earliest project activities (the first idea for a project) and will not end with a project. The stored information must be available after a project is finished for several purposes (e.g. following project, legal issues, etc.).

Each of the technical process blocks includes activities which might be performed in different project phases. Figure 2 shows an example to map project process steps to single technical processes. The details for the technical processes are described in different DP packages.



Figure 2 DP structure and linkage to project steps

## Why is Verification and Validation Important?

Verification provides continuous feedback to other project processes to help reduce risk and surface problems early. The goal is to completely verify system capability to meet all requirements prior to production and operation stages. Problems uncovered at in these stages are very costly to correct. As such, early discovery of deviations from requirements reduces overall project risk and helps the project deliver a successful, low-cost system. Verification results are an important element of decision gate reviews.

Validation determines that a system does all the things it should and does not do what it should not do.

## Tailoring this Deployment Package

This DP describes the minimum set of V&V activities and tasks that should be implemented by a VSE. A VSE may have existing processes that can be substituted for these activities, tasks, steps, products and roles.

# 2. Definitions

In this section, the reader will find two sets of definitions. The first set defines the terms used in all Deployment Packages, i.e. generic terms. The second set of terms used in this Deployment package, i.e. specific terms.

## Generic Terms

***Process***: a set of interrelated or interacting activities which transform inputs into outputs [ISO 9000:2000].

***Activity:*** a set of cohesive tasks of a process [ISO 15288]

***Task:*** required, recommended, or permissible action, intended to contribute to the achievement of one or more outcomes of a process [ISO 15288]

***Sub-Task:*** When a task is complex, it is divided into sub-tasks.

***Step:*** In a deployment package, a taskis decomposed in a sequence of steps.

***Role***: a defined function to be performed by a project team member, such as testing, filing, inspecting, coding [PMBOK].

***Product:*** result of a process [ISO 9000:2005]

NOTE There are four agreed generic product categories: hardware (e.g. engine mechanical part), software (e.g. computer program), services (e.g. transport), and processed materials (e.g. lubricant). Hardware and processed materials are generally tangible products, while software or services are generally intangible. Most products comprise elements belonging to different generic product categories. Whether the product is then called hardware, processed material, software or service depends on the dominant element.

***Artifact:*** information, which is not listed in ISO/IEC 29110 Part 5, but can help a VSE during the execution of a project.

## Specific Terms

Audit: independent assessment of products and processes, conducted by an authorized person to assess compliance with requirements [ISO 12207]

NOTE—An audit should result in a clear indication of whether the audit criteria have been met.

*Correction:* action to eliminate a detected nonconformity [SOURCE]

NOTE A correction can be, for example, rework or regrade.

*Customer*: organization or person that receives a product

NOTE acquirer or user is customer [ISO 9000]

Inspection: a visual examination of a system product to detect and identify system anomalies, including errors and deviations from standards and specifications [IEEE 1028].

NOTE—Inspections are peer examinations led by impartial facilitators who are trained in inspection techniques. Determination of remedial or investigative action for an anomaly is a mandatory element of a system inspection, although the solution should not be determined in the inspection meeting.

Life cycle: the evolution of a system, product, service, project or other human-made entity from conception through retirement. [ISO/IEC 15288]

Management review: A systematic evaluation of a system product or process performed by or on behalf of management that monitors progress, determines the status of plans and schedules, confirms requirements and their system allocation, or evaluates the effectiveness of management approaches used to achieve fitness for purpose [IEEE 1028].

Report: describe the results of activities such as investigations, assessments, and tests [ISO/IEC 15289]

***Review:*** a process or meeting during which a system product, set of system products, or a system process is presented to project personnel, managers, users, customers, user representatives, auditors or other interested parties for examination, comment or approval [IEEE 1028].

Technical review: a systematic evaluation of a system product by a team of qualified personnel that examines the suitability of the system product for its intended use and identifies discrepancies from specifications and standards [IEEE 1028]

NOTE—Technical reviews may also provide recommendations of alternatives and examination of various alternatives.

Validation: confirmation, through the provision of objective evidence that the requirements for a specific intended use or application have been fulfilled [ISO 9000:2005].

NOTE Validation in a life cycle context is the set of activities ensuring and gaining confidence that a system is able to accomplish its intended use, goals and objectives.

***Verification:*** confirmation, through the provision of objective evidence that specified requirements have been fulfilled [ISO 9000:2005]

NOTE Verification in a life cycle context is a set of activities that compares a product of the life cycle against the required characteristics for that product. This may include, but is not limited to, specified requirements, design description and the system itself.

***Walk-through:*** a static analysis technique in which a designer or programmer leads members of the development team and other interested parties through a system product, and the participants ask questions and make comments about possible anomalies, violation of development standards, and other problems [IEEE 1028].

# 3. Relationships with ISO/IEC 29110

This deployment package covers the processes and activities related to V&V for Very Small Entities (VSEs) as described in ISO/IEC 29110-5-11-2.

In this section, the reader will find a list of processes, activities, tasks and roles of ISO/IEC 29110 that are directly related to V&V.

* **Process: Project Planning (PM)**
* **Activity: PM.1 Project Planning**
* **Tasks:**

|  |  |
| --- | --- |
| **PM.1.16 Verify and obtain approval of the *Project Plan****.*  Verify that all *Project Plan* elementsare viable and consistent. The results found are documented in a *Verification Results* and corrections are made until the document is approved by PM. | PM  TL |
| **PP.1.2 Validation of the *Project Plan.***  Validate that the *Project Plan* elements definition match with the *Statement of Work.* The results found are documented in a *Validation Results* and corrections are made until the document is approved by CUS. | PM  CUS |

* **Process: Project Assessment and Control (PM.O2)**
* **Activity: PA.1 Control the project**
* **Tasks:**

|  |  |
| --- | --- |
| **Tasks** | **Roles** |
| **PA.1.1 Analyze and evaluate the *Change Request***for cost, schedule and technical impact, and include the accepted changes in the *Project Plan.*  The *Change Request* can be initiated externally by the Customer or internally by the Work Team.  The evaluation of *Change Request* initiated by Customer or those which affects the Customer needs. Negotiate with Customer to obtain its acceptance. | PM  TL |

* **Process: Project Measurement (PM)**
* **Activity: PM.1 Perform measurement**
* **Tasks:**

|  |  |
| --- | --- |
| **Tasks** | **Roles** |
| **PM.1.1 Evaluate project progress** with respect to the *Project Plan*, comparing:   * actual tasks against planned tasks * actual results against established project objectives * actual resource allocation against planned resources * actual cost against budget estimates * actual time against planned schedule * actual risk against previously identified | PM  TL  WT |

* **Process: Requirements Analysis (RA)**
* **Activity: RA.1 Analyze and maintain the system requirements**
* **Tasks:**

|  |  |
| --- | --- |
| **Tasks** | **Roles** |
| **RA.1.1 Verification of the *Requirements Specification.***  Verify the correctness and testability of the *Requirements Specification* and its consistency with the *Product Description*. Additionally, review that requirements are complete, unambiguous and not contradictory. The results found are documented in a *Verification Results* and corrections are made until the document is approved by SE. If significant changes were needed, initiate a *Change Request.* | SE |

* **Process: Stakeholder Requirements Analysis (SR)**
* **Activity: SR.1 Analyze and maintain stakeholder requirements**
* **Tasks:**

|  |  |
| --- | --- |
| **SR.1.1 Validation of the *Requirements Specification***  Validate that *Requirements Specification* satisfies needs and agreed upon expectations, including the user interface usability. The results found are documented in a *Validation Results* and corrections are made until the document is approved by CUS. | CUS  SE |

* **Process: Architectural Design (AD)**
* **Activity: AD.1 Document and maintain the architecture**
* **Tasks:**

|  |  |
| --- | --- |
| **Tasks** | **Roles** |
| **AD1.1 Verification of the *System Design***  Verify correctness of *System Design* documentation, its feasibility and consistency with their *Requirement Specification*. Verify that the *Traceability Record* contains the adequate relationships between requirements and the *System Design* elements. The results found are documented in a *Verification Results* and corrections are made until the document is approved by SE. If significant changes were needed, initiate a *Change Request*. | SE  DES |

* **Process: Validation (VA)**
* **Activity: VA.1 Perform validation**
* **Tasks:**

|  |  |
| --- | --- |
| **VA.1.1 Verification of the Test Cases and Test Procedures.**  Verify consistency among Requirements Specification, System Design and Test Cases and Test Procedures. The results found are documented in a Verification Results and corrections are made until the document is approved by SE. | DES  SE |

* **Process: Implementation (IM)**
* **Activity: IM.1 Perform implementation**
* **Tasks:**

|  |  |
| --- | --- |
| **Tasks** | **Roles** |
| **IM.1.1 Apply unit test cases to verify** that functions work accordingly to the detailed part of the *System Design.* | FA |

* **Process: Integration (IN)**
* **Activity: IN.1 Perform integration**
* **Tasks:**

|  |  |
| --- | --- |
| **Tasks** | **Roles** |
| **IN.1.1 Perform tests using *Test Cases and Test Procedures*** for integration and document results in *Test Report*. | FA  CUS |

* **Process: Maintenance (MA)**
* **Activity: MA.1 Perform maintenance**
* **Tasks:**

|  |  |
| --- | --- |
| **Tasks** | **Roles** |
| **MA.1.1 Verification of the *Maintenance Documentation.***  Verify consistency of *Maintenance Documentation* with *System Configuration*. The results found are documented in a *Verification Results* and corrections are made until the document is approved by DES. | DES |

# 4. Description of Processes, Activities, Tasks, Steps, Roles and Products

**Process: Project Planning (PP)**

The purpose of the Project Planning Process is to produce and communicate effective and workable project plans.

**Activity: PP.1 Plan project technical and quality management**

The Project Planning activity documents the planning details needed to manage the project

* **PP.1.1 Verification of the *Project Plan****.*

Verify that all *Project Plan* elementsare viable and consistent.

* **PP.1.2 Validation of the *Project Plan.***

Validate that the *Project Plan* elements definition match with the *Statement of Work.*

## Verification & Validation of the Project Plan

|  |  |
| --- | --- |
|  | |
| ***Objectives:*** | Verify all Project Plan elements and validate if elements match with the Statement of Work. |
| ***Rationale:*** | In order to accomplish project objectives in the expected quality, time and cost, it is important to verify and validate all project elements. |
| ***Roles:*** | Project Manager |
| Technical Leader |
| Customer |
| ***Products:*** | Verification Results |
| Acceptance Record |
| ***Artifacts:*** | *Project Plan* |
| *Statement of Work* |
| ***Steps:*** | 1.Verify the *Project Plan* |
| 2. Validate the Project Plan |
| 3. Document the results |
| 4. Make corrections |
| ***Step Description:*** | ***Step 1.* Verify that all Project Plan**  Verify that all *Project Plan* elementsare viable and consistent  ***Step 2.* Validate the Project Plan**  Validate that the Project Plan elements definition match with the Statement of Work.  ***Step 3.* Document the results**  Document the results of verification in Verification Results  ***Step 4.* Make corrections**  Make corrections until the document is approved (by TL or CUS)  Note: Verify that the Project Plan includes V&V tasks in order to assure the quality of work products. |

**Process: Project Assessment and Control (PA)**

The purpose of the Project Assessment and Control Process is to determine the status of the project and direct project plan execution to ensure that the project performs according to plans and schedules, within projected budgets, to satisfy technical objectives.

**Activity: PA.1 Control the project**

The Control the Project activity implements the documented plan on the project.

* **PA.1.1 Analyze and evaluate the *Change Request***for cost, schedule and technical impact, and include the **accepted changes** in the *Project Plan.*

## Analysis and Evaluation of the Change Request for the Project

|  |  |
| --- | --- |
|  | |
| ***Objectives:*** | To manage Project Plan changes according with a process agreed upon with the customer. |
| ***Rationale:*** | Project Plan changes must be planned and agreed upon with the customer on the project. |
| ***Roles:*** | Project Manager |
| Customer |
| Technical Leader |
| ***Products:*** | Project Plan |
| Acceptance Record |
| ***Artifacts:*** | Change Requests |
| Progress Status Record |
| ***Steps:*** | 1.Analyze the *Change* |
| 2.Evaluate the *Change* |
| 3. Prioritize changes |
| 4.Approve changes |
| 5.Include changes |
| ***Step Description:*** | ***Step 1.*** Analyze the *Change*   * Perform an impact analysis of changes on the project in term of cost, schedule and technical considerations.   ***Step 2.*** Evaluate the *Change*   * Estimate the impact of changes in terms of cost, schedule and technical side.   ***Step 3.*** Prioritize changes   * The project manager must obtain from the customer a prioritization of the identified   ***Step 4.*** Approve changes   * Obtain customer sign-off on agree change.   ***Step 5.*** Include changes   * Include the prioritized and accepted changes in the Project Plan. |

**Process: Project Measurement (PM)**

The purpose of the Measurement Process is to collect, analyze, and report data relating to the products developed and processes implemented within the organization, to support effective management of the processes, and to objectively demonstrate the quality of the products.

**Activity: PM.1 Perform measurement**

The Perform Measurement activity monitors and evaluates the performance of the plan against documented commitments.

* **PM.1.1 Evaluate project progress** with respect to the *Project Plan*

## Evaluation the performance of the Project Plan

|  |  |
| --- | --- |
|  | |
| ***Objectives:*** | The purpose of the Evaluation of the performance of the Project Plan is to determine the status of the project and ensure that the project performs according to plans and schedules, within projected budgets and it satisfies technical objectives. |
| ***Rationale:*** | This task shows how a Project Plan should be assessed in terms of planned activities identified at the project planning phase versus actual project progress. |
| ***Roles:*** | Project Manager |
| Technical Leader |
| Work Team |
| ***Products:*** | *Project Plan* |
| *Progress Status Record* |
| ***Artifacts:*** | *Project Plan* |
| *Progress Status Record* |
| ***Steps:*** | 1. Evaluate project |
| 1. Record the Progress Status |
| ***Step Description:*** | ***Step 1.* Evaluate project, in terms of:**   * Actual tasks against planned tasks * Actual results against established project objectives * Actual resource allocation against planned resources * Actual cost against budget estimates * Actual time against planned schedule * Actual risk against previously identified   ***Step 2***. **Record the *Progress Status*** of the Project  A record actual project data in should be maintained in a Progress Status Record where the status of an item is typically recorded according to the ‘traffic light’ system:   * Green - as ‘on target’ * Amber - as ‘not on target but recoverable’ * Red - as ‘not on target and recoverable only with difficulty’ |

**Process: Requirements Analysis (RA)**

The purpose of the Requirements Analysis Process is to transform the stakeholder, requirement‐driven view of desired services into a technical view of a required product that could deliver those services.

**Process: Stakeholder Requirements Analysis (SR)**

The purpose of the Stakeholder Requirements Definition Process is to define the requirements for a system that can provide the services needed by users and other stakeholders in a defined environment.

**Activity: RA.1 Analyze and maintain the system requirements**

The Analyze and Maintain the System Requirements Activity defines verification criteria. This activity is conducted concurrent with requirements analysis efforts to ensure verifiable requirements. This activity also maintains continuity of configuration control and traceability.

* **RA.1.1 Verification of the *Requirements Specification.***

Verify the correctness and testability of the *Requirements Specification* and its consistency with the *Product Description*. Additionally, review that requirements are complete, unambiguous and not contradictory.

**Activity: SR.1 Analyze and maintain stakeholder requirements**

The Analyze and Maintain Stakeholder Requirements Activity analyzes requirements for clarity, completeness, and consistency and it establishes and maintain a traceability matrix to document how the formal requirements are intended to meet the stakeholder objectives and achieve stakeholder agreement.

* **SR.1.1 Validation of the *Requirements Specification***

Validate that *Requirements Specification* satisfies needs and agreed upon expectations, including the user interface usability.

## Verification & Validation of the Requirement Specification

|  |  |
| --- | --- |
|  | |
| ***Objectives:*** | Verify requirements and obtain validation from the customer or his representative. |
| ***Rationale:*** | In order to avoid constant fundamental changes in the requirements, it is important to ask for the requirement validation from the customer. |
| ***Roles:*** | Analyst |
| Customer |
| ***Products:*** | Requirements Document |
| Verification Results |
| Acceptance Record |
| ***Artifacts:*** | Requirements Document |
| ***Steps:*** | 1.Verify the *Requirements Specification* |
| 2.Document Results |
| 3.MakeCorrections |
| 4. Initiate a Change Request (as necessary) |
| 5. Validate *Requirements Specification* |
| ***Step Description:*** | ***Step 1.* Verify the Requirements Specification for:**   * Correctness and testability * Consistency with the Product Description * Complete, unambiguous and not contradictory   ***Step 2.* Document Results**.   * Document results of verification in *Verification Results*   ***Step 3.* Make Corrections**.   * Make corrections until the document is approved by SE or CUS.   ***Step 4.* Initiate a Change Request (as necessary)**   * Identify purpose of the Change Request * Document the impact of Change (high level) * Identify the critically of the Change   ***Step 5.* Validate Requirements Specification**   * Obtain from your customer an approval of the requirements (or of a given subset if you are using an iterative lifecycle). |

**Process: Architectural Design (AD)**

The purpose of the Architectural Design Process is to synthesize a solution that satisfies system requirements.

**Activity: AD.1 Document and maintain the architecture**

Document and Maintain the Architecture Activity documents and maintains the architectural design and relevant decisions made to reach agreement on the baseline design. It also establishes and maintains the traceability between requirements and system elements.

* **AD.1.1 Verification of the *System Design***

Verify correctness of *System Design* documentation, its feasibility and consistency with their *Requirement Specification*. Verify that the *Traceability Record* contains the adequate relationships between requirements and the *System Design* elements.

**Process: Validation (VA)**

The purpose of the Validation Process is to provide objective evidence that the services provided by a system when in use comply with stakeholders’ requirements, achieving its intended use in its intended operational environment.

**Activity: VA.1 Perform validation**

The Perform Validation Activity develops validation procedures that demonstrate that the system is fit for its purpose and satisfies the stakeholders’ requirements. The activity documents validation results and enters the data into the RVTM.

* **VA.1.1** **Verification of the *Test Cases and Test Procedures.***

Verify consistency among *Requirements Specification*, *System Design* and *Test Cases and Test Procedures*.

## Verification of Design, Test Cases and Test Procedures

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| --- | --- |
|  | |
| ***Objectives:*** | To verify that System Architecture and Detail Design are correct, consistent and feasible according with the Requirement Specification |
| ***Rationale:*** | In order to avoid lack of consistency, feasibility, correctness, traceability between System Architectural and Design and the Requirements Specifications a set of verification tasks are recommend to be implemented in the project |
| ***Roles:*** | Analyst |
| Designer |
| ***Products:*** | Verification Results |
| Acceptance Record |
| Change Request (if necessary) |
| ***Artifacts:*** | *System Design* documentation |
| *Requirements Specification* |
| *Traceability Record* |
| *Test Cases and Test Procedures* |
| ***Steps:*** | 1. Verify the *System Design* documentation |
| 2. Verify the *Traceability Record* |
| 3. Verify the *Test Cases and Test Procedures* |
| 4. Verify consistency |
| 5.Document Results |
| 6.MakeCorrections |
| 7. Initiate a Change Request (if necessary) |
| ***Step Description:*** | ***Step 1.* Verify the *System Design* documentation for:**   * Correctness * Feasibility and consistency   ***Step 2.* Verify the *Traceability Record***   * Verify that the *Traceability Record* contains the adequate relationships between requirements and the *System Design* elements.   ***Step 3.* Verify the *Test Cases and Test Procedures***   * Verify consistency among *Requirements Specification*, *System Design* and *Test Cases and Test Procedures*.   ***Step 4.* Verify consistency**   * Verify consistency among *Requirements Specification*   ***Step 5.* Document Results**.   * Document results of verification in *Verification Results, System Design* and *Test Cases and Test Procedures*.   ***Step 6.* Make Corrections**.   * Make corrections until the document is approved by DES /SE.   ***Step 7.* Initiate a Change Request (as necessary)**   * Identify purpose of the Change Request * Document the impact of Change (high level) * Identify the critically of the Change |

**Process: Implementation (IM)**

The purpose of the Implementation Process is to realize a specified system element.

**Activity: IM.1 Perform implementation**

Complete detailed product, process, material specifications (“Build‐to” or “Code‐to” documents) and corresponding analyses and produce documented evidence of Implementation compliance

* **IM.1.1 Apply unit test cases to verify** that functions work accordingly to the detailed part of the *System Design.*

## Verify System Construction

|  |  |
| --- | --- |
|  | |
| ***Objectives:*** | Verify System functions using test cases |
| ***Rationale:*** | To assure that key functions identified in the Requirements Specifications have been implemented according to System Design |
| ***Roles:*** | Programmer |
| ***Products:*** | System Component |
| Verification Results |
| ***Artifacts:*** | System Design |
| System Component |
| Test cases and Procedures |
| ***Steps:*** | 1.Identify System Component |
| 2.Apply unit test |
| ***Step Description:*** | ***Step 1.*** Identify System Component   * Identify unit of code and data to be tested   ***Step 2.*** Apply Unit Test   * Verify using *Test Cases* and Procedures if system component works according to *System Design* |

**Process: Integration (IN)**

The purpose of the Integration Process is to assemble a system that is consistent with the architectural design.

**Activity: IN.1 Perform integration**

The Perform Integration Activity verifies and analyzes assemblies to confirm correct functionality of assembled products through integration testing and analysis at each successive level of assembly

* **IN.1.1** Perform **tests using *Test Cases and Test Procedures*** for integration and document results in *Test Report*.

## System Test for Integration

|  |  |
| --- | --- |
|  | |
| ***Objectives:*** | To verify that system components are integrated and satisfy system requirements |
| ***Rationale:*** | To assure that System Components are integrated and defects are documented the *Test Report*. |
| ***Roles:*** | Programmer |
| Customer |
| ***Products:*** | System Component |
| Test Report |
| ***Artifacts:*** | System Component |
| Test Report |
| Requirements Specification |
| Test Cases and Test Procedures |
| ***Steps:*** | 1.Identify Integrated System Component |
| 2.Perform test integration |
| 2.Document Results |
| ***Step Description:*** | ***Step 1.*** Identify Integrated System Component   * Identify integrated code and data to be tested   ***Step 2.*** Perform Test Integration   * Perform tests using *Test Cases and Test Procedures* for integration   ***Step 3.*** Document Results   * Document results of Test Integration in the Test Report. |

**Process: Maintenance (MA)**

The purpose of the Maintenance Process is to sustain the capability of the system to provide a service.

**Activity: MA.1 Perform maintenance**

The Perform Maintenance Activity implements maintenance and problem resolution procedures including scheduled replacement of system elements prior to failure (i.e., preventive maintenance).

* **MA.1.1 Verification of the *Maintenance Documentation.***

Verify consistency of *Maintenance Documentation* with *System Configuration*.

## Verification of Maintenance Documentation

|  |  |
| --- | --- |
|  | |
| ***Objectives:*** | The purpose of this task is verifying the consistency of the Configuration Item related to Maintenance Documentation with the System Configuration Database. Any change in the configuration Item should be registered in the Database according to a documented procedure in the corresponding DP. |
| ***Rationale:*** | Verify that Maintenance Documentation and System version are consistent and ready for delivery. |
| ***Roles:*** | Designer |
| Technical Leader |
| ***Products:*** | Verification Results |
| Acceptance Record |
| Maintenance Documentation |
| ***Artifacts:*** | System Configuration |
| Maintenance Documentation |
| Acceptance Record |
| ***Steps:*** | 1.Verify consistency of *Maintenance Documentation* |
| 2.Document Results |
| 3.MakeCorrections |
| ***Step Description:*** | **Step 1.** Verify the Maintenance Documentation.   * Verify consistency of *Maintenance Documentation* with *System Configuration*.   **Step 2.** Document Results.   * Document results of verification in *Verification Results*   **Step 3.** Make Corrections.   * Make corrections until the document is approved by TL. |

## Role Description

This is an alphabetical list of the roles, abbreviations and required competencies description.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Role** | **Abbreviation** | **Competency** |
| 1. | System Engineer | SE | Knowledge and experience eliciting, specifying and analyzing the requirements.  Knowledge in designing user interfaces and ergonomic criteria.  Knowledge of the revision techniques and experience on the system development and maintenance.  Knowledge of the editing techniques and experience on the system development and maintenance. |
| 2. | Customer | CUS | Knowledge of the Customer processes and ability to explain the Customer requirements.  The Customer (representative) must have the authority to approve the requirements and their changes.  The Customer includes user representatives in order to ensure that the operational environment is addressed.  Knowledge and experience in the application domain. |
| 3. | Designer | DES | Knowledge and experience in the system components and architecture design.  Knowledge of the revision techniques and experience on the system development and maintenance.  Knowledge of the editing techniques and experience on the system development and maintenance.  Knowledge and experience in the planning and performance of integration and system tests. |
| 4. | Fabricator | FA | Knowledge and/or experience in fabrication/construction, integration and unit tests.  Knowledge of the revision techniques and experience on the system development and maintenance.  Knowledge of the editing techniques and experience on the system development and maintenance. |
| 5. | Project Manager | PM | Leadership capability with experience making decisions, planning, personnel management, delegation and supervision, finances and system development. |
| 6. | Technical Leader | TL | Knowledge and experience in the system development and maintenance. |
| 7. | Work Team | WT | Knowledge and experience according to their roles on the project: SE, DES, and/or FA. |

## Product & Artifacts Descriptions

This is an alphabetical list of the input, output and internal process products & artifacts, its descriptions, possible states and the source of the product.

|  | **Name** | **Description** | **Source** |
| --- | --- | --- | --- |
| *1.* | *Acceptance Record* | Document establishing the customer acceptance of the deliverables of the project. It may contain:   * Record of the receipt of the delivery * Identifies the date received * Identifies the delivered elements * Records the verification of any Customer acceptance criteria defined * Signed by receiving Customer | Project Management |
| *2.* | *Change Request* | It may has the following characteristics:   * Identifies purpose of change * Identifies request status (new, accepted, rejected) * Identifies requester contact information * Impacted system(s) * Impact to operations of existing system(s) defined * Impact to associated documentation defined * Criticality of the request, date needed by   The applicable statuses are: initiated, evaluated, and accepted. | System Implementation  Customer  Project Management |
| *3.* | *Correction Register* | Activities established to correct a deviation or problem concerning the accomplishment of a plan. It may contain:   * Identifies the initial problem * Identifies the ownership for completion of defined action * Defines a solution * Identifies the open date and target closure date * Contains a status indicator * Indicates follow up actions | Project Management |
| *4.* | *Maintenance Documentation* | Electronic or printed document describing the *System Configuration* and the environment used for development and testing (compilers, design tools, construction and tests). The *Maintenance Documentation* includes or refers to products developed during implementation such as the *Requirements Specification.* It is written in terms that maintenance personnel can understand.  The applicable statuses are: verified and baselined. | System Implementation |
| *5.* | *Meeting Record* | Record of the agreements established with Customer and/or Work Team. May address the following:   * purpose of meeting * attendees * date, place held * reference to previous minutes * what was accomplished * identifies issues raised * any open issues * agreements * next meeting, if any.   The applicable status is: updated. | Project Management |
| *6.* | *Progress Status Record* | Record of the status of the project against the *Project Plan*. It may contain:   * status of actual tasks against planned tasks * status of actual results against established objectives / goals * status of actual resource allocation against planned resources * status of actual cost against budget estimates * status of actual time against planned schedule * status of actual risk against previously identified   Record of any deviations from planned tasks and reason why.  The applicable status is: evaluated. | Project Management |
| 7. | *Project Plan* | Includes:   * *Product Description* * *Scope* * *Objectives* * *Deliverables* * *Tasks, including* verification, validation and reviews with Customer and Work Team, to assure the quality of work products. Tasks may be represented as a Work Breakdown Structure (WBS). * *Relationship and Dependence of the Tasks* * *Estimated Duration* of tasks * *Resources* (humans, materials, equipment and tools) including the required training, and the schedule when the resources are needed. * *Composition of Work Team* * *Schedule of the Project Tasks,* the expected start and completion date, for each task. * *Estimated Effort and Cost* * *Identification of Project Risks* * *Version Control Strategy* * Product repository tools or mechanism identified * Location and access mechanisms for the repository specified * Version identification and control defined * Backup and recovery mechanisms defined * Storage, handling and delivery (including archival and retrieval) mechanisms specified * *Delivery Instructions* * Elements required for product release identified (i.e., hardware, system, documentation etc.) * Delivery requirements * Sequential ordering of tasks to be performed * Applicable releases identified * Identifies all delivered system components with version information * Identifies any necessary backup and recovery procedures   The applicable statuses are: verified, validated, changed and reviewed*.* | Project Management |
| *8.* | *Requirements Specification* | Includes an introduction and a description of the requirements. It may contain:   * Introduction –general description of system and its use within the scope of the customer business; * Requirements description: * functionality – established needs to be satisfied by the system when it is used in specific conditions. Functionality must be adequate, accurate and safe. * user interface – definition of those user interface characteristics that allow to understand and learn the system easily so the user be able to perform his/her tasks efficiently including the interface exemplar description; external interfaces – definition of interfaces with other systems or software; * reliability – specification of the system execution level concerning the maturity, fault tolerance and recovery; * efficiency – specification of the system execution level concerning the time and use of the resources; * maintenance – description of the elements facilitating the understanding and execution of the future system modifications; * portability – description of the system characteristics that allow its transfer from one place to other; * design and construction limitations – needs imposed by the customer; * inter-operability – capability for two or more systems or system components be able to interact with each other and use it. * reusability – feature of any product/sub-product, or a part of it, so that it can be used by several users as an end product, in the own system development, or in the execution of other system products. * legal and regulative – needs imposed by laws, regulations, etc.   Each requirement is identified, unique and it is verifiable or can be assessed.  The applicable statuses are:verified, validated and baselined. | System Implementation |
| *9.* | *System Component* | A set of related system elements.  The applicable statuses are:unit tested, corrected and baselined. | System Implementation |
| *10.* | *System Design* | This document includes textual and graphical information on the system structure. This structure may include the following parts:  Architectural High Level System Design – Describes the overall *System* structure:   * Identifies the required system *Components* * Identifies the relationship between system *Components* * Consideration is given to any required: * system performance characteristics * system interfaces * security characteristics * database design requirements * error handling and recovery attributes   Detailed Low Level System Design – includes details of the system components to facilitate its construction and test within the construction environment;   * Provides detailed design (could be represented as calculations, drawings, specifications, and data sheets) * Provides characteristics of inputs / outputs * Provides specification of storage needs * Establishes required naming conventions * Defines the characteristics of structures * Defines components and their purpose * Provides the engineering / procurement specifications   The applicable statuses are:verified and baselined. | System Implementation |
| *11.* | *Statement of Work* | It may Include:   * *Product Description* * *Scope* * *Objectives* * *Deliverables*   The applicable status is:reviewed | Customer |
| *12.* | *Test Cases and Test Procedures* | Test Case may include:   * Identifies the test case * Test items * Input specifications * Output specifications * Environmental needs * Special procedural requirements * Interface dependencies     Test Procedures may include:   * Identifies: test name, test description and test completion date * Identifies potential implementation issues * Identifies the person who completed the test procedure * Identifies prerequisites * Identifies procedure steps including the step number, the required action by the tester and the expected results     The applicable statuses are: verified and baselined. | System Implementation |
| *13.* | *Test Report* | Documents the tests, it may include:   * A summary of each defect * Identifies the related test case * Identifies the tester who found each defect * Identifies the severity for each defect * Identifies the affected function(s) for each defect * Identifies the date when each defect originated * Identifies the date when each defect was resolved * Identifies the person who resolved each defect   The applicable status is: baselined. | System Implementation |
| *14.* | *Traceability Record* | * Identification Number * Text of the need * Text of the Requirement * Stage of the life cycle * Verification Method * Title or ID of test Procedure * Verification date * Name of person that performed the verification * Result of verification | Project Management  System Implementation |
| *15.* | *Verification Results* | May include the record of:   * Participants * Date * Place * Duration * Verification check-list * Passed items of verification * Failed items of verification * Pending items of verification * Defects identified during verification | Project Management  System Implementation |

# 5. Templates

System Verification and Validation Plan (SVVP)

Adapted from IEEE 1012

*1. Purpose*

*2. Referenced documents*

*3. Definitions*

*4. V&V overview*

*4.1 Organization*

*4.2 Master schedule*

*4.3 System integrity level scheme*

*4.4 Resources summary*

*4.5 Responsibilities*

*4.6 Tools, techniques, and methods*

*5. V&V processes*

*5.1 Process: Management*

*5.1.1 Activity: Management of V&V*

*5.2 Process: Acquisition (Optional)*

*5.2.1 Activity: Acquisition support V&V*

*5.3 Process: Supply (Optional)*

*5.3.1 Activity: Planning V&V*

*5.4 Process: Development*

*5.4.1 Activity: Concept V&V*

*5.4.2 Activity: Requirements V&V*

*5.4.3 Activity: Design V&V*

*5.4.4 Activity: Implementation V&V*

*5.4.5 Activity: Test V&V*

*5.4.6 Activity: Installation and checkout V&V*

*5.5 Process: Operation*

*5.5.1 Activity: Operation V&V*

*5.6 Process: Maintenance*

*5.6.1 Activity: Maintenance V&V*

*6. V&V reporting requirements*

*6.1 Task reports*

*6.2 Activity summary reports*

*6.3 Anomaly reports*

*6.4 V&V final report*

*6.5 Special studies reports (optional)*

*6.6 Other reports (optional)*

*7. V&V Administrative requirements (Optional)*

*7.1 Anomaly resolution and reporting*

*7.2 Task iteration policy*

*7.3 Deviation policy*

*7.4 Control procedures*

*7.5 Standards, practices, and conventions*

*8. V&V test documentation requirements (Optional)*

# 6. Example

* **System Verification plan – Examples**

# 7. Checklist

Review, Inspections, Testing Checklists

* Information should be taken from Construx[[1]](#footnote-1)

[**http://www.construx.com/Page.aspx?nid=208**](http://www.construx.com/Page.aspx?nid=208)

# 8. Tools

Comparison of review types – from IEEE 1028

**

****

Verification Methods

* Inspection – An examination of the item against applicable documentation to confirm compliance with requirements. Inspection is used to verify properties best determined by examination and observation (e.g., paint color, weight, etc.).
* Analysis – Use of analytical data or simulations under defined conditions to show theoretical compliance. Analysis (including simulation) is used where verifying to realistic conditions cannot be achieved or is not cost‐effective and when such means establish that the appropriate requirement, specification, or derived requirement is met by the proposed solution.
* Demonstration – A qualitative exhibition of functional performance, usually accomplished with no or minimal instrumentation. Demonstration (a set of verification activities with system stimuli selected by the system developer) may be used to show that system or subsystem response to stimuli is suitable. Demonstration may also be appropriate when requirements or specifications are given in statistical terms (e.g., mean time to repair, average power consumption, etc.).
* Test – An action by which the operability, supportability, or performance capability of an item is verified when subjected to controlled conditions that are real or simulated. These verifications often use special test equipment or instrumentation to obtain very accurate quantitative data for analysis.

Traceability Tool

*Requirements traceability should:*

* *Ensure traceability for each level of decomposition performed on the project. In particular:*
  + *Ensure that every lower level requirement can be traced to a higher level requirement or original source*
  + *Ensure that every design, implementation, and test element can be traced to a requirement*
  + *Ensure that every requirement is represented in design and implementation*
  + *Ensure that every requirement is represented in testing/verification*
* *Ensure that traceability is used in conducting impact analysis of requirements changes on project plans, activities and work products*
* *Be maintained and updated as changes occur.*
* *Be consulted during the preparation of Impact Analysis for every proposed change to the project*
* *Be planned for, since maintaining the links/references is a labor intensive process that should be tracked/monitored and should be assigned to a project team member*
* *Be maintained as an electronic document*

**

|  |  |
| --- | --- |
| ***Instructions*** | |
| *The above table should be created in a spreadsheet or database such that it may be easily sorted by each column to achieve bi-directional traceability between columns. The unique identifiers (ID) should be assigned in a hierarchical outline form such that the lower level (i.e. more detailed) items can be traced to higher items.* | |
| *Identification Number* | *The Unique Requirement Identification (ID) where the requirement is referenced, and/or the unique identification for decomposed requirements.* |
| *Text of the need* | *The original text of the need from the customer* |
| *Text of the requirement* | *The text of the requirement* |
| *Verification Method* | *The verification method is identified (e.g. Test (T), Demonstration (D), Analysis (A), Simulation (S), Inspection (I)).* |
| *Title or ID of Use Case* | *The unique identifier of the Use Case or design component where a requirement is designed.* |
| *Title or ID of Code Module* | *The unique identifier of the system module where the design is realized or coded.* |
| *Verification Date* | *The date the requirement is verified (e.g. tested)* |
| *Name of person that performed the verification* | *The name of the person that performed the verification* |
| *Result of the verification* | *Result of verification (i.e. Success (S) or Failure (F))* |

# 9. References to Other Standards and Models

This section provides references of this deployment package to ISO/IEC 15288, ISO 9001 and to the Capability Maturity Model IntegrationSM for Development version 1.3 of the System Engineering Institute (CMMI-DEV®[[2]](#footnote-2)).

Notes:

* This section is provided for information purpose only.
* Only tasks covered by this Deployment Package are listed in each table.
* The tables use the following convention:
* Full Coverage = F
* Partial Coverage = P
* No Coverage = N

## ISO/IEC 15288 Coverage Matrix

|  |  |  |  |
| --- | --- | --- | --- |
| **Title of the Task and Step** | **Coverage**  **F/P** | **Clause of ISO/IEC 15288** | **Comments** |
| *<details>* | *<details>* | *<details>* |  |
|  |  |  |  |

## 

## CMMI for Development, Version 1.3 Coverage Matrix

|  |  |  |  |
| --- | --- | --- | --- |
| **Title of the Task and Step** | **Coverage**  **F/P/N** | **Objective/ Practice of CMMI** | **Comments** |
| *<details>* | *<details>* | *<details>* |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

## ISO 9001 Coverage Matrix

|  |  |  |  |
| --- | --- | --- | --- |
| **Title of the Task and Step** | **Coverage**  **F/P/N** | **Clause of ISO 9001** | **Comments** |
| *<details>* | *<details>* | *<details>* |  |
|  |  |  |  |
|  |  |  |  |

# 10. References

|  |  |
| --- | --- |
| **Key** | **Reference** |
| [ISO/IEC 15288] | ISO/IEC 15288:2008 Systems and software engineering - System life cycle processes. |
| [ISO/IEC 15289] | ISO/IEC 15289:2011 Systems and software engineering - Content of systems and software life cycle process information products (Documentation) |
| [ISO/IEC 24765] | ISO/IEC 24765:2011, Systems and Software Engineering Vocabulary.  An electronic version of the glossary is available at: <http://pascal.computer.org/sev_display/index.action> |
| [ISO/IEC 29110] | ISO/IEC TR 29110 5-11-2 Systems Engineering — Lifecycle Profiles for Very Small Entities (VSEs) — Part 5-11-2: Management and engineering guide – Generic profile group: Basic profile.  Once published by ISO, this document will be available at no cost on the following ISO site: <http://standards.iso.org/ittf/PubliclyAvailableStandards/index.html> |
| [INCOSE] | Systems Engineering Handbook - A Guide for System Life Cycle  Processes and Activities, INCOSE (International Council on  Systems Engineering), Version 3.2, 2010  <https://www.incose.org/ProductsPubs/products/sehandbook.aspx> |
| [PMBOK] | A Guide to the Project Management Body of Knowledge (PMBOK®  Guide) — Fourth Edition, Project Management Institute, <http://www.pmi.org/> |
| [ISO 9000] | ISO 9000:2005, Quality management systems — Fundamentals and vocabulary, International Organization for Standardization, 2005. |
|  |  |
|  |  |

# 11. Evaluation Form

|  |
| --- |
| **Deployment Package – Verification and Validation Version 0.2**  Your feedback will allow us to improve this deployment package, your comments and suggestions are welcomed. |
| **1. How satisfied are you with the CONTENT of this deployment package?**   *Very Satisfied*  *Satisfied*  *Neither Satisfied nor Dissatisfied*  *Dissatisfied*  *Very Dissatisfied* |
| **2. The sequence in which the topics are discussed, are logical and easy to follow?**   *Very Satisfied*  *Satisfied*  *Neither Satisfied nor Dissatisfied*  *Dissatisfied*  *Very Dissatisfied* |
| **3. How satisfied were you with the APPEARANCE/FORMAT of this deployment package?**   *Very Satisfied*  *Satisfied*  *Neither Satisfied nor Dissatisfied*  *Dissatisfied*  *Very Dissatisfied* |
| **4. Have any unnecessary topics been included? (please describe)** |
| **5. What missing topic would you like to see in this package? (please describe)**   * Proposed topic: * Rationale for new topic |
| **6. Any error in this deployment package?**   * + Please indicate:     - * Description of error :       * Location of error (section #, figure #, table #) : |
| **7. Other feedback or comments:** |
| **8. Would you recommend this Deployment package to a colleague from another VSE?**   *Definitely*  *Probably*  *Not Sure*  *Probably Not*  *Definitely Not* |

**Optional**

* Name:
* e-mail address : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Email this form to**: [joseph.marvin@incose.org](mailto:joseph.marvin@incose.org) or [claude.y.laporte@etsmtl.ca](mailto:claude.y.laporte@etsmtl.ca)

1. http://www.construx.com [↑](#footnote-ref-1)
2. SM CMM Integration is a service mark of Carnegie Mellon University.

   ® Capability Maturity Model, CMMI are registered in the U.S. Patent and Trademark Office by Carnegie Mellon University. [↑](#footnote-ref-2)