Introduction

The Requirements Management Database helps organizations achieve a CMMI Capability Level 2, Level 3, and above.

The purpose of this Quality Certification Guide is to map the capabilities of the Requirements Management Database to the goals of CMMI and to the equivalent ISO 9001:2000 standard. The Requirements Management Database specifically addresses the CMMI Engineering process areas of Requirements Development and Requirements Management.

About the Capability Maturity Model Integration (CMMI)

Capability Maturity Models (CMMs) contain essential elements of effective processes to manage the development and maintenance of products or services. The purpose of CMM Integration (CMMI) is to provide guidance for improving an organization’s processes.

There are six capability levels in CMMI, designated by the numbers 0 through 5:

0. Incomplete
1. Performed
2. Managed
3. Defined
4. Quantitatively Managed
5. Optimizing

The Engineering process areas of CMMI are as follows:

- Requirements Development
- Requirements Management
- Technical Solution
- Product Integration
- Verification
- Validation

The following table illustrates the Engineering process areas where the Requirements Management Database helps you achieve CMMI capability certification:

<table>
<thead>
<tr>
<th>CMMI Capability Level 2 and above</th>
<th>Requirements Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMMI Capability Level 3 and above</td>
<td>Requirements Development</td>
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</table>
**Engineering Process Areas of CMMI**

The Engineering process Areas of CMMI are illustrated in Figure 1 below.

![Diagram of Engineering Process Areas of CMMI](image)

**Requirements Management**

The Requirements Management process area *maintains the requirements*. It describes activities for obtaining and controlling requirement changes and ensuring that other relevant plans and data are kept current. It provides traceability of requirements from customer to product, to product component.

Requirements Management ensures that changes to requirements are reflected in project plans, activities, and work products. *This cycle of changes may impact all the other Engineering process areas; thus requirements management is a dynamic and often recursive sequence of events.* Establishment and maintenance of the Requirements Management process area is fundamental to a controlled and disciplined engineering design process.
Requirements Development

The Requirements Development process area identifies customer needs and translates these needs into product requirements. The set of product requirements is analyzed to produce a high-level conceptual solution. This set of requirements is then allocated to a set of product-component requirements. Other requirements that help define the product are derived and allocated to product components. This set of product and product-component requirements clearly describes the product's performance, design features, verification requirements, etc. in terms the developer understands and uses.

The Requirements Development process area supplies requirements to the Technical Solution process area, where the requirements are converted into the product architecture, product-component design, and the product component itself (e.g., coding, fabrication). Requirements are also supplied to the Product Integration process area, where product components are combined and interfaces are ensured to meet the interface requirements supplied by Requirements Development.

More Information

See the Appendix for more information about CMMI Capability Levels.
Capabilities Map of the Requirements Management Database

The following section maps the capabilities of the Requirements Management Database to the goals of CMMI and to the equivalent ISO 9001:2000 standard.

Legend

The Requirements Management Database provides general capabilities to help the organization achieve the goals defined within CMMI.

The Requirements Management Database provides specific capabilities to help the organization achieve the goals defined within CMMI.
Requirements Management

SG 1 Manage Requirements
The project maintains a current and approved set of requirements over the life of the project by doing the following:

- Managing all changes to the requirements
- Maintaining the relationships between the requirements, the project plans, and the work products
- Identifying inconsistencies between the requirements, the project plans, and the work products
- Taking corrective action

SP 1.1-1 Obtain an Understanding of Requirements
- ISO 9001:2000 Equivalent: 7.2.1, 7.2.2, 8.2.4

SP 1.2-2 Obtain Commitment to Requirements
- ISO 9001:2000 Equivalent: 7.2.3

SP 1.3-1 Manage Requirements Changes
- ISO 9001:2000 Equivalent: 7.2.2

SP 1.4-2 Maintain Bidirectional Traceability of Requirements
- ISO 9001:2000 Equivalent: 7.5.3

SP 1.5-1 Identify Inconsistencies between Project Work and Requirements
- ISO 9001:2000 Equivalent: 7.2.2

SP 1.1-1 Obtain an Understanding of Requirements
Develop an understanding with the requirements providers on the meaning of the requirements.

- Establish objective criteria for the acceptance of requirements
- Reach an understanding of the requirements with the requirements provider so the project participants can commit to them
**SP 1.2-2 Obtain Commitment to Requirements**
Obtain commitment to the requirements from the project participants.

- ✔ Requirements impact assessments
- ✔+ Documented commitments to requirements and requirements changes
- ✔ Assess the impact of requirements on existing commitments
- ✔+ Negotiate and record commitments

**SP 1.3-1 Manage Requirements Changes**
Manage changes to the requirements as they evolve during the project.

- ✔+ Requirements status
- ✔+ Requirements database
- ✔+ Capture all requirements and requirements changes that are given to or generated by the project
- ✔+ Maintain the requirements change history with the rationale for the changes
- ✔+ Evaluate the impact of requirement changes from the standpoint of relevant stakeholders
- ✔+ Make the requirements and change data available to the project
**SP 1.4-2 Maintain Bidirectional Traceability of Requirements**
Maintain bidirectional traceability among the requirements and the project plans and work products.

- ✔+ Maintain requirements traceability to ensure that the source of lower level (derived) requirements is documented.
- ✔+ Maintain requirements traceability from a requirement to its derived requirements as well as to its allocation of functions, objects, people, processes, and work products.
- ✔+ Maintain horizontal traceability from function to function and across interfaces.
- ✔+ Generate the requirements traceability matrix.

**SP 1.5-1 Identify Inconsistencies between Project Work and Requirements**
Identify inconsistencies between the project plans and work products and the requirements.

- ✔+ Documentation of inconsistencies including sources, conditions, and rationale.
- ✔ Review the project's plans, activities, and work products for consistency with the requirements and the changes made to them.
- ✔ Identify the source of the inconsistency and the rationale.
- ✔+ Identify changes that need to be made to the plans and work products resulting from changes to the requirements baseline.
- ✔+ Initiate corrective actions.
Requirements Development

- SG 1 Develop Customer Requirements
- SG 2 Develop Product Requirements
- SG 3 Analyze and Validate Requirements

SG 1 Develop Customer Requirements
Stakeholder needs, expectations, constraints, and interfaces are collected and translated into customer requirements.

The needs of stakeholders (e.g., customers, end users, suppliers, builders, and testers) are the basis for determining customer requirements. The stakeholder needs, expectations, constraints, interfaces, operational concepts, and product concepts are analyzed, harmonized, refined, and elaborated for translation into a set of customer requirements.

Frequently, stakeholder needs, expectations, constraints, and interfaces are poorly identified or conflicting. Since stakeholder needs, expectations, constraints, and limitations should be clearly identified and understood, an iterative process is used throughout the life of the project to accomplish this objective. To facilitate the required interaction, a surrogate for the end user or customer is frequently involved to represent their needs and help resolve conflicts. The customer relations or marketing part of the organization as well as members of the development team from disciplines such as human engineering or support can be used as surrogates. Environmental, legal, and other constraints should be considered when creating and resolving the set of customer requirements.

SP 1.1-1 Collect Stakeholder Needs
- ISO 9001:2000 Equivalent: 5.2, 7.2.1, 7.3.2, 8.4

SP 1.1-2 Elicit Needs
- ISO 9001:2000 Equivalent: 5.2, 7.2.1, 7.2.2, 7.3.2, 8.4

SP 1.3-1 Develop the Customer Requirements
- ISO 9001:2000 Equivalent: 5.2, 7.2.1, 7.3.2

SP 1.1-1 Collect Stakeholder Needs
Identify and collect stakeholder needs, expectations, constraints, and interfaces for all phases of the product life cycle.

The basic activity addresses the receipt of requirements that a customer provides to define what is needed or desired.
**SP 1.1-2 Elicit Needs**
Elicit stakeholder needs, expectations, constraints, and interfaces for all phases of the product life cycle.

- Engage relevant stakeholders using methods for eliciting needs, expectations, constraints, and external interfaces.

**SP 1.2-1 Develop the Customer Requirements**
Transform stakeholder needs, expectations, constraints, and interfaces into customer requirements.

- Translate the stakeholder needs, expectations, constraints, and interfaces into documented customer requirements
- Define constraints for verification and validation
SG 2 Develop Product Requirements
Customer requirements are refined and elaborated to develop product and product-component requirements.

Customer requirements are analyzed in conjunction with the development of the operational concept to derive more detailed and precise sets of requirements called “product and product-component requirements.” Product and product-component requirements address the needs associated with each product life-cycle phase. Derived requirements arise from constraints, consideration of issues implied but not explicitly stated in the customer requirements baseline, and factors introduced by the selected architecture, the design, and the developer’s unique business considerations. The requirements are reexamined with each successive, lower level set of requirements and functional architecture, and the preferred product concept is refined.

The requirements are allocated to product functions and product components including objects, people, and processes. The traceability of requirements to functions, objects, tests, issues, or other entities is documented. The allocated requirements and functions are the basis for the synthesis of the technical solution. As internal components are developed, additional interfaces are defined and interface requirements established.

SP 2.1-1 Establish Product and Product-Component Requirements
- ISO 9001:2000 Equivalent: 5.2, 7.2.1, 7.3.2, 8.4

SP 2.2-1 Allocate Product-Component Requirements
- ISO 9001:2000 Equivalent: 7.2.1

SP 2.3-1 Identify Interface Requirements
- ISO 9001:2000 Equivalent: 7.2.1
**SP 2.1-1 Establish Product and Product-Component Requirements**

Establish and maintain product and product-component requirements, which are based on the customer requirements.

- ✓ + Develop requirements in technical terms necessary for product and product-component design
- ✓ Derive requirements that result from design decisions
- ✓ + Establish and maintain relationships between requirements for consideration during change management and requirements allocation

**SP 2.2-1 Allocate Product-Component Requirements**

Allocate the requirements for each product component.

- ✓ + Allocate requirements to functions
- ✓ + Allocate requirements to product components
- ✓ Allocate design constraints to product components
- ✓ + Document relationships among allocated requirements

**SP 2.3-1 Identify Interface Requirements**

Identify interface requirements.

- ✓ Identify interfaces both external to the product and internal to the product (i.e., between functional partitions or objects)
- ✓ Develop the requirements for the identified interfaces
SG 3 Analyze and Validate Requirements
The requirements are analyzed and validated, and a definition of required functionality is developed.

Analyses are performed to determine what impact the intended operational environment will have on the ability to satisfy the stakeholders' needs, expectations, constraints, and interfaces. Considerations such as feasibility, mission needs, cost constraints, potential market size, and acquisition strategy must all be taken into account, depending on the product context. A definition of required functionality is also established. All specified usage modes for the product are considered, and a timeline analysis is generated for time-critical sequencing of functions.

The objectives of the analyses are to determine candidate requirements for product concepts that will satisfy stakeholder needs, expectations, and constraints; and then translate these concepts into requirements. In parallel with this activity, the parameters that will be used to evaluate the effectiveness of the product are determined based on customer input and the preliminary product concept.

Requirements are validated to increase the probability that the resulting product will perform as intended in the use environment.

- **SP 3.1-1 Establish Operational Concepts and Scenarios**
  - ISO 9001:2000 Equivalent: 7.2.1, 8.4

- **SP 3.2-1 Establish a Definition of Required Functionality**
  - ISO 9001:2000 Equivalent: 7.2.1, 7.3.2, 8.4

- **SP 3.3-1 Analyze Requirements**
  - ISO 9001:2000 Equivalent: 8.4, 7.3.2

- **SP 3.4-3 Analyze Requirements to Achieve Balance**
  - ISO 9001:2000 Equivalent: 8.4, 7.3.2

- **SP 3.5-1 Validate Requirements**
  - ISO 9001:2000 Equivalent: 7.2.2, 7.3.2

- **SP 3.5-2 Validate Requirements with Comprehensive Methods**
  - ISO 9001:2000 Equivalent: 7.2.2, 7.3.2
**SP 3.1-1 Establish Operational Concepts and Scenarios**
Establish and maintain operational concepts and associated scenarios.

- Develop operational concepts and scenarios that include functionality, performance, maintenance, support, and disposal as appropriate
- Define the environment the product will operate in, including boundaries and constraints
- Review operational concepts and scenarios to refine and discover requirements
- Develop a detailed operational concept, as products and product components are selected, that defines the interaction of the product, the end user, and the environment, and that satisfies the operational, maintenance, support, and disposal needs

**SP 3.2-1 Establish a Definition of Required Functionality**
Establish and maintain a definition of required functionality.

- Analyze and quantify functionality required by end users
- Analyze requirements to identify logical or functional partitions (e.g., sub-functions)
- Partition requirements into groups, based on established criteria (e.g., similar functionality, performance, or coupling), to facilitate and focus the requirements analysis
- Consider the sequencing of time-critical functions both initially and subsequently during product-component development
- Allocate customer requirements to functional partitions, objects, people, or support elements to support the synthesis of solutions
- Allocate functional and performance requirements to functions and sub-functions
**SP 3.3-1 Analyze Requirements**
Analyze requirements to ensure that they are necessary and sufficient.

- Analyze stakeholder needs, expectations, constraints, and external interfaces to remove conflicts and to organize into related subjects
- Analyze requirements to determine whether they satisfy the objectives of higher level requirements
- Analyze requirements to ensure that they are complete, feasible, realizable, and verifiable
- Identify key requirements that have a strong influence on cost, schedule, functionality, risk, or performance
- Identify technical performance measures that will be tracked during the development effort
- Analyze operational concepts and scenarios to refine the customer needs, constraints, and interfaces and to discover new requirements

**SP 3.4-3 Analyze Requirements to Achieve Balance**
Analyze requirements to balance stakeholder needs and constraints.

- Use proven models, simulations, and prototyping to analyze the balance of stakeholder needs and constraints
- Perform a risk assessment on the requirements and functional architecture
- Examine product life-cycle concepts for impacts of requirements on risks

**SP 3.5-1 Validate Requirements**
Validate requirements to ensure the resulting product will perform appropriately in its intended-use environment.

- Analyze the requirements to determine the risk that the resulting product will not perform appropriately in its intended-use environment
**SP 3.5-2 Validate Requirements with Comprehensive Methods**

Validate requirements to ensure the resulting product will perform as intended in the user's environment using multiple techniques as appropriate.

- Analyze the requirements to determine the risk that the resulting product will not perform appropriately in its intended-use environment.

- Explore the adequacy and completeness of requirements by developing product representations (e.g., prototypes, simulations, models, scenarios, and storyboards) and by obtaining feedback about them from relevant stakeholders.

- Assess the design as it matures in the context of the requirements validation environment to identify validation issues and expose unstated needs and customer requirements.
Appendix

CMMI Capability Level Descriptions
The following section describes in greater detail each of the CMMI Capability Levels.

Capability Level 0: Incomplete
An incomplete process is a process that is either not performed or partially performed. One or more of the specific goals of the process area are not satisfied.

Capability Level 1: Performed
A capability level 1 process is characterized as a “performed process.”

A performed process is a process that satisfies the specific goals of the process area. It supports and enables the work needed to produce identified output work products using identified input work products.

A critical distinction between an incomplete process and a performed process is that a performed process satisfies all of the specific goals of the process area.

Capability Level 2: Managed
A capability level 2 process is characterized as a “managed process.”

A managed process is a performed (capability level 1) process that is also planned and executed in accordance with policy, employs skilled people having adequate resources to produce controlled outputs, involves relevant stakeholders; is monitored, controlled, and reviewed; and is evaluated for adherence to its process description. The process may be instantiated by an individual project, group, or organizational function. Management of the process is concerned with the institutionalization of the process area and the achievement of other specific objectives established for the process, such as cost, schedule, and quality objectives.

Capability Level 3: Defined
A capability level 3 process is characterized as a “defined process.”

A defined process is a managed (capability level 2) process that is tailored from the organization's set of standard processes according to the organization’s tailoring guidelines, and contributes work products, measures, and other process-improvement information to the organizational process assets.
Capability Level 4: Quantitatively Managed
A capability level 4 process is characterized as a “quantitatively managed process.”

A quantitatively managed process is a defined (capability level 3) process that is controlled using statistical and other quantitative techniques. Quantitative objectives for quality and process performance are established and used as criteria in managing the process. The quality and process performance are understood in statistical terms and are managed throughout the life of the process.

Capability Level 5: Optimizing
A capability level 5 process is characterized as an “optimizing process.”

An optimizing process is a quantitatively managed (capability level 4) process that is changed and adapted to meet relevant current and projected business objectives. An optimizing process focuses on continually improving the process performance through both incremental and innovative technological improvements. Process improvements that would address root causes of process variation and measurably improve the organization’s processes are identified, evaluated, and deployed as appropriate. These improvements are selected based on a quantitative understanding of their expected contribution to achieving the organization’s process-improvement objectives versus the cost and impact to the organization. The process performance of the organization’s processes is continually improved.

A critical distinction between a quantitatively managed process and an optimizing process is that the optimizing process is continuously improved by addressing common causes of process variation.

About The Software Engineering Institute
The Software Engineering Institute developed CMMI. It is a federally funded research and development center sponsored by the U.S. Department of Defense.

About ISO 9001:2000 to CMMI v1.1 Mappings
Each ISO 9001 “shall” statement has been mapped to a CMMI practice, using only the most prominent correspondence. This is a many-to-many mapping, meaning that one ISO statement may correspond to more than one CMMI specific or generic practice, and vice versa.
More Information and Feedback

We are always tracking our own enhancement requests for the Requirements Management Database. If you’d like to request that we add a new feature then please email us at: feedback@reqdb.com.

If you’d like more information about any feature, or about any service that we can provide you, please email us at: info@reqdb.com.

Good luck!