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Note: This document has been updated to a new version. If you want to see the newer document, see *CMMISM for Systems Engineering/Software Engineering/Integrated Product and Process Development, Version 1.1, Continuous Representation (CMMI-SE/SW/IPPD, V1.1, Continuous)* (CMU/SEI-2002-TR-003, <http://www.sei.cmu.edu/publications/documents/02.reports/02tr003.html>).



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CMMISM for Systems Engineering/Software Engineering/Integrated Product and Process Development, Version 1.02

CMMISM-SE/SW/IPPD, V1.02

Continuous Representation

CMU/SEI-2000-TR-031

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CMMI Product Development Team

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38
39 **Joanne E. Spriggs**
40 **Contracting Office Representative**

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Preface

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The Capability Maturity Model®¹ Integration (CMMI^{SM2}) project has involved a large number of people from different organizations throughout the world. These organizations were using one or more CMMs® and were interested in the benefits of developing an integration framework to aid in enterprise-wide process improvement and integration activities. [FM101.T101]

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The CMMI project work is sponsored by the U.S. Department of Defense (DoD), specifically the Office of the Under Secretary of Defense, Acquisition, Technology, and Logistics (OUSD/AT&L). Industry sponsorship is provided by the Systems Engineering Committee of the National Defense Industrial Association (NDIA). [FM101.T102]

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Organizations from industry, government, and the Software Engineering Institute (SEI) joined together to develop the CMMI Framework, the CMMI model, and supporting products. These organizations donated the time of one or more of their people to participate in the CMMI project. [FM101.T103]

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Model Development History

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As CMMI project team, we have been working to provide systems engineering and software engineering guidance that encourages process improvement in organizations of any structure. [FM101.HDA101.T101]

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Since 1991, CMMs have been developed for a myriad of disciplines. Some of the most notable include models for systems engineering, software engineering, software acquisition, workforce practices, and integrated product and process development. [FM101.HDA101.T102]

¹ ® CMM, Capability Maturity Model, and Capability Maturity Modeling are registered in the U.S. Patent and Trademark Office.

² SM CMMI is a service mark of Carnegie Mellon University.

99 Although these models have proven useful to many organizations, the
100 use of multiple models has been problematic. Many organizations
101 would like to focus their improvement efforts across the disciplines
102 within their organizations. However, the differences among these
103 discipline-specific models, including their architecture, content, and
104 approach, has limited these organizations' ability to focus their
105 improvement successfully. Further, applying multiple models that are
106 not integrated within and across an organization becomes more costly
107 in terms of training, assessments, and improvement activities. A model
108 that successfully integrates disciplines and has integrated training and
109 assessment support would address these problems. [FM101.HDA101.T103]

110 The CMM Integration^{SM3} project was formed to sort out the problem of
111 using multiple CMMs. Our project's mission was to combine three
112 source models—(1) Capability Maturity Model for Software (SW-
113 CMM®) v2.0 draft C, (2) Electronic Industries Alliance/Interim Standard
114 (EIA/IS) 731, and (3) Integrated Product Development Capability
115 Maturity Model (IPD-CMM) v0.98—into a single model for use by
116 organizations pursuing enterprise-wide process improvement.
117 [FM101.HDA101.T106]

118 Developing this model has involved more than simply adding existing
119 model materials together. Using processes that promote consensus, we
120 have built a framework that accommodates multiple disciplines and is
121 flexible enough to support two different representations (staged and
122 continuous). [FM101.HDA101.T107]

123 Using information from popular and well-regarded models as source
124 material, we created a cohesive integrated model that can be adopted
125 by those currently using other CMMs as well as by those new to the
126 CMMI concept. [FM101.HDA101.T108]

127 Our mission included the development of a common framework for
128 supporting the future integration of other discipline-specific CMMI
129 models. Furthermore, our mission contained the objective of ensuring
130 all of the products developed are consistent and compatible with the
131 International Organization for Standardization/International
132 Electrotechnical Commission (ISO/IEC) 15504 technical report for
133 software process assessment. [FM101.HDA101.T109]

^{3 SM} CMMI Integration is a service mark of Carnegie Mellon University.

134 Acknowledgments

135 Many talented people were involved as part of our development team
136 for the CMMI Product Suite⁴. Three primary groups involved in this
137 development have been the steering group, product development team,
138 and stakeholder/reviewers. [FM101.HDA102.T101]

139 The steering group guides and approves the plans of the product
140 development team, provides consultation on significant CMMI project
141 issues, and ensures involvement from a variety of interested
142 communities. [FM101.HDA102.T102]

143 The product development team writes, reviews, revises, discusses, and
144 agrees on the structure and technical content of the CMMI Product
145 Suite¹ including the framework, model, training, and assessment
146 materials. Development activities were based on an A-Specification
147 provided by the steering group, the three source models, and
148 comments from stakeholder and steering group members. [FM101.HDA102.T104]

149 The stakeholder/reviewer group of organizations provided valuable
150 insight in the early effort that was used to combine the models. Their
151 review of both the pre-release version (v0.1) and the piloted version 0.2
152 gave the product development team valuable organizational
153 perspectives. [FM101.HDA102.T105]

154 Version 0.2 was publicly reviewed and used in initial pilot activities.
155 Following release of that version, improvement has been guided by
156 change requests from the public review, piloting organizations, and
157 various focus group sessions. The product development team, led by
158 the CMMI Editor team, evaluated over 3,000 change requests to create
159 this version. But as with any release, the opportunity for further
160 improvement remains. We have begun planning for version 1.1 to
161 accommodate further improvements from early use of this model.

162 [FM101.HDA102.T106]

163 The CMMI product development team has had the benefit of two
164 distinguished leaders during the last 2-1/2 years. Project manager, Jack
165 Ferguson, led the CMMI development team from the project's inception
166 through to the release of CMMI-SE/SW V0.2. Project manager, Mike
167 Phillips, led the team from the release of CMMI-SE/SW V0.2 to the
168 present. [FM101.HDA102.T107]

⁴ The CMMI Product Suite is the set of products produced from the CMMI Framework, which includes the framework itself, models, assessment materials, and training materials.

169 Members of the CMMI Editor team played a critical role in releasing this
170 model. In fact, this team was primarily responsible for guiding revision
171 of the model from V0.2 to V1.0. The Editor team served as the core
172 model development team, configuration control board, and decision-
173 making body for the model revision. Members contributed many hours
174 of intensive work that resulted in Version 1.0. [FM101.HDA102.T108]

175 In particular, we wish to recognize the following Editor team members:
176 [FM101.HDA102.T109]

- 177 • Dennis Ahern (Editor team co-leader)
- 178 • Jim Armstrong
- 179 • Roger Bate (chief architect)
- 180 • Aaron Clouse
- 181 • Mary Beth Chrissis
- 182 • Rick Hefner
- 183 • Craig Hollenbach
- 184 • Dave Kitson
- 185 • Mike Konrad (Editor team co-leader)
- 186 • John Kordik
- 187 • Chris Kormos
- 188 • Mike Phillips
- 189 • Karen Richter
- 190 • Sandy Shrum

191 The database architect and configuration manager, Mark Cavanaugh,
192 also played a key role in producing the model and preparing the team
193 for future model releases. Carolyn Tady, the team's administrative
194 coordinator, provided accurate and efficient support in entering
195 information into the database. [FM101.HDA102.T110]

196 Both present and emeritus members of the three groups involved in
197 developing CMMI products are listed in Appendix E. [FM101.HDA102.T111]

198 Where to Look for Additional Information

199 You can find additional information, such as the intended audience,
200 background, history of the CMMI models, and the benefits of using the
201 CMMI models, in various additional sources. Many of these sources we
202 have documented on the CMMI Web site, which is located at
203 <http://www.sei.cmu.edu/cmml/> [FM101.HDA103.T101]

204 Feedback Information

205 We are very interested in your ideas for improving these products. You
206 can help these products continually improve. [FM101.HDA104.T101]

207 See the CMMI Web site for information on how to provide feedback:
208 <http://www.sei.cmu.edu/cmmi/> [FM101.HDA104.T102]

209 If you have questions, send an email to cmmi-comments@sei.cmu.edu.
210 [FM101.HDA104.T103]

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1 Introduction

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A model is a simplified representation of the world. Capability Maturity Models (CMMs) contain the essential elements of effective processes for one or more disciplines. These elements are based on the concepts developed by Crosby, Deming, Juran, and Humphrey [Crosby 79, Juran 88, Deming 86, Humphrey 89]. [FM108.T101]

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Like other CMMs, Capability Maturity Model-Integrated (CMMI) models provide guidance to use when developing processes. CMMI models are not processes or process descriptions. The actual processes used in an organization depend on many factors, including application domain(s) and organization structure and size. In particular, the process areas of a CMMI model may not map one-to-one with the processes used in your organization. [FM108.T102]

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Selecting a CMMI Model

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There are multiple CMMI models available, as generated from the CMMI Framework. Consequently, you need to be prepared to decide which CMMI model best fits your organization's process improvement needs. [FM108.HDA101.T101]

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You must select a representation, either continuous or staged, and you must determine which disciplines you want to include in the model your organization will use. [FM108.HDA101.T102]

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Representations: Continuous or Staged?

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There are many valid reasons to select one representation or the other. Perhaps your organization will choose to use the representation it is most familiar with. The following lists describe some of the possible advantages and disadvantages to selecting each of the two representations. [FM108.HDA101.HDB101.T101]

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Continuous Representation

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If you choose the continuous representation for your organization, expect that the model will do the following: [FM108.HDA101.HDB102.T101]

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- Allow you to select the order of improvement that best meets the organization's business objectives and mitigates the organization's areas of risk
- Enable comparisons across and among organizations on a process area by process area basis or by comparing maturity levels through the use of equivalent staging
- Provide an easy migration from EIA/IS 731 to CMMI
- Afford an easy comparison of process improvement to ISO/IEC 15504 because the organization of process areas is derived from ISO/IEC 15504

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Staged Representation

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If you choose the staged representation for your organization, expect that the model will do the following: [FM108.HDA101.HDB103.T101]

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- Provide a proven sequence of improvements, beginning with basic management practices and progressing through a predefined and proven path of successive levels, each serving as a foundation for the next
- Permit comparisons across and among organizations by using maturity levels
- Provide an easy migration from the SW-CMM to CMMI
- Allow comparison to ISO/IEC 15504, but the organization of process areas does not correspond to the organization used in ISO/IEC 15504

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Whether used for process improvement or assessments, both representations are designed to offer essentially equivalent results.

[FM108.HDA101.HDB103.T102]

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Disciplines and Environments: Which to Choose?

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Currently there are two disciplines and one development environment included in the CMMI model: systems engineering and software engineering disciplines and the integrated product and process development environment. Distinctions between the systems engineering and software engineering material is limited to amplifications that are more appropriate to one discipline than the other. Consequently, we recommend that you select both systems and software engineering when selecting a CMMI model, even if you are interested in only one of these disciplines, because the only distinction between the two is at the level of amplifications to practices within otherwise identical process areas. [FM108.HDA101.HDB104.T102]

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The differences between the IPPD material and the systems engineering/software engineering material can be summarized as follows: [FM108.HDA101.HDB104.T103]

- 500 • Two additional process areas
- 501 • A number of amplifications throughout the process areas
- 502 • A revised Integrated Project Management (IPPD) process area
- 503 • A new definition in the glossary
- 504 • Two new entries in the acronym list
- 505 • A revised equivalent staging graphic (in the continuous
- 506 representation)
- 507 • Some new and revised material in the Overview section of the
- 508 model

509 **Systems Engineering**

510 The systems engineering discipline covers the development of total
511 systems, which may or may not include software. Systems engineers
512 focus on transforming customer needs, expectations, and constraints
513 into product solutions and supporting those product solutions
514 throughout the product life cycle. [FM108.HDA101.HDB105.T101]

515 **Software Engineering**

516 The software engineering discipline covers the development of software
517 systems. Software engineers focus on applying systematic, disciplined,
518 and quantifiable approaches to the development, operation, and
519 maintenance of software. [FM108.HDA101.HDB106.T101]

520 **Integrated Product and Process Development**

521 Integrated Product and Process Development (IPPD) is a systematic
522 approach to product development that achieves a timely collaboration of
523 relevant stakeholders throughout the product life cycle to better satisfy
524 customer needs. The CMMI-SE/SW/IPPD model captures the
525 underlying best practices exhibited by a good IPPD approach. These
526 practices may be used in developing, improving, or appraising the
527 implementation of IPPD. [FM108.HDA101.HDB107.T101]

528 IPPD is not a separate discipline, but an approach and an environment
529 in which a project or organization performs the CMMI-SE/SW/IPPD
530 processes. The IPPD processes are integrated with the processes in
531 the CMMI-SE/SW model. The IPPD process areas, specific goals, and
532 specific practices alone cannot achieve IPPD. If a project or
533 organization chooses IPPD, it performs the IPPD practices concurrently
534 with the systems engineering and/or software engineering practices.
535 That is, if an organization or project wishes to use the IPPD
536 environment, it chooses the CMMI-SE/SW/IPPD model.⁵
537 [FM108.HDA101.HDB107.T102]

538 About CMMI Models

539 A process is a leverage point for an organization's sustained
540 improvement. The purpose of CMM Integration is to provide guidance
541 for improving your organization's processes and your ability to manage
542 the development, acquisition, and maintenance of products or services.
543 CMM Integration places proven practices into a structure that helps
544 your organization assess its organizational maturity or process area
545 capability, establish priorities for improvement, and implement these
546 improvements. [FM108.HDA102.T101]

547 Your organization can use a CMMI model to help set process
548 improvement objectives and priorities, improve processes, and provide
549 guidance for ensuring stable, capable, and mature processes. CMM
550 Integration can serve as a guide for organizational self-improvement.
551 [FM108.HDA102.T102]

552 The CMMI Product Suite contains and is produced from a framework
553 that provides the ability to generate multiple models and associated
554 training and assessment materials. These models may represent
555 software and systems engineering, integrated product and process
556 development, newly identified disciplines, or combinations of
557 disciplines. [FM108.HDA102.T103]

558 Professional judgment should be used by your organization to interpret
559 CMMI practices. Although process areas depict behavior that should be
560 exhibited in any organization, practices must be interpreted using an in-
561 depth knowledge of the CMMI model, the organization, the business
562 environment, and the specific circumstances involved. [FM108.HDA102.T104]

⁵ Additional information on IPPD background, benefits, and implementation guidance can be found in published Technical Notes at <http://www.sei.cmu.edu/cmmi/>.

563 The Content of CMMI Models

564 CMMI models with a continuousstaged representation consist of seven
565 chapters and six appendices: [FM108.HDA103.T102]

- 566 • Chapter 1: The Introduction chapter (this chapter) offers a broad
567 view of the model, suggestions on where to look for other
568 information not included in this volume, and the typographical
569 conventions used throughout the model.
- 570 • Chapter 2: The Structure of the Model chapter describes the
571 components of the model, including capability levels, goals, and
572 practices.
- 573 • Chapter 3: The Model Terminology chapter describes the
574 approach taken to using terms in the model as well as how terms
575 were selected and defined in the glossary.
- 576 • Chapter 4: The Capability Levels and Generic Model Components
577 chapter describes the capability levels, generic goals and
578 practices, which ensure that the implementation of process areas is
579 effective, repeatable, and lasting.
- 580 • Chapter 5: The Understanding the Model chapter provides insight
581 into the meaning of the model for your organization.
- 582 • Chapter 6: The Using the Model chapter explains the ways in
583 which your organization can use the model.
- 584 • Chapter 7: The Process Areas chapter contains descriptions of the
585 required, expected, and informative components of the model,
586 including goals, practices, subpractices, and typical work products.

587 The Appendices are as follows: [FM108.HDA103.T103]

- 588 • Appendix A: The References appendix contains information you
589 can use to locate the documented sources, such as reports,
590 process improvement models, industry standards, and books, that
591 were used to create the content of the CMMI Product Suite.
- 592 • Appendix B: The Acronym List appendix defines acronyms used in
593 the CMMI models.
- 594 • Appendix C: The Glossary appendix defines terms used in the
595 CMMI Product Suite that are not adequately defined in the context
596 of this model by the Webster's American English dictionary.
- 597 • Appendix D: The Required and Expected Model Components
598 appendix contains the required and expected components for each
599 of the process areas. No informative material is given other than
600 the process area purpose, titles, and component names. This view
601 of the model is convenient when you want to quickly understand
602 the content and flow of large portions of the model or are intimately
603 familiar with it.

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- Appendix E: The CMMI Project Participants appendix contains a list of participants on the CMMI Steering Group, Product Development Team, and Stakeholder/Reviewer Team.
- Appendix F: The Equivalent Staging appendix contains a description of how assessments using a continuous model can be translated into maturity level ratings.

610 About the Model You Selected

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All CMMI models contain common elements that you can use to improve processes. This model is designed specifically for organizations interested in improving processes in both systems engineering and software engineering disciplines in an integrated product and process development environment. This model is also a continuous representation. [FM108.HDA104.T102]

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The CMMI model for systems engineering/software engineering/integrated product and process development (CMMI-SE/SW/IPPD) consists of the same process areas, regardless of representation (continuous or staged). Each process area contains goals, practices, typical work products, and other informative components. (See Structure of the Model for more information about the model components within each process area.) [FM108.HDA104.T104]

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In the Understanding the Model chapter you will find descriptions of all process area categories and the process areas that belong to them. This chapter provides a high-level view of the model that is designed to help you understand the interactions that occur between and among process areas. [FM108.HDA104.T105]

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Since you have chosen IPPD, you will find that descriptions of the IPPD components, how they interact with other process areas, and how they fit into the process area categories will also be included in the discussion. [FM108.HDA104.T106]

633 Typographical Conventions

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We designed the CMMI model format with typographical conventions that optimize its readability and usability. We present model components in formats that allow you to quickly find them on the page. The following sections provide some tips for locating various model components in CMMI models. [FM108.HDA105.T101]

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Refer to the Structure of the Model chapter to see definitions of the model components mentioned. [FM108.HDA105.T101.R101]

641 **Specific and Generic Goals**

642 All goal names and statements within the process areas appear in bold
643 with the goal number (for example, SG 1 for specific goal 1 or GG 1 for
644 generic goal 1) appearing on the left side of the page. The goal name is
645 not used for assessments or rated in any way. Only the goal statement
646 is designed to be used for process improvement and assessment
647 purposes. Here is an example: [FM108.HDA105.HDB101.T101]

648 **SG 1. Establish Estimates**

649 ***Estimates of project planning parameters are established and maintained.***
650 [FM108.HDA105.HDB101.T102]

651 **Specific and Generic Practices**

652 All specific practice names within the process areas appear in bold and
653 the practice statements appear in bold italics within a gray box
654 indicating that it is the statement that you use for process improvement
655 and assessments, not the name. The name is only used for easy
656 reference. Here is an example: [FM108.HDA105.HDB102.T101]

657 **SP 2.1 Select Suppliers**

658 ***Select suppliers based on an evaluation of their ability to meet the***
659 ***specified requirements.*** [FM108.HDA105.HDB102.T102]

660 **References**

661 All references to components are identifiable in the model, because
662 they always appear in italics. Here is an example: [FM108.HDA105.HDB103.T101]

663 *Refer to the Decision Analysis and Resolution process area for more*
664 *information about formal decision making.* [FM108.HDA105.HDB103.T101.R101]

665 **Introductory Notes, Typical Work Products, and Subpractices**

666 These headings indicate the location of introductory notes, typical work
667 products, and subpractices within a process area. [FM108.HDA105.HDB104.T101]

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Generic Practice Elaborations

At the end of every process area, the generic practice names and statements (in bold and bold italics respectively) appear for the generic practices that apply to the process area. After each generic practice statement, an elaboration may appear in plain text with the heading “Elaboration.” The elaboration provides information about how the generic practice should be interpreted for the process area. If there is no elaboration present, it is because we judged the application of the generic practice to be obvious without it. [FM108.HDA105.HDB105.T102]

Discipline Amplifications

Model components that provide guidance for interpreting model information for specific disciplines (for example, systems engineering or software engineering) are called “discipline amplifications.” These are easy to locate because they appear near the right side of the page and have a title indicating the discipline that they address (for example, “For Software Engineering”). [FM108.HDA105.HDB106.T101]

Numbering Scheme

In the continuous representation, we numbered specific and generic goals so that they correspond to the specific goals in the continuous representation. Each specific goal has a number beginning with SG, for example, SG1. Each generic goal has a number beginning with GG, for example, GG1. [FM108.HDA105.HDB107.T102]

Specific and generic practices are numbered so that you can identify to which goal the practice is mapped, its sequence number, and its capability level. Each specific practice has a number beginning with SP, for example, SP1.1-1. Each generic practice has a number beginning with GP, for example, GP1.1. [FM108.HDA105.HDB107.T104]

A typical example of specific practice numbering is in the Project Planning process area. The first specific practice is numbered SP1.1-1 and the second is SP1.2-2. Sometimes, however, the numbering varies because one specific practice builds on another. In these cases, the sequence number is the same for both practices, that is, SP1.1-1 and SP1.1-3. Specific practices with a capability level of 1 are called “base practices” and those with capability levels greater than 1 are referred to as “advanced practices.” (In the staged representation, only the 1.1 exists.) [FM108.HDA105.HDB107.T105]

The numbering scheme used in each representation enables you to easily find the practice in the continuous representation that corresponds to the practice in the staged representation.

[FM108.HDA105.HDB107.T111]

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Advanced practices may or may not have associated base practices:

[FM108.HDA105.HDB107.T112]

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- When base practices are not present, the advanced practice is automatically included in the staged representation.
- When base practices are present, the advanced practice is included in the staged representation, but the base practice is not. Further, informative material is added after the practice that identifies both the base and advanced practices as they appear in the continuous representation.

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Remember, in the staged representation, the specific practice numbers do not indicate a capability level. [FM108.HDA105.HDB107.T113]

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Refer to the Structure of the Model chapter for a description of advanced practices and base practices. [FM108.HDA105.HDB107.T113.R101]

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Database Codes

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At the end of lines and paragraphs throughout the Process Area section of the model, you will find a short sequence of numbers and letters in very small type set off in brackets that look like this: [PA150.EL112]. These are codes for the database, and you can just ignore them.

[FM108.HDA105.HDB108.T101]

2 Structure of the Model

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Of the two representations of the CMMI model, you have chosen the continuous representation. The components of both representations are process areas, specific goals, specific practices, generic goals, generic practices, typical work products, subpractices, notes, discipline amplifications, generic practice elaborations, and references. [FM103.T101]

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The continuous representation uses six capability levels, capability profiles, target staging, and equivalent staging as organizing principles for the model components. The continuous representation groups process areas by affinity categories and designates capability levels for process improvement within each process area. Capability profiles (described later in this chapter) illustrate process improvement paths in terms of staging of process areas. Equivalent staging is used to relate the process areas' capability levels to the staged representation's maturity levels. [FM103.T103]

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In this chapter, we describe each component of the model you have chosen, the relationships between the components, and the relationships between the two representations. Many of the components described here are also components of CMMI models with a continuous representation. [FM103.T105]

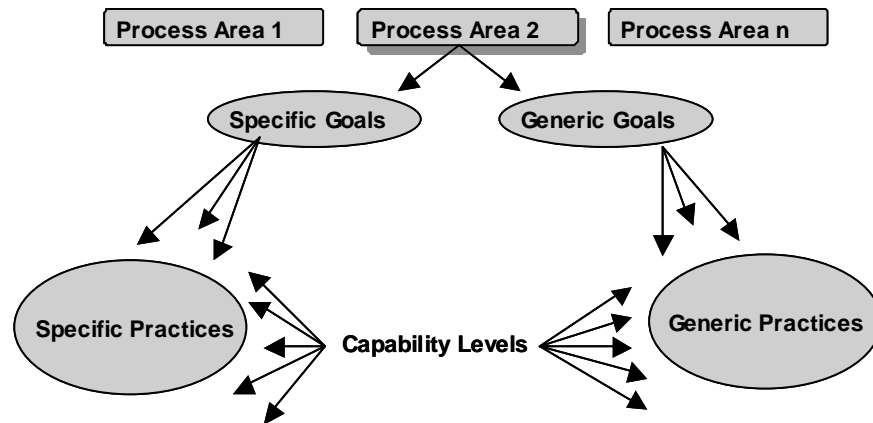
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Structural Overview

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The continuous representation of each CMMI model consists of the major components is illustrated in Figure 1. [FM103.HDA101.T101]



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Figure 1: CMMI Model Components [FM103.HDA101.T103]

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CMMI models are designed to describe discrete levels of process improvement. In the continuous representation, capability levels provide a recommended order for approaching process improvement within each process area. At the same time, the continuous representation allows some flexibility for the order in which the process areas are addressed. [FM103.HDA101.T105]

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The process dimension of this model focuses on best practices your organization can use to improve processes in particular process areas. Before you begin using a CMMI model for improving processes, you must understand the importance of mapping your processes to CMMI process areas. This mapping activity enables you to control process improvement in your organization by helping you track your organization's level of conformance to the CMMI model. [FM103.HDA101.T107]

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All continuous representations of CMMI models reflect capability levels in their design and content. A capability level consists of related specific and generic practices for a process area that, when performed, increase the capability of the organization in that process area and enhance the organization's overall process capability. [FM103.HDA101.T108]

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Capability levels of the continuous representation focus on maturing the organization's ability to perform, control, and improve its performance in a process area. These levels enable you to track, evaluate, and demonstrate your organization's progress as you improve processes associated with process areas. [FM103.HDA101.T109]

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There are six capability levels, designated by the numbers 0 through 5:
[FM103.HDA101.T110]

- 777 0.) Incomplete
778 1.) Performed
779 2.) Managed
780 3.) Defined
781 4.) Quantitatively Managed
782 5.) Optimizing [FM103.HDA101.T111]

783 Capability levels are determined by reviewing the organization's
784 implementation of the specific and generic practices and its
785 achievement of the associated goals through that capability level. For
786 example, to achieve capability level 2 for a process area, the
787 organization's activities are reviewed against the specific and generic
788 practices and goals through capability level 2. The specific and generic
789 goals through capability level 2 must be satisfied. [FM103.HDA101.T112]

790 Capability levels are determined by reviewing the organization's
791 implementation of the specific and generic practices and its
792 achievement of the associated goals through that capability level. For
793 example, to achieve capability level 2 for a process area, the
794 organization's activities are reviewed against the specific and generic
795 practices and goals through capability level 2. The specific and generic
796 goals through capability level 2 must be satisfied. [FM103.HDA101.HDB101.T106]

797 As you achieve the generic and specific goals for a process area at a
798 particular capability level, you are increasing your process capability
799 and reaping the benefits of process improvement. [FM103.HDA101.HDB101.T108]

800 The generic goals and practices define a sequence of capability levels,
801 which represent improvements in the implementation and effectiveness
802 of the processes. The characteristics of these capability levels are
803 described in the Capability Levels and Generic Model Components
804 chapter. [FM103.HDA101.HDB101.T109]

805 Specific goals and specific practices apply to individual process areas.
806 Generic goals and generic practices apply to multiple process areas.
807 Only the statement and title of each generic goal and practice appears
808 in each process area; their informative components are found only in
809 chapter four of the model, "Capability Levels and Generic Model
810 Components." [FM103.HDA101.HDB101.T110]

811 **Required, Expected, and Informative Components**

812 All components of a CMMI model are grouped into three categories:
813 [FM103.HDA101.HDB103.T101]

- 814 • Required: Specific goals and generic goals are required model
815 components that are to be achieved by an organization's planned
816 and implemented processes. Required components are considered
817 essential to achieving process improvement in a given process
818 area. They are used in assessments to determine process area

819 satisfaction and organizational process maturity. Only the
820 statement of the specific or generic goal is a required model
821 component. The title of a specific or generic goal and any notes
822 associated with the goal are considered informative model
823 components.

824 • Expected: Specific practices and generic practices are expected
825 model components. Expected components describe what practices
826 an organization that is achieving a set of specific and generic goals
827 will typically implement. They are meant to guide individuals and
828 groups implementing improvements or performing assessments.
829 Either the practices as described, or acceptable alternatives to
830 them must be present in the planned and implemented processes
831 of the organization, before goals can be considered satisfied. Only
832 the statement of the specific or generic practice is an expected
833 model component. The title of a specific or generic practice and
834 any notes associated with the practice are considered informative
835 model components.

836 • Informative: Subpractices, typical work products, discipline
837 amplifications, generic practice elaborations, goal and practice
838 titles, goal and practice notes, and references are informative
839 model components that help model users understand the goals
840 and practices and how they can be achieved. Informative
841 components provide details that help model users get started in
842 thinking about how to approach practices and goals.

843 When you use a CMMI model as a guide, you plan and implement
844 processes that conform to the required and expected components of
845 process areas. Conformance with a process area means that in the
846 planned and implemented processes there is an associated process (or
847 processes) that carries out either the specific and generic practices of
848 the process area, or alternatives that clearly and unequivocally
849 accomplish a result that meets the goal associated with that specific or
850 generic practice.⁶ [FM103.HDA101.HDB103.T102]

851 Model Components

852 The continuous representation of each CMMI model consists of the
853 major components illustrated in Figure 1. The following are further
854 explanations of the CMMI model components. [FM103.HDA102.T101]

⁶ For additional information about alternative practices, see the Model Terminology section.

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Process Areas

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A process area is a group of related practices that are performed collectively to achieve a set of objectives, including what it does (specific practices) and the anticipated behavior (specific goals). All CMMI process areas are common to both continuous and staged representations. [FM103.HDA102.HDB101.T101]

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Capability Levels

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Capability levels focus on maturing the organization's ability to perform, control, and improve its performance in a process area. These levels enable you to track, evaluate, and demonstrate your organization's progress as you improve processes associated with a process area. There are six (0 through 5) capability levels. These capability levels build on each other, providing a recommended order for approaching process improvement. [FM103.HDA102.HDB102.T101]

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Generic Goals

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Each capability level has only one generic goal that prescribes what the organization must achieve at that capability level. Achievement of each of these goals relative to a process area signifies improved control in performing the process area. Generic goals and generic practices appear in chapter 4. [FM103.HDA102.HDB105.T102]

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Generic Practices

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Generic practices are practices that apply to any process area because they can improve the performance and control of any process. Generic practices are categorized by capability level and are expected components in the model. In the continuous representation, each generic practice maps to one generic goal. [FM103.HDA102.HDB107.T103]

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Refer to chapter four for a detailed description of the generic practices. (Only the generic practice title, statement, and elaborations appear in the process areas.) [FM103.HDA102.HDB107.T103.R101]

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Generic practices may depend on certain process areas in two different ways: [FM103.HDA102.HDB107.T104]

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- Some generic practices rely on the support of a process area. An example is the generic practice “place designated work products of the process under appropriate levels of configuration management” This generic practice is supported by the Configuration Management process area. This means that to implement this generic practice for another process area, you might choose to implement the Configuration Management process area, all or in part, to make it happen.

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- Other generic practices cannot be executed without an output from a process area. An example is the generic practice “establish and maintain the description of a defined process” This generic practice requires the process assets created by the Organizational Process Definition process area. This means that to make full use of this generic practice for another process area, you should first use the Organizational Process Definition process area, all or in part, to secure the output needed to achieve the generic practice.

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Capability Level Details

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All continuous representations of CMMI models reflect capability levels in their design and content. A capability level consists of related specific and generic practices for a process area that achieve a set of goals that increase the capability of the organization in that area of concentration.

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[FM103.HDA102.HDB108.T101]

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The generic practices and certain process areas upon which they depend create a sequence of capability levels, which stimulate certain improvements in the implementation and effectiveness of the processes. The characteristics of these levels are described below. Each of the processes described may include the development and maintenance of work products and processes and the delivery of services.

[FM103.HDA102.HDB108.T102]

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Capability Level 0: Incomplete [FM103.HDA102.HDB108.T103]

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- A process that is considered incomplete does not implement all of the capability level 1 specific and generic practices.

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Capability Level 1: Performed [FM103.HDA102.HDB108.T104]

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- A performed process is a process that is expected to perform all of the capability level 1 specific and generic practices. Performance may not be stable and may not meet specific objectives such as quality, cost, and schedule, but useful work can be done.

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Capability Level 2: Managed [FM103.HDA102.HDB108.T105]

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- A capability level 2 process is a managed process. A managed process is planned, performed, monitored, and controlled for individual projects, groups, or stand alone processes to achieve a given purpose. Managing the process achieves both the model objectives for the process as well as other objectives, such as cost, schedule, and quality.

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Capability Level 3: Defined [FM103.HDA102.HDB108.T106]

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- A capability level 3 process is a defined process. A defined process is a managed process that is tailored from the organization’s set of standard processes. Deviations beyond those allowed by the

934 tailoring guidelines are documented, justified, reviewed, and
935 approved.

936 **Capability Level 4: Quantitatively Managed** [FM103.HDA102.HDB108.T107]

- 937 • A capability level 4 process is a quantitatively managed process. A
938 quantitatively managed process is a defined process that is
939 controlled using statistical and other quantitative techniques.
940 Product quality, service quality, process performance, and other
941 business objectives are understood in statistical terms and are
942 controlled throughout the life cycle.

943 **Capability Level 5: Optimizing** [FM103.HDA102.HDB108.T108]

- 944 • A capability level 5 process is an optimizing process. An optimizing
945 process is a quantitatively managed process that is improved
946 based on an understanding of the common causes of process
947 variation⁷ inherent in the process. An optimizing process focuses
948 on continually improving process performance through both
949 incremental and innovative improvements. Both the defined
950 processes and the organization's set of standard processes are
951 targets of the improvement activities.

952 **Capability Level Profiles** [FM103.HDA102.HDB108.T110]

- 953 • A capability level profile is a list of process areas and their
954 corresponding capability levels. The profile may be an achievement
955 profile when it represents the organization's progress for each
956 process area while climbing up the capability levels. Or, the profile
957 may be a target profile when it represents an objective of process
958 improvement. An achievement profile when compared with a target
959 profile enables you to not only track your process improvement
960 progress, but also enables you to demonstrate your progress to
961 management. We recommend maintaining capability level profiles
962 throughout the process improvement life cycle.

963 **Specific Goals**

964 Specific goals apply to only one process area and address the unique
965 characteristics that describe what must be implemented to satisfy the
966 purpose of the process area. Goals are required model components
967 and are used in assessments to determine whether a process area is
968 satisfied. There can be specific practices at different capability levels
969 mapped to the same goal. However, every goal has at least one
970 capability level 1 practice mapped to it. [FM103.HDA102.HDB109.T101]

⁷ A common cause of process variation is the variation of a process that exists because of normal and expected interactions among the components of a process.

971 **Specific Practices**

972 A specific practice is an activity that is considered important in
973 achieving the specific goal that it is mapped to. The specific practices
974 describe the activities expected to result in achievement of the specific
975 goal of a process area. Every specific practice is associated with a
976 capability level. [FM103.HDA102.HDB110.T101]

977 **Base Practices**

978 The specific practices in the continuous representation that are at a
979 capability level of 1 are called base practices. These practices are
980 considered essential in achieving the purpose of the process area to
981 which it belongs. [FM103.HDA102.HDB111.T101]

982 **Advanced Practices**

983 Some specific practices in the continuous representation are at a
984 capability level higher than 1. These practices are called advanced
985 practices. [FM103.HDA102.HDB112.T101]

986 For example, within the Requirements Management process area,
987 “Develop an understanding with the requirements providers on the
988 meaning of the requirements” is a capability level 1 specific practice,
989 whereas “Obtain commitment to the requirements from the project
990 participants” is a capability level 2 specific practice. [FM103.HDA102.HDB112.T102]

991 Some advanced practices build on base practices (that is, capability
992 level 1 specific practices); these are combined into a single practice for
993 the staged representation. Practices that are combined in the staged
994 representation are clearly marked. Informative material following the
995 combined practices also identifies the base and advanced practices in
996 the continuous representation that the specific practice is derived from.
997 Advanced practices that do not build on base practices are included in
998 the staged representation automatically as specific practices.

999 [FM103.HDA102.HDB112.T103]

1000 The specific practice numbering format identifies these conditions. In
1001 the continuous representation, specific practices are numbered so that
1002 the reader can identify to which specific goal the practice is mapped, its
1003 sequence number and its capability level. For example, in the
1004 Requirements Management case above, the first practice will be
1005 numbered 1.1-1 and the second will be 1.2-2. In the case where a
1006 specific practice builds on another, the sequence number will be the
1007 same for both practices, that is, 1.1-1 and 1.1-3. In the staged
1008 representation, only the 1.1 will exist. [FM103.HDA102.HDB112.T104]

1009 **Typical Work Products**

1010 Typical Work Products are an informative model component that
1011 provide example outputs from a practice. These examples are called
1012 typical work products because there are often other work products that
1013 are just as effective, but are not listed. [FM103.HDA102.HDB113.T101]

1014 **Subpractices**

1015 Subpractices are detailed descriptions that provide guidance for
1016 interpreting specific or generic practices. Subpractices may be worded
1017 as if prescriptive, but are actually an informative component in the
1018 model meant only to provide ideas that may or may not be used for
1019 process improvement. [FM103.HDA102.HDB114.T101]

1020 **Discipline Amplifications**

1021 Discipline amplifications are informative model components that contain
1022 information relevant to a particular discipline and are associated with
1023 specific practices. For example, if in the CMMI-SE/SW model, you want
1024 to find a discipline amplification for Software Engineering, you would
1025 look in the model for items labeled “For Software Engineering.”

1026 [FM103.HDA102.HDB115.T101]

1027 **Generic Practice Elaborations**

1028 Generic practice elaborations are informative model components that
1029 appear in each process area to provide guidance on how the generic
1030 practices should uniquely be applied to the process area. For example,
1031 when the generic practice “Train the people performing or supporting
1032 the planned process as needed” is incorporated into the Configuration
1033 Management process area, the specific kinds of training for doing
1034 configuration management is described. [FM103.HDA102.HDB116.T101]

1035 *Refer to the details of the generic practices in chapter 4.*

1036 [FM103.HDA102.HDB116.T101.R101]

1037 **References**

1038 References are informative model components that direct the user to
1039 additional or more detailed information in related process areas. Typical
1040 phrases expressing these pointers are “Refer to the Decision and
1041 Analysis and Resolution process area for determining the best
1042 integration strategy” or “Refer to the Project Planning process area for
1043 more information about global project planning.” All references are
1044 clearly marked in the model in italics. [FM103.HDA102.HDB117.T101]

1045 **Model Representation Comparison**

1046 The continuous representation uses capability levels, while the staged
1047 representation uses maturity levels. The main difference between these
1048 two types of levels is the representation they belong to and how they
1049 are applied: [FM103.HDA103.T101]

- 1050 • Capability levels apply to an organization’s process-improvement
1051 achievement for each process area. There are six capability levels,
1052 numbered 0 through 5. Each capability level corresponds to a
1053 generic goal and a defined set of generic practices.
- 1054 • Maturity levels, which belong to a staged representation, apply to
1055 an organization’s overall process capability and organizational
1056 maturity. Each maturity level comprises a predefined set of process
1057 areas and generic goals. There are five maturity levels, numbered
1058 1 through 5.

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Level	Continuous Representation Capability Levels	Staged Representation Maturity Levels
Level 0	Incomplete	N/A
Level 1	Performed	Initial
Level 2	Managed	Managed
Level 3	Defined	Defined
Level 4	Quantitatively Managed	Quantitatively Managed
Level 5	Optimizing	Optimizing

1060 [FM103.HDA103.T102]

1061 **Capability Level Profiles**

1062 In the continuous representation, a capability level profile is a list of
1063 process areas and their corresponding capability levels. This profile is a
1064 way for the organization to track its capability level by process area.

1065 [FM103.HDA103.HDB101.T101]

1066 The profile is an achievement profile when it represents the
1067 organization’s progress for each process area while climbing up the
1068 capability levels. Alternatively, the profile is a target profile when it
1069 represents the organization’s process improvement objectives. An
1070 achievement profile when compared with a target profile enables you
1071 not only to track your organization’s process improvement progress, but
1072 also to demonstrate your organization’s progress to management.
1073 Maintaining capability level profiles is advisable when using a
1074 continuous representation. [FM103.HDA103.HDB101.T102]

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Target Staging

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Target staging is a sequence of target profiles that describe the path of process improvement to be followed by the organization. When building target profiles, the organization should pay attention to the dependencies between generic practices and Process Areas. When a generic practice is dependent upon a certain process area, either to carry out the generic practice or to provide a prerequisite product, the generic practice will be ineffective when the process area is not implemented. When a target profile is chosen with these dependencies accounted for, the target profile is admissible. [FM103.HDA103.HDB102.T101]

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3 Model Terminology

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In any CMM, the terminology used and how it is defined is important to understanding the content of the model. Although a model glossary is included in Appendix C, some terms are used in a special way throughout the CMMI model. [FM114.T101]

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Terminology Evolution

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When developing the CMMI models, the product development team started with the terminology used in the source models. However, since this terminology was not consistent and in some instances terms conflicted with one another, we had to decide which terms should be used and which were to be abandoned. This selection of terminology was accomplished throughout the model development process using consensus methods. [FM114.HDA101.T101]

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Inevitably, consensus was reached when the terms selected were most neutral, broad, and flexible. When conflicts were identified between potential user groups (government and industry) or between discipline areas (software engineering and systems engineering), a compromise was reached. We chose not to use some terms that were too closely identified with a specific interest group and instead favored terms that were more broadly accepted. [FM114.HDA101.T102]

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Furthermore, terms were chosen to express concepts consistently throughout the model, regardless of representation. Definitions for these terms were communicated to the entire development team to encourage consistent usage. Despite these efforts, some differences in interpretation are inevitable. You should always apply the guidance herein in the way that provides the greatest value to your process improvement effort. [FM114.HDA101.T103]

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Common Terminology with Special Meaning

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Some of the terms used in the CMMI models have meanings attached to them that are more specific than their everyday use. Although these terms are not included in the glossary, we've explained their use in the model in this chapter. [FM114.HDA102.T101]

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Adequate, appropriate, as needed

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These words are used so that you can interpret goals and practices in light of your organization's business objectives. When using any CMMI model, you must interpret the practices so that they work for your organization. These terms are used in goals and practices where the practice may not be done all of the time. [FM114.HDA102.HDB101.T101]

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Establish and Maintain

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When using a CMMI model, you will encounter goals and practices that include the phrase "establish and maintain." This phrase connotes a meaning beyond the component terms; it includes documentation as well as a usage component. For example, "Establish and maintain an organizational policy for planning and performing the organizational process focus process" means that not only must a policy be formulated, it must be documented and it must be used throughout the organization. [FM114.HDA102.HDB102.T101]

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Independent Group

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The "independent group" is a concept that a CMMI model uses when discussing quality assurance. A quality assurance group is independent if it is not involved in the development of the product in any other way and there is a separate reporting channel for escalating issues.

[FM114.HDA102.HDB103.T101]

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Stakeholder

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A "stakeholder" is a group or individual that is affected by or in some way accountable for the outcome of an undertaking. Stakeholders can include project members, suppliers, customers, and others. The term "relevant stakeholder" is used to designate a group or individual that is called out in a plan to perform certain types of activities or to receive certain kinds of information. [FM114.HDA102.HDB104.T101]

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Manager

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Within the scope of CMMI models, the word "manager" is a person that provides technical and administrative direction and control to those performing tasks or activities within the manager's area of responsibility. The traditional functions of a manager include planning, organizing, directing, and controlling work within an area of responsibility.

[FM114.HDA102.HDB105.T101]

1152 **Project Manager**

1153 In the CMMI Product Suite, a “project manager” is the person
1154 responsible for planning, directing, controlling, structuring, and
1155 motivating the project. The project manager is ultimately responsible to
1156 the customer. In some matrix organizations, only the business staff may
1157 report directly to the project manager, whereas the engineering groups
1158 report to the project manager indirectly. [FM114.HDA102.HDB106.T101]

1159 **Senior Manager**

1160 The term “senior manager,” when used in a CMMI model, refers to a
1161 management role at a high enough level in an organization that the
1162 primary focus of the person filling the role is the long-term vitality of the
1163 organization, rather than short-term project and contractual concerns
1164 and pressures. A senior manager has authority to direct the allocation
1165 or reallocation of resources in support of organizational process
1166 improvement effectiveness. [FM114.HDA102.HDB107.T101]

1167 A senior manager can be any manager who satisfies this description,
1168 including the head of the organization. Synonyms for “senior manager”
1169 include “executive” and “top-level manager.” However, these synonyms
1170 are not used in CMMI models to ensure consistency and usability.

1171 [FM114.HDA102.HDB107.T102]

1172 **Organization**

1173 An organization is typically an administrative structure in which people
1174 collectively manage one or more projects as a whole, and whose
1175 projects share a senior manager and operate under the same policies.
1176 However, the word “organization” as used throughout CMMI models
1177 can apply to one person who performs a function in a small organization
1178 that might be performed by a group of people in a large organization.

1179 [FM114.HDA102.HDB108.T101]

1180 **Enterprise**

1181 When CMMI models refer to an “enterprise,” they illustrate the larger
1182 entity not always reached by the word “organization.” Very large
1183 companies may consist of many organizations in many different
1184 locations with different customers. The word “enterprise” refers to the
1185 full composition of these large companies. [FM114.HDA102.HDB109.T101]

1186 **Development**

1187 The word “development,” when used in the CMMI Product Suite, implies
1188 not only development activities, but also maintenance activities.
1189 Projects that benefit from the best practices of CMMI can focus
1190 exclusively on maintenance, development, or both activities.

1191 [FM114.HDA102.HDB110.T101]

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Project

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In CMMI models, a “project” is a managed set of interrelated resources that delivers one or more products to a customer or end user. This set of resources has a definite beginning and end and typically operates according to a plan. Such a plan is frequently documented and specifies the product to be delivered or implemented, the resources and funds used, the work to be done, and a schedule for doing the work. A project can be composed of projects. (The word “program” is not used in CMMI models.) [FM114.HDA102.HDB111.T101]

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Product

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The word “product” is used throughout the CMMI Product Suite to mean any tangible output or service that is a result of a process and that is intended for delivery to a customer or end user. A product is a work product that is delivered to the customer. [FM114.HDA102.HDB112.T101]

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Work Product

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The term “work product” is used throughout the CMMI Product Suite to mean any artifact produced by a process. These artifacts can include files, documents, parts of the product, services, processes, specifications, and invoices. Examples of processes to be considered as work products include a manufacturing process, a training process, and a disposal process for the product. [FM114.HDA102.HDB113.T101]

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In various places in the model, you will see the phrase “work products and services.” Even though the definition of work product includes services, this phrase is used to emphasize the inclusion of services in the discussion. [FM114.HDA102.HDB113.T102]

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Product Component

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The term “product component” is used as a relative term in CMMI models. In CMMI, product components are generally lower level components of the product; product components are integrated to “build” the product. There may be multiple levels of product components. Product component is defined as any work product that must be engineered (requirements defined, designed, and integrated solution developed) to achieve the intended use of the product throughout its life cycle. [FM114.HDA102.HDB114.T101]

1226 Product components may be a part of the product delivered to the
1227 customer or serve in the manufacture or use of the product. A car
1228 engine and a piston are examples of product components of a car (the
1229 product). The manufacturing process to machine the piston; the repair
1230 process used to remove the engine from the car for repair; and the
1231 process used to train the mechanic to repair the engine are also
1232 examples of product components. These latter examples are product
1233 components even if they are not delivered to the customer, but
1234 developed by the project for internal use or for use by another party.
1235 [FM114.HDA102.HDB114.T102]

1236 **Assessment**

1237 CMMI follows ISO/IEC 15504 in using the term “assessment” rather
1238 than the EIA/IS 731 term, “appraisal” or using both terms, as in SW-
1239 CMM. [FM114.HDA102.HDB115.T101]

1240 **Objective Review**

1241 An “objective review” is another concept that CMMI models use when
1242 discussing quality assurance. These reviews can be done by
1243 independent groups, or by project members themselves.
1244 [FM114.HDA102.HDB116.T101]

1245 **Tailoring Guidelines**

1246 Tailoring a process makes, alters, or adapts the process description for
1247 a particular end. For example, a project tailors its defined process from
1248 the organization’s set of standard processes to meet the objectives,
1249 constraints, and environment of the project. [FM114.HDA102.HDB117.T101]

1250 “Tailoring guidelines” are used in CMMI models to enable organizations
1251 to implement standard processes appropriately in their projects. The
1252 organization’s set of standard processes is described at a general level
1253 that may not be directly usable to perform a process. [FM114.HDA102.HDB117.T102]

1254 Tailoring guidelines aid those who establish the defined processes for
1255 projects. Tailoring guidelines cover (1) selecting a standard process, (2)
1256 selecting an approved product life cycle, and (3) tailoring the selected
1257 standard process and life cycle to fit project needs. Tailoring guidelines
1258 describe what can and cannot be modified and identify process
1259 components that are candidates for modification. [FM114.HDA102.HDB117.T103]

1260 **Project Development Plan**

1261 The project’s defined process is usually not specific enough to be
1262 performed directly because it doesn’t specify who will assume the roles,
1263 what work products to create, or when tasks will be performed.
1264 [FM114.HDA102.HDB118.T101]

1265 In CMMI models, the “project development plan,” as a single plan or
1266 collection of plans, links the project’s defined process to how the project
1267 will be performed. The project’s defined process and its development
1268 plan together make it possible to perform and manage the process. You
1269 can also look at a “project development plan” as a “project management
1270 plan” because it can cover product maintenance and/or product
1271 development. [FM114.HDA102.HDB118.T102]

1272 **ISO/IEC 15504 Compatibility and Conformance**

1273 One objective that the CMMI Product Suite was designed to achieve is
1274 that of “ISO/IEC 15504 compatibility and conformance.” There are two
1275 aspects of conformance to the 1998 Technical Report version of
1276 ISO/IEC 15504—model compatibility and assessment conformance.
1277 When the full international standard version of ISO/IEC 15504 is
1278 published (estimated to occur in 2003), there will be some changes to
1279 what ISO/IEC 15504 conformance means. [FM114.HDA102.HDB119.T101]

1280 For an assessment model (for example, Bootstrap, CMMI SE/SW, and
1281 so on) to claim to be ISO/IEC 15504 conformant (an ISO/IEC 15504
1282 compatible model), a “demonstration of compatibility” document would
1283 need to show how the model compatibility requirements of ISO/IEC
1284 15504-2 have been addressed. These requirements are constructed to
1285 provide reasonable assurance that the model will work properly with the
1286 associated documented assessment process (assessment method).
1287 [FM114.HDA102.HDB119.T102]

1288 There are also ISO/IEC 15504 requirements that pertain to the actual
1289 conduct (planning as well as performance) of an assessment. If the
1290 conduct of an assessment is such that the requirements in ISO/IEC
1291 15504-3 are satisfied, then the assessment is said to be ISO/IEC 15504
1292 conformant. One of these requirements is that a ISO/IEC 15504
1293 compatible assessment model is used. [FM114.HDA102.HDB119.T103]

1294 **Integrated**

1295 When the term “integrated” is used in the CMMI Product Suite, the
1296 integration refers to the use of the models to apply to multiple
1297 disciplines. In other words, your organization’s engineering process
1298 group can learn one model that it can use to introduce process
1299 improvement into software engineering, systems engineering, and, as
1300 time goes on, more disciplines. Integration does not refer to your
1301 organization’s structure. The decision to integrate departments or
1302 development processes is best determined by analyzing business
1303 objectives. [FM114.HDA102.HDB120.T101]

1304 **Verification and Validation**

1305 Although “verification and validation” at first seem quite similar in CMMI
1306 models, on closer inspection you can see that each addresses different
1307 issues. Verification confirms that work products properly reflect the
1308 requirements specified for them. Validation confirms that the product, as
1309 provided, will fulfill its intended use. [FM114.HDA102.HDB121.T101]

1310 **Goal**

1311 A “goal” is a required CMMI component that can be either a generic
1312 goal or specific goal. Each goal within a process area must be achieved
1313 to consider the process area to be achieved. When you see the word
1314 “goal” in a CMMI model, it always refers to model components (for
1315 example, generic goal, specific goal). [FM114.HDA102.HDB122.T101]

1316 **Objective**

1317 Instead of using “goal” in its common everyday sense, the term
1318 “objective” is used to avoid confusion. [FM114.HDA102.HDB123.T101]

1319 **Practice**

1320 A “practice” is an expected CMMI component that can be either a
1321 generic practice or specific practice. Each practice within a process
1322 area, or an equivalent alternative must be achieved to consider the
1323 process area to be achieved. Every practice supports only one goal.
1324 [FM114.HDA102.HDB124.T101]

1325 When you see the word “practice” in a CMMI model, it always refers to
1326 model components (for example, generic practice, specific practice).
1327 Instead of using “practice” in its common everyday sense, we chose
1328 another term that means the same thing (for example, carry out,
1329 perform, apply, follow, rehearse, attempt, exercise). [FM114.HDA102.HDB124.T102]

1330 **Standard**

1331 When you see the word “standard” in a CMMI model, it refers to the
1332 formal mandatory requirements developed and used to prescribe
1333 consistent approaches to development (for example, ISO standards,
1334 IEEE standards). Instead of using “standard” in its common everyday
1335 sense, we chose another term that means the same thing (for example,
1336 typical, traditional, usual, customary). [FM114.HDA102.HDB125.T101]

1337 **CMMI-Specific Terminology**

1338 The following terms were created for CMMI products or are critical to
1339 the understanding of CMMI products. [FM114.HDA103.T101]

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CMMI Product Suite

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The CMMI Product Suite is the complete set of products developed around the CMMI concept. These products include the framework itself, models, assessment methods, assessment materials, and all levels and types of training that are produced from the CMMI Framework.

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[FM114.HDA103.HDB101.T101]

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CMMI Framework

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The CMMI Framework is actually a database that enables products to be generated according to selections that a user makes. The CMMI Framework is the basic structure that organizes CMMI products and components, which include common elements of the current CMMI models as well as rules and methods for generating models, their assessment methods (including associated artifacts), and their training materials. The framework enables new disciplines to be added to CMMI so that the new disciplines will integrate with the existing ones.

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[FM114.HDA103.HDB102.T101]

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CMMI Model

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Since the CMMI Framework can generate different models based on the needs of the organization using it, there are multiple models. Consequently, the phrase “CMMI model” could be any one of many collections of information. It could be CMMI-SE/SW, CMMI-SE/SW/IPPD, or another model in the future when additional disciplines are added. The phrase “CMMI models” refers to one or more of these models and will most likely refer to the entire collection of possible models that can be generated from the CMMI Framework.

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[FM114.HDA103.HDB103.T101]

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A CMMI model describes the key elements of an effective process for one or more disciplines that is generated from the CMMI Framework and conforms to the framework’s rules. [FM114.HDA103.HDB103.T102]

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Process Area

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A “process area” is a set of goals with a cluster of related practices that, when performed collectively, may be expected to improve an organization’s process performance. The phrase “process area” represents the large building blocks of all CMMI models. This phrase was derived from a compromise between those used by the source models. [FM114.HDA103.HDB104.T101]

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Subpractice

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“Subpractices” are model components that support specific and generic practices with informative material. Reading the subpractices helps you more clearly understand the scope and intent of the practices to which they belong. [FM114.HDA103.HDB105.T101]

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Subpractices are listed beneath the specific and generic practices in CMMI models. They describe activities that may be implemented in establishing the specific or generic practice. Subpractices are for informational purposes only and are intended to provide clarification of the practices or ideas for possible use by the user. [FM114.HDA103.HDB105.T102]

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Typical Work Product

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“Typical work products” are model components that provide example outputs of a practice. These examples are called “typical work products” because there are often other work products that are just as effective, but are not listed. They help those who need examples to understand the outputs that might be expected from a practice. [FM114.HDA103.HDB106.T101]

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Peer Review

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The term “peer review” is used in the CMMI Product Suite instead of the term “work product inspection.” Essentially, these terms mean the same thing. A peer review is the review of work products performed by peers during the development of the work products to identify defects for removal. [FM114.HDA103.HDB107.T101]

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Organization’s Set of Standard Processes

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An “organization’s set of standard processes” contains the definitions of the basic processes that guide all processes in an organization. These process descriptions cover the fundamental process elements (and their relationships to each other) that must be incorporated into the defined processes that are implemented in projects across the organization. A standard process establishes consistent development and maintenance activities across the organization and is essential for long-term stability and improvement. [FM114.HDA103.HDB108.T101]

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The organization’s set of standard processes describes the fundamental process elements that will be part of the projects’ defined processes. It also describes the relationships (for example, ordering and interfaces) between these process elements. [FM114.HDA103.HDB108.T102]

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Defined Process

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A “defined process” is a managed process that is tailored from the organization’s set of standard processes according to the organization’s tailoring guidelines; has a maintained process description; and contributes work products, measures, and other process improvement information to the organization’s process assets. [FM114.HDA103.HDB109.T101]

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A project’s defined process provides a basis for planning, performing, and improving the project’s tasks and activities. A project may have more than one defined process (for example, one for development of the product and another for testing the product). [FM114.HDA103.HDB109.T102]

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Organizational Process Assets

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“Organizational process assets” are artifacts considered useful for defining and implementing processes in an organization. The organization maintains a collection of process assets for use by projects and others developing, tailoring, maintaining, and implementing processes. [FM114.HDA103.HDB110.T101]

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The primary organizational process assets that are described in this CMMI model include the following: [FM114.HDA103.HDB110.T102]

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- Organization’s set of standard processes, including the process architectures and process elements
- Descriptions of project life cycles (that is, development life cycle) approved for use (for example, waterfall, spiral)
- Guidelines and criteria for tailoring the organization’s set of standard processes
- Organizational measurement repository process database
- Organizational library of process-related documentation

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An organization may bundle these process assets in many ways, depending on its approach to establishing its set of standard processes. For example, the description of the product life cycle may be an integral part of the organization’s set of standard processes. [FM114.HDA103.HDB110.T103]

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Process Architectures

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A “process architecture” describes the ordering, interfaces, interdependencies, and other relationships among the process elements in a standard process. A process architecture also describes the interfaces, interdependencies, and other relationships between it and external processes (for example, contract management).

[FM114.HDA103.HDB111.T101]

1448 **Process Elements**

1449 A “process element” is a fundamental unit of process description. A
1450 process may be defined in terms of subprocesses or process elements.
1451 A subprocess can be further decomposed; a process element cannot
1452 be decomposed into finer-grained descriptions. [FM114.HDA103.HDB112.T101]

1453 Each process element covers a closely related set of activities (for
1454 example, estimating element, peer review element). Process elements
1455 can be portrayed using templates to be completed, abstractions to be
1456 refined, or descriptions to be modified or used. A process element can
1457 be an activity or task. [FM114.HDA103.HDB112.T102]

1458 **Product Life Cycle**

1459 A “product life cycle” is the period of time that begins when a product is
1460 conceived and ends when the product is no longer available for use.
1461 Since an organization may be producing multiple products for multiple
1462 customers, one product life cycle may not be adequate. Therefore, the
1463 organization may define a set of approved product life cycles. These life
1464 cycles are typically found in published literature and are likely to be
1465 modified to fit the organization. [FM114.HDA103.HDB113.T101]

1466 An example of a product life cycle is (1) concept/vision, (2) feasibility,
1467 (3) design/development, (4) production, and (5) phase-out. A project life
1468 cycle is a different concept that describes the development process
1469 used by the project (for example, waterfall, spiral). [FM114.HDA103.HDB113.T102]

1470 **Organizational Measurement Repository**

1471 The “organizational measurement repository” is a repository used to
1472 collect and make available measurement data on processes and work
1473 products, particularly as they relate to the organization’s set of standard
1474 processes. This repository contains or references actual measurement
1475 data and related information needed to understand and assess the
1476 measurement data. [FM114.HDA103.HDB114.T101]

1477 Examples of process and work product data include estimated size of
1478 work products, effort estimates, and cost estimates; actual size of work
1479 products, actual effort expended, and actual cost amounts; peer review
1480 efficiency and coverage statistics; and the number and severity of
1481 defects. [FM114.HDA103.HDB114.T102]

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Organizational Library of Process-Related Documentation

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The “organizational library of process-related documentation” is a library of information used to store and make available process documents that are potentially useful to those who are defining, implementing, and managing processes in the organization. This library contains documents, document fragments, process implementation aids, and other artifacts that are useful in defining, implementing, and managing processes that are tailored from the organization’s set of standard processes. [FM114.HDA103.HDB115.T101]

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Examples of process-related documentation include policies, defined processes, standards, procedures, development plans, measurement plans, and training materials. This library is an important resource that can help reduce the effort in beginning a new process.

[FM114.HDA103.HDB115.T102]

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4 Capability Level and Generic Model Components

1498 Overview

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The capability levels and generic model components of CMMI models focus on building the organization's ability to pursue process improvement in multiple process areas. Using capability levels, generic goals, and generic practices, users are able to improve their processes, as well as demonstrate and evaluate their organization's progress as they improve processes associated with process areas. [FM121.HDA101.T101]

1505 Capability Levels

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CMMI models are designed to describe levels of process improvement. Capability levels in the continuous representation provide a recommended order for approaching process improvement within each process area. [FM121.HDA102.T101]

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All continuous representations of CMMI models reflect capability levels in their design and content. For each process area, a capability level consists of related specific and generic practices that, when performed, achieve a set of goals that improve the processes associated with the process area and enhance the organization's process capability.

[FM121.HDA102.T102]

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There are six capability levels, numbered 0 through 5. Capability levels are measured by the achievement of the specific and generic goals that apply to a process area. For example, an organization can reach capability level 2 of a process area when the generic goals and specific goals up through capability level 2 are achieved for the process area. A process area that does not satisfy all of the requirements for capability level 1 is said to be at level 0. [FM121.HDA102.T103]

1523 “Institutionalization”⁸ is an important dimension to each of the capability
1524 levels. When mentioned below in the capability level descriptions,
1525 institutionalization implies that the implementation of the process area is
1526 appropriate to ensure that the process area is an ingrained part of the
1527 way the work is performed in the organization. [FM121.HDA102.T104]

1528 Interpreting Specific Goals in the Continuous Representation

1529 When using the continuous representation in an assessment, process
1530 areas are assessed relative to a particular capability level. The
1531 particular capability level being considered determines the set of
1532 specific practices that are investigated when rating a specific goal. The
1533 rule is this: when rating a specific goal relative to capability level N, all
1534 specific practices through capability level N associated with that specific
1535 goal must be investigated. [FM121.HDA103.T101]

1536 In the descriptions of the capability levels, generic goals, and generic
1537 practices that follow, the phrases “satisfies ... the specific goals of the
1538 process area” and “achieves ... the specific goals of the process area”
1539 need to be interpreted in light of the rule given above. [FM121.HDA103.T102]
1540 Capability Levels

1541 Capability Level 0: Incomplete

1542 An incomplete process is a process that is either not performed or
1543 partially performed. One or more of the specific goals of the process
1544 area are not satisfied. [CL101]

1545 Capability Level 1: Performed

1546 A performed process is a process that satisfies the specific goals of the
1547 process area. It supports and enables the work needed to produce
1548 identified output work products using identified input work products.
1549 [CL102]

1550 A critical distinction between an incomplete process and a performed
1551 process is that a performed process satisfies all of the specific goals of
1552 the process area. [CL102.N103]

⁸ Institutionalization is the building and reinforcement of infrastructure and corporate culture that support methods, practices, and procedures so that they are the ongoing way of doing business, even after those who originally defined them are gone.

1553 Level 1 Generic Goals

1554 Achieve Specific Goals The process supports and enables
1555 achievement of the specific goals of the process area by transforming
1556 identifiable input work products to produce identifiable output work
1557 products. [CL102.GL101]

1558 Level 1 Generic Practices

1559 **GP 1.1 Identify Work Scope** [GP101]

1560 ***Identify the scope of the work to be performed and work products***
1561 ***or services to be produced, and communicate this information to***
1562 ***those performing the work.***

1563 The purpose of this practice is to ensure that the people doing the work
1564 have a common understanding of the work to be performed and work
1565 products to be produced.

1566 **GP 1.2 Perform Base Practices** [GP102]

1567 ***Perform the base practices of the process to develop work***
1568 ***products and provide services to achieve the specific goals of the***
1569 ***process area.***

1570 The purpose of this practice is to produce the work products and deliver
1571 the services that are expected by performing the process. These
1572 practices may be done informally, not following a documented process
1573 description or plan. The rigor with which these practices are performed
1574 depends on the individuals managing and performing the work and may
1575 vary considerably.

1576 When using the continuous representation of CMMI, the base practices
1577 of a process area refer to all of the capability level one specific practices
1578 for the process area, or an equivalent alternative set. [GP102.N101]

1579 Capability Level 2: Managed

1580 A managed process is a performed (capability level 1) process that is
1581 also planned and executed in accordance with policy, employs skilled
1582 people having adequate resources to produce controlled outputs,
1583 involves stakeholders, and is reviewed and evaluated for adherence to
1584 requirements. The process may be instantiated by an individual project,
1585 group, organizational function, or may be a standalone process.
1586 Management of the process is concerned with the institutionalization of
1587 the process area; and the achievement of other specific objectives
1588 established for the process, such as cost, schedule, and quality
1589 objectives. [CL103]

1590 A critical distinction between a performed process and a managed
1591 process is the extent to which a process is managed. A managed
1592 process is planned (the plan may be part of a more encompassing plan)
1593 and the performance of the process is managed against the plan.
1594 Corrective actions are taken when the actual results and performance
1595 deviate significantly from the plan. A managed process achieves the
1596 objectives of the plan and is institutionalized for consistent performance
1597 (see generic practices below). [CL103.N107]

1598 Those responsible for performing the process establish objectives for
1599 their situation and revise them as appropriate. These objectives are
1600 determined based on an understanding of what will satisfy the relevant
1601 stakeholders. Objectives may be quantitative or qualitative. [CL103.N102]

1602 The objectives for the process may be specific objectives for the
1603 individual process or they may be defined at a higher level (i.e., for a set
1604 of processes), with the individual processes contributing to achieving
1605 these objectives. These objectives may be revised as part of the
1606 corrective actions taken for the process. [CL103.N103]

1607 The process discipline of a managed process helps ensure that existing
1608 practices are retained during times of stress. When these practices are
1609 used on efforts similar to the current effort, similar results can be
1610 expected. [CL103.N104]

1611 The requirements, standards, and objectives for the process, its work
1612 products, and its services are defined and documented. The status of
1613 the work products and delivery of the services are visible to
1614 management at defined points (e.g., at major milestones and
1615 completion of major tasks). Commitments are established among those
1616 involved in performing the work and relevant stakeholders.
1617 Commitments are revised as necessary. Work products are reviewed
1618 with affected stakeholders and are controlled. The work products and
1619 services satisfy their specified requirements, standards, and objectives.
1620 [CL103.N105]

1621 A managed process is institutionalized by doing the following: [CL103.N106]

- 1622 • Adhering to organizational policies
- 1623 • Following a documented plan and process description
- 1624 • Applying adequate and appropriate resources (including funding,
- 1625 people, and tools)
- 1626 • Maintaining appropriate assignment of responsibility and authority
- 1627 • Training the people performing and supporting the process
- 1628 • Placing work products under appropriate levels of configuration
- 1629 management
- 1630 • Monitoring and controlling the performance of the process and
- 1631 taking corrective action
- 1632 • Objectively evaluating the process, its work products, and its
- 1633 services, and addressing noncompliance
- 1634 • Reviewing the activities, status, and results of the process with
- 1635 appropriate levels of management and taking corrective action
- 1636 • Involving relevant stakeholders affected by the process, its work
- 1637 products, and its services

1638 Institutionalization also implies that the breadth and depth of the
1639 implementation of the process and the length of time the process has
1640 been in place is appropriate to ensure that the process is an ingrained
1641 part of the way the work is performed. [CL103.N108]

1642 Level 2 Generic Goals

1643 Institutionalize a Managed Process The process is institutionalized as a
1644 managed process. [CL103.GL101]

1645 Level 2 Generic Practices

1646 **GP 2.1 Establish an Organizational Policy** [GP103]

1647 ***Establish and maintain an organizational policy for planning and***
1648 ***performing the process***

1649 The purpose of this practice is to define the organizational expectations
1650 for the process and make these expectations visible to those in the
1651 organization who are affected.

1652 Not all direction from senior management will bear the label, "policy."
1653 The existence of appropriate organizational direction is the expectation
1654 of this practice, regardless of what it is called. [GP103.N101]

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GP 2.2 Plan the Process [GP104]

Establish and maintain the requirements and objectives, and plan for performing the process.

The purpose of this practice is to determine what is needed to perform the process and achieve the established objectives, prepare a plan for performing the process, and get agreement on the plan from relevant stakeholders.

Requirements are defined for the process's specified work products and for performing the work. [GP104.N101]

The objectives for the process are established by those responsible for performing the process. Included are objectives for their specific situation, including quality, cost, and schedule objectives. For example, an objective might be to reduce the cost of performing a process for this implementation over the previous implementation. [GP104.N102]

Establishing a plan includes documenting it. Maintaining the plan includes changing it, as necessary, as a result of corrective actions, changes to the process, and changes to the requirements and objectives for the process. [GP104.N103]

In some CMMI process areas there are specific practices that also talk about developing strategies or plans. This generic practice addresses overall planning for the entire process area, whereas the specific practices address a topic for more detailed or focused planning.

[GP104.N104]

Subpractices

1. Obtain management sponsorship for performing the process.

[GP104.SubP101]

2. Define and document the process description. [GP104.SubP102]

The process description, which includes relevant standards and procedures, may be included as part of the plan for the process or may be included in the plan by reference. [GP104.SubP102.N101]

3. Define and document the plan for performing the process.

[GP104.SubP103]

This plan may be a standalone document, embedded in a more comprehensive document, or distributed across multiple documents. In the case of the plan being distributed across multiple documents, ensure that a coherent picture is preserved of who does what. Documents may be hardcopy or softcopy. [GP104.SubP103.N102]

The plan for performing the process typically covers the following: [GP104.SubP103.N101]

- Standards for the work products and services of the process

- 1693 • Requirements for the work products and services of the process
- 1694 • Specific objectives for the performance of the process (e.g., quality, time-scale,
- 1695 cycle time, and resource usage)
- 1696 • Schedule (events and activity dependencies) for performing the process
- 1697 • Dependencies among the activities, work products, and services of the process
- 1698 • Resources (including funding, people, and tools) needed to perform the process
- 1699 • Assignment of responsibility and authority
- 1700 • Training needed for performing and supporting the process
- 1701 • Work products to be placed under configuration management and the level of
- 1702 configuration management for each item
- 1703 • Measurement requirements to provide insight into the performance of the process,
- 1704 its work products, and its services
- 1705 • Activities for monitoring and controlling the process
- 1706 • Objective verification activities for the process and the work products
- 1707 • Management review activities for the process and the work products
- 1708 4. Review the plan with relevant stakeholders and get their
- 1709 agreement. [GP104.SubP104]
- 1710 This includes reviewing that the planned process satisfies the applicable policies,
- 1711 plans, requirements, and standards to provide assurance to relevant
- 1712 stakeholders. [GP104.SubP104.N101]
- 1713 5. Revise the plan as necessary. [GP104.SubP105]

GP 2.3 Provide Resources [GP105]

Provide adequate resources for performing the process, developing the work products, and providing the services of the process.

1718 The purpose of this practice is to ensure that the resources necessary
1719 to perform the process as defined by the plan are available when they
1720 are needed. Resources include adequate funding, appropriate physical
1721 facilities, skilled people, and appropriate tools.

1722 The interpretation of the term "adequate" depends on many factors and
1723 may change over time. Inadequate resources may be addressed by
1724 increasing resources or by removing requirements, constraints, and
1725 commitments. [GP105.N101]

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GP 2.4 Assign Responsibility [GP106]

Assign responsibility and authority for performing the process, developing the work products, and providing the services of the process

The purpose of this practice is to ensure that there is accountability, throughout the life of the process for performing the process and achieving the specified results. The people assigned must have the appropriate authority to perform the assigned responsibilities.

Responsibility can be assigned using detailed job descriptions or in living documents, such as a plan for the process. Dynamic assignment of responsibility is another legitimate way to perform this practice, as long as the assignment and acceptance of responsibility is assured throughout the life of the process. [GP106.N101]

Subpractices

1. Assign overall responsibility and authority for performing the process. [GP106.SubP101]
2. Assign responsibility for performing the specific tasks of the process. [GP106.SubP102]
3. Confirm that the people assigned to the responsibilities and authorities understand and accept them. [GP106.SubP103]

GP 2.5 Train People [GP107]

Train the people performing or supporting the process as needed.

The purpose of this practice is to ensure that the people have the necessary skills and expertise to perform or support the process.

Appropriate training is provided to the people who will be performing the work. Overview training is provided to orient people who interact with those performing the work. [GP107.N101]

Training supports the successful performing of the process by establishing a common understanding of the process and by imparting the skills and knowledge needed to perform the process. [GP107.N103]

GP 2.6 Manage Configurations [GP109]

Place designated work products of the process under appropriate levels of configuration management.

1759 The purpose of this practice is to establish and maintain the integrity of
1760 the designated work products of the process (or their descriptions)
1761 throughout their useful life.

1762 *Refer to the Configuration Management process area for more*
1763 *information.* [GP109.R101]

1764 The designated work products are specifically identified in the plan for
1765 performing the process, along with a specification of the level of
1766 configuration management. [GP109.N101]

1767 Different levels of configuration management are appropriate for
1768 different work products and for different points in time. For some work
1769 products, it may be sufficient to maintain version control (i.e., the
1770 version of the work product in use at a given time, past or present, is
1771 known and changes are incorporated in a controlled manner). Version
1772 control is usually under the sole control of the work product owner
1773 (which may be an individual, a development group, or a team). [GP109.N102]

1774 Sometimes, it may be critical that work products be placed under formal
1775 or "baseline" configuration management. This type of configuration
1776 management includes defining and establishing baselines at
1777 predetermined points. These baselines are formally reviewed and
1778 agreed on, and serve as the basis for further development. [GP109.N104]

1779 Additional levels of configuration management between version control
1780 and formal configuration management are possible. An identified work
1781 product may be under various levels of configuration management at
1782 different points in time. [GP109.N103]

1783 **GP 2.7 Identify and Involve Relevant Stakeholders** [GP124]

1784 ***Identify and involve the relevant stakeholders as planned.***

1785 The purpose of this practice is to establish and maintain the expected
1786 involvement of stakeholders during the execution of the process.

1787 *Refer to Project Planning process area for information on the project*
1788 *planning for stakeholder involvement.* [GP124.R101]

1789 Involve stakeholders as described in an appropriate plan for
1790 stakeholder involvement (e.g., as developed in the Project Planning
1791 PA). Involve them appropriately in activities such as: [GP124.N101]

- 1792 • Planning
- 1793 • Decisions
- 1794 • Communications
- 1795 • Coordination

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- Assessments
- Requirements definitions
- Resolution of problems/issues

The objective of planning the stakeholder involvement is to assure that interactions necessary to the process are accomplished, while not allowing excessive numbers of affected groups and individuals to impede process execution. [GP124.N102]

Subpractices

1. Identify stakeholders relevant to this process and decide what type of involvement should be practiced. [GP124.SubP101]

Stakeholders are identified among the suppliers of inputs to, the users of outputs from, and the performers of the activities within the process. Once the relevant stakeholders are identified, the appropriate level of their involvement in process activities is planned. [GP124.SubP101.N101]

2. Share these identifications with project planners or other planners as appropriate. [GP124.SubP102]
3. Get stakeholders involved as planned. [GP124.SubP103]

GP 2.8 Monitor and Control the Process [GP110]

Monitor and control the process against the plan and take appropriate corrective action.

The purpose of this practice is to perform the direct day-to-day monitoring and controlling of the process. Appropriate visibility into the process is maintained so that appropriate corrective action can be taken when necessary.

Refer to the Measurement and Analysis process area for more information about measurement. [GP110.R101]

Subpractices

1. Measure actual performance against the plan. [GP110.SubP101]

The measures are of the process, its work products, and its services.
[GP110.SubP101.N101]

2. Review accomplishments and results of the process against the plan. [GP110.SubP102]

- 1828 3. Review activities, status, and results of the process with the
1829 immediate level of management responsible for the process and
1830 identify issues. The reviews are intended to provide the immediate
1831 level of management with appropriate visibility into the process.
1832 The reviews can be both periodic and event-driven. [GP110.SubP108]
- 1833 4. Identify and evaluate the effects of significant deviations from the
1834 plan. [GP110.SubP104]
- 1835 5. Identify problems in the process and in the plan. [GP110.SubP105]
- 1836 6. Take corrective action when requirements and objectives are not
1837 being satisfied, when issues are identified, or when progress differs
1838 significantly from the plan. [GP110.SubP106]
- 1839 There are inherent risks that need to be considered before any of the corrective
1840 actions are taken. [GP110.SubP106.N102]
- 1841 Corrective action may include the following: [GP110.SubP106.N101]
- 1842 • Taking remedial action to repair defective work products or services
 - 1843 • Changing the plan
 - 1844 • Adjusting resources, including people, tools, and other resources
 - 1845 • Negotiating changes to the established commitments
 - 1846 • Securing change to the requirements and standards that have to be satisfied
 - 1847 • Terminating the effort
- 1848 7. Track corrective action to closure. [GP110.SubP107]

1849 GP 2.9 Objectively Evaluate Adherence [GP113]

1850 ***Objectively evaluate adherence of the process and the work***
1851 ***products and services of the process to the applicable***
1852 ***requirements, objectives, and standards, and address***
1853 ***noncompliance.***

1854 The purpose of this practice is to provide credible assurance that the
1855 process is implemented as planned and satisfies the relevant policies,
1856 requirements, standards, and objectives.

1857 *Refer to the Process and Product Quality Assurance process area for*
1858 *more information about the specific goal and practices needed to*
1859 *objectively evaluate adherence.* [GP113.R101]

1860 People not directly responsible for managing or performing the activities
1861 of the process typically evaluate adherence. As a result, credible
1862 assurance of adherence can be provided even during times when the
1863 process is under stress (e.g., when the effort is behind schedule or over
1864 budget). [GP113.N101]

1865 **GP 2.10 Review Status with Higher-Level Management** [GP112]

1866 ***Review the activities, status, and results of the process with***
1867 ***higher-level management and resolve issues.***

1868 The purpose of this practice is to provide higher-level management with
1869 the appropriate visibility into the process.

1870 Higher-level management includes those levels of management in the
1871 organization above the immediate level of management responsible for
1872 the process. In particular, higher-level management includes senior
1873 management. These reviews are for managers who provide
1874 sponsorship and overall guidance for the process, not for those who
1875 perform the direct day-to-day monitoring and controlling of the process.

1876 [GP112.N102]

1877 Different managers have different needs for information about the
1878 process. These reviews help ensure that informed decisions on the
1879 planning and performing of the process can be made. Therefore, these
1880 reviews are expected to be both periodic and event driven. [GP112.N101]

1881 **Capability Level 3: Defined**

1882 A defined process is a managed (capability level 2) process that is
1883 tailored from the organization's set of standard processes according to
1884 the organization's tailoring guidelines; has a maintained process
1885 description; and contributes work products, measures, and other
1886 process improvement information to the organization's process assets.

1887 [CL104]

1888 The organization's set of standard processes, which are the basis of the
1889 defined process, are established and improved over time. Standard
1890 processes describe the fundamental process elements that are
1891 expected in the defined processes. Standard processes also describe
1892 the relationships (e.g., the ordering and interfaces) between these
1893 process elements. The organization-level infrastructure to support
1894 current and future use of the organization's set of standard processes is
1895 established and improved over time. [CL104.N101]

1896 The organization's standard process assets are artifacts that relate to
1897 describing, implementing, and improving processes. These artifacts are
1898 assets because they are developed or acquired to meet the business
1899 objectives of the organization, and they represent investments by the
1900 organization that are expected to provide current and future business
1901 value. [CL104.N102]

1902 A defined process clearly states the following: [CL104.N103]

- 1903 • Purpose

- 1904 • Inputs
- 1905 • Entry criteria
- 1906 • Activities
- 1907 • Roles
- 1908 • Measures
- 1909 • Verification steps
- 1910 • Outputs
- 1911 • Exit criteria

1912 A defined process is institutionalized by doing the following: [CL104.N104]

- 1913 • Satisfying the items that institutionalize a managed process
- 1914 • Following a plan that incorporates a defined process
- 1915 • Collecting work products, measures, and improvement information
- 1916 for supporting the use and improvement of the organization's
- 1917 process assets

1918 A critical distinction between a managed process and a defined process
 1919 is the scope of application of the standards, process descriptions, and
 1920 procedures. For a managed process, the standards, process
 1921 descriptions, and procedures may be in use in only a specific instance
 1922 of the process (e.g., on a particular project). Because the standards,
 1923 process descriptions, and procedures are tailored from the
 1924 organization's set of standard processes and related organizational
 1925 process assets, the defined processes that are performed across the
 1926 organization are appropriately consistent. Another critical distinction is
 1927 that a defined process is described in more detail and performed more
 1928 rigorously than a managed process. Management of the defined
 1929 process is based on the additional insight provided by an understanding
 1930 of the interrelationships of the process activities and detailed measures
 1931 of the process, its work products, and its services. [CL104.N105]

1932 Level 3 Generic Goals

1933 Institutionalize a Defined Process The process is institutionalized as a
 1934 defined process. [CL104.GL101]

1935 Level 3 Generic Practices

1936 **GP 3.1 Establish a Defined Process** [GP114]

1937 ***Establish and maintain the description of a defined process.***

1938 The purpose of this practice is to establish and maintain a description of
1939 the process that is tailored from the organization's set of standard
1940 processes to address the needs of a specific instantiation. With a
1941 defined process, variability in how the processes are performed across
1942 the organization is reduced; and process assets, data, and learning can
1943 be effectively shared.

1944 *Refer to the Organizational Process Definition process area for more*
1945 *information about the organization's standard set of processes and*
1946 *tailoring guidelines.* [GP114.R101]

1947 The descriptions of the defined processes provide the basis for
1948 planning, performing, and managing the activities, work products, and
1949 services associated with the process. [GP114.N102]

1950 **Subpractices**

- 1951 1. Select the standard process that best fits the specific instantiation
1952 from the organization's set of standard processes. [GP114.SubP101]
- 1953 2. Establish the defined process by tailoring the selected standard
1954 processes and other process assets according to the
1955 organization's tailoring guidelines. [GP114.SubP102]
- 1956 3. Ensure that the organization's process objectives are appropriately
1957 addressed in the defined process. [GP114.SubP103]
- 1958 4. Document the defined process and the records of the tailoring.
1959 [GP114.SubP104]
- 1960 5. Revise the description of the defined process as necessary.
1961 [GP114.SubP106]

1962 **GP 3.2 Collect Improvement Information** [GP117]

1963 ***Collect work products, measures, measurement results, and***
1964 ***improvement information derived from planning and performing***
1965 ***the process to support the future use and improvement of the***
1966 ***organization's processes and process assets.***

1967 The purpose of this practice is to collect information and artifacts
1968 derived from planning and performing the process. This practice is
1969 performed so that the information and artifacts can be included in the
1970 organization's process assets and made available to those who are (or
1971 who will be) planning and performing the same or similar processes.
1972 The information and artifacts are stored in the organizational
1973 measurement repository and the organizational library of process-
1974 related assets.

1975 *Refer to the Organizational Process Definition process area for more*
1976 *information about the organizational measurement repository and*
1977 *library of process-related assets.* [GP117.R101]

1978 **Subpractices**

1979 1. Store process and product measures in the organizational
1980 measurement repository. [GP117.SubP102]

1981 The process and product measures are primarily those that are defined in the
1982 organization's common set of measures for the set of standard processes.

1983 [GP117.SubP102.N101]

1984 2. Submit documentation for inclusion in the organizational library of
1985 process-related assets. [GP117.SubP103]

1986 3. Document lessons learned from the process for inclusion in the
1987 organizational library of process-related assets. [GP117.SubP104]

1988 4. Propose improvements to the organization's process assets.
1989 [GP117.SubP101]

1990 **Capability Level 4: Quantitatively Managed**

1991 A quantitatively managed process is a defined (capability level 3)
1992 process that is controlled using statistical and other quantitative
1993 techniques. Quantitative objectives for quality and process
1994 performance are established and used as criteria in managing the
1995 process. The quality and process performance are understood in
1996 statistical terms and are managed throughout the life of the process.

1997 [CL105]

1998 The quantitative objectives are based on the capability of the
1999 organization's standard processes, the needs of the customer, end-
2000 users, organization, and process implementers. [CL105.N101]

2001 The people performing the process are directly involved in quantitatively
2002 managing the process. [CL105.N102]

2003 Quantitative management is performed on the overall set of processes
2004 that produces a product or provides a service. The processes that are
2005 significant contributors to the overall process performance are
2006 quantitatively managed. For these selected processes, detailed
2007 measures of the process performance are collected and statistically
2008 analyzed. Special causes of process variation are identified and, where
2009 appropriate, the source of the special cause is addressed to prevent
2010 future occurrences. [CL105.N103]

2011	The quality and process performance measures are incorporated into the organizational measurement repository to support future fact-based decision-making. [CL105.N104]
2012	
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2014	A quantitatively managed process is institutionalized by doing the following: [CL105.N105]
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2016	<ul style="list-style-type: none">• Satisfying the items that institutionalize a defined process• Establishing and maintaining quantitative objectives for quality and process performance• Stabilizing the performance of subprocesses critical to the performance of the process• Establishing and maintaining an understanding of the ability of the process to achieve the established quantitative objectives for quality and process performance
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2024	A critical distinction between a defined process and a quantitatively managed process is the predictability of the process performance. The term "quantitatively managed" implies using appropriate statistical and other quantitative techniques to manage the performance of one or more critical subprocesses of a process so that the future performance of the process can be predicted. A defined process only provides qualitative predictability. [CL105.N106]
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2031	Activities for quantitatively managing the performance of a process includes the following: [CL105.N110]
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2033	<ul style="list-style-type: none">• Identifying the subprocesses of the process area that are to be brought under statistical management• Identifying and measuring product and process attributes that are important contributors to quality and process performance• Identifying and addressing special causes of subprocess variations (based on the selected product and process attributes and subprocesses selected for statistical management)• Bringing the performance of each selected subprocess within its natural bounds (i.e., make the subprocess performance statistically stable and predictable based on the selected product and process attributes)• Predicting the ability of the process to satisfy established quantitative quality and process performance objectives• Taking appropriate corrective actions when it is determined that the established quantitative quality and process performance objectives will not be satisfied
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2049 The corrective actions described above may be limited to merely
2050 changing the objectives or ensuring that the stakeholders concerned
2051 about the objective have a quantitative understanding of, and have
2052 agreed to, the performance shortfall. [CL105.N109]

2053 Level 4 Generic Goals

2054 Institutionalize a Quantitatively Managed Process The process is
2055 institutionalized as a quantitatively managed process. [CL105.GL101]

2056 Level 4 Generic Practices

2057 **GP 4.1 Establish Quality Objectives** [GP118]

2058 ***Establish and maintain quantitative objectives for the process***
2059 ***about quality and process performance based on customer needs***
2060 ***and business objectives.***

2061 The purpose of this practice is to determine and obtain agreement from
2062 relevant stakeholders about specific quantitative objectives for the
2063 process about quality and process performance.

2064 *Refer to Quantitative Project Management process area for information*
2065 *on how quantitative objectives are set for subprocesses of the project's*
2066 *defined process.* [GP118.R101]

2067 The quantitative objectives may be specific to the process or they may
2068 be defined at a higher level (i.e., for a set of processes). In the latter
2069 case, the quantitative objectives defined at the higher level may be
2070 allocated to lower processes. [GP118.N101]

2071 These quantitative objectives are criteria used to judge whether the
2072 products, services, and process performance will satisfy the customers,
2073 end users, organization's management, and process implementers.
2074 These quantitative objectives referred to here go beyond the traditional
2075 end-product objectives. They also cover intermediate objectives that are
2076 used to manage the achievement of the objectives over time. They
2077 reflect, in part, the demonstrated performance of the organization's set
2078 of standard processes. These quantitative objectives should be set to
2079 values that are likely to be achieved when the processes involved are
2080 stable and within their natural bounds. [GP118.N102]

2081 **Subpractices**

2082 1. Obtain quantitative objectives for the project's defined process or if
2083 they are not available, from other sources. [GP118.SubP101]

2084

2. Allocate the quantitative objectives to the process. [GP118.SubP102]

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GP 4.2 Stabilize Subprocess Performance [GP119]

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Stabilize the performance of one or more subprocesses of the process to determine its ability to achieve the established quantitative quality and process performance objectives.

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The purpose of this practice is to stabilize the performance of one or more subprocesses of the defined (capability level 3) process that are critical contributors to the overall performance using appropriate statistical and other quantitative techniques. Stabilizing selected subprocesses of the process supports estimating (predicting) the ability of the process to achieve the established quantitative quality and process performance objectives.

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A stable subprocess shows no significant indication of special causes of process variation. Stable subprocesses are predictable within the limits established by the natural bounds of the subprocess. Variations in the stable subprocess are due to a constant system of chance causes, and the magnitude of the variations may be small or large. [GP119.N103]

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Predicting the ability of the process to achieve the established quantitative objectives requires a quantitative understanding of the contributions of the subprocesses that are critical to achieving these objectives and establishing and managing against interim quantitative objectives over time. [GP119.N104]

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Selected process and product measures are incorporated into the organizational measurement repository to support process performance analysis and future fact-based decision-making. [GP119.N101]

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Subpractices

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1. Statistically manage the performance of one or more subprocesses that are critical contributors to the overall performance of the process. [GP119.SubP101]

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2. Estimate the ability of the process to achieve its established quantitative objectives considering the performance of the statistically managed subprocesses. [GP119.SubP102]

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3. Incorporate selected process performance measurements into the organization's process performance baselines. [GP119.SubP103]

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2118 Capability Level 5: Optimizing

2119 An optimizing process is a quantitatively managed (capability level 4)
2120 process that is changed and adapted to meet relevant current and
2121 projected business objectives. An optimizing process focuses on
2122 continually improving the process performance through both
2123 incremental and innovative technological improvements. Process
2124 improvements that would address common causes of process variation
2125 and measurably improve the organization's processes are identified,
2126 evaluated, and deployed as appropriate. These improvements are
2127 selected based on a quantitative understanding of their expected
2128 contribution to achieving the organization's process improvement
2129 objectives versus the cost and impact to the organization. The process
2130 performance of the organization's processes is continually improved.

2131 [CL106]

2132 Selected incremental and innovative technological process
2133 improvements are deployed into the organization in a systematic
2134 manner. The effects of the deployed process improvements are
2135 measured and evaluated against the quantitative process improvement
2136 objectives. [CL106.N103]

2137 An optimizing process is institutionalized by doing the following:

2138 [CL106.N104]

- 2139 • Satisfying the items that institutionalize a quantitatively managed
2140 process
- 2141 • Establishing and maintaining quantitative process improvement
2142 objectives
- 2143 • Identifying and deploying both incremental and innovative
2144 technological improvements that continually improves the range of
2145 process performance

2146 A critical distinction between a quantitatively managed process and an
2147 optimizing process is that the optimizing process is continuously
2148 improved by addressing common causes of process variation. A
2149 quantitatively managed process is concerned with addressing special
2150 causes of process variation and providing statistical predictability for the
2151 results. Though the process may produce predictable results, the
2152 results may be insufficient to achieve the established objectives. An
2153 optimizing process is concerned with addressing common causes of
2154 process variation and changing the process (i.e., shift the mean of the
2155 process performance) to improve process performance (while
2156 maintaining statistical predictability) to achieve the established
2157 quantitative process improvement objectives. [CL106.N105]

2158 A common cause of process variation is a cause that is inherently part
2159 of a process and affects the overall performance of the process.

2160 [CL106.N106]

2161 Level 5 Generic Goals

2162 Institutionalize an Optimizing Process The process is institutionalized as
2163 an optimizing process. [CL106.GL101]

2164 Level 5 Generic Practices

2165 **GP 5.1 Ensure Continuous Process Improvement** [GP125]

2166 ***Ensure continuous improvement of the process in fulfilling the***
2167 ***relevant business goals of the organization.***

2168 The purpose of this practice is to select and systematically deploy
2169 process and technology improvements that contribute to meeting
2170 established quality and performance objectives for the process.

2171 Optimizing processes that are agile and innovative depend on the
2172 participation of an empowered workforce aligned with the business
2173 values and objectives of the organization. The organization's ability to
2174 rapidly respond to changes and opportunities is enhanced by finding
2175 ways to accelerate and share learning. Improvement of the processes
2176 is inherently part of everybody's role, resulting in a cycle of continual
2177 improvement. [GP125.N101]

2178 **Subpractices**

2179 1. Establish and maintain quantitative process improvement
2180 objectives that support the organization's business objectives.

2181 [GP125.SubP101]

2182 The quantitative process improvement objectives may be specific to the individual
2183 process or they may be defined at a higher level (i.e., for a set of processes), with
2184 the individual processes contributing to achieving these objectives. Objectives that
2185 are specific to the individual process are typically allocated from quantitative
2186 objectives established at a higher level. [GP125.SubP101.N101]

2187 These process improvement objectives are primarily derived from the
2188 organization's business objectives and from a detailed understanding of process
2189 capability. These objectives are the criteria used to judge whether the process
2190 performance is quantitatively improving the organization's ability to meet its
2191 business objectives. These process improvement objectives are often set to
2192 values beyond the current process performance, and both incremental and
2193 innovative technological improvements may be needed to achieve these
2194 objectives. These objectives may also be revised frequently to continue to drive
2195 the improvement of the process (i.e., when a objective is achieved, it may be set
2196 to a new value that is again beyond the new process performance). [GP125.SubP101.N102]

2197 These process improvement objectives may be the same as or a refinement of
2198 the objectives established in GP 4.1 Establish Quality Objectives, as long as they
2199 can serve as both drivers and criteria for successful process improvement.

2200 [GP125.SubP101.N103]

2201 2. Identify process improvements that would result in measurable
2202 improvements to process performance. [GP125.SubP102]

2203 Process improvements include both incremental changes and innovative
2204 technological improvements. The innovative technological improvements are
2205 typically pursued as efforts that are separately planned, performed, and managed.
2206 Piloting is often performed. These efforts often address specific areas of the
2207 processes that are determined by analyzing the process performance and
2208 identifying specific opportunities for significant measurable improvement.

2209 [GP125.SubP102.N101]

2210 3. Define strategies and manage deployment of selected process
2211 improvements based on the quantified expected benefits, the
2212 estimated costs and impacts, and the measured change to process
2213 performance. [GP125.SubP103]

2214 The costs and benefits of these improvements are estimated quantitatively, and
2215 the actual costs and benefits are measured. Benefits are primarily considered
2216 relative to the organization's quantitative process improvement objectives.
2217 Improvements are made to both the organization's set of standard processes and
2218 the defined processes. [GP125.SubP103.N101]

2219 Managing deployment of the process improvements includes piloting of changes
2220 and implementing adjustments where appropriate, addressing potential and real
2221 barriers to the deployment, minimizing disruption to ongoing efforts, and
2222 managing risks. [GP125.SubP103.N102]

2223 GP 5.2 Correct Common Cause of Problems [GP121]

2224 ***Identify and correct the root causes of defects and other problems***
2225 ***in the process.***

2226 The purpose of this practice is to analyze defects and other problems
2227 that were encountered, to correct the root causes of these types of
2228 defects and problems, and to prevent these defects and problems from
2229 occurring in the future.

2230 *Refer to the Causal Analysis and Resolution process area for more*
2231 *information on identifying and correcting root causes of selected*
2232 *defects. Even though the Causal Analysis and Resolution process area*
2233 *has a project context, the practices described there can be readily*
2234 *applied to a process as well.* [GP121.R101]

5 Understanding the Model

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The CMMI Product Suite represents a consensus-based approach to identifying and describing best practices in a variety of disciplines. This model is a tool used to reasonably interpret the CMMI practices when you apply them to your organization. [FM102.T101]

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Successful process improvement initiatives must be driven by the business objectives of the organization. Process improvement objectives are derived from the business objectives. In turn, process objectives are dependent on the processes the organization wishes to improve. [FM102.T102]

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For example, a common business objective is to reduce the time it takes to get a product to market. The process improvement objective derived from that might be to improve the project management processes to ensure on-time delivery. Finally, the process objectives applied from the CMMI model would be those found in the Project Planning and Project Monitoring and Control process areas. [FM102.T103]

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Four Categories of CMMI Process Areas

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In the continuous representation, there are four defined categories of CMMI process areas: [FM102.HDA101.T101]

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- Process Management Processes
- Project Management Processes
- Engineering Processes
- Support Processes

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Although process areas are grouped this way, interactions with process areas not in the group often play key roles in the evolution of an organization's processes relative to a process area category. For example, the Decision Analysis and Resolution process area provides structured decision making practices that may be used in the Technical Solution process area for selecting a technical solution from alternative solutions. Technical Solution is an Engineering process area and Decision Analysis and Resolution is a Support process area.

[FM102.HDA101.T103]

2267 For another example, the Organizational Process Definition process
2268 area provides the organization's set of standard processes and
2269 supporting assets that may be used in any process area to share "best
2270 practices," process assets, and lessons learned from across the
2271 organization. [FM102.HDA101.T105]

2272 The Engineering process areas are written in a general engineering
2273 terminology so any technical discipline involved in the product
2274 development process (for example, software engineering, mechanical
2275 engineering) can use them for process improvement. The Process
2276 Management, Project Management and Support process areas also
2277 apply to all such disciplines, as well as others. [FM102.HDA101.T106]

2278 Whether you use a model with a staged or continuous representation,
2279 you must be aware of the interactions that exist among the CMMI model
2280 components to apply the model in a useful and productive way. The
2281 following sections describe the interactions that occur among CMMI
2282 model components. [FM102.HDA101.T107]

2283 Process Management Processes

2284 **The Scope of Process Management Processes**

2285 Process management process areas contain the cross-project practices
2286 related to defining, planning, resourcing, deploying, implementing,
2287 monitoring, controlling, verifying, measuring, and improving processes.
2288 The process management process areas of CMMI are as follows:

2289 [FM102.HDA102.HDB101.T101]

- 2290 • Organizational Process Focus
- 2291 • Organizational Process Definition
- 2292 • Organizational Training
- 2293 • Organizational Process Performance
- 2294 • Organizational Innovation and Deployment

2295 To describe the interactions among the process management process
2296 areas, it is most useful to address them in two process area groups:

2297 [FM102.HDA102.HDB101.T102]

- 2298 • The "basic" process management process areas are
2299 Organizational Process Focus, Organizational Process Definition,
2300 and Organizational Training.
- 2301 • The "advanced" process management process areas are
2302 Organizational Process Performance and Organizational
2303 Innovation and Deployment.

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Basic Process Management Process Areas

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The basic process management process areas provide the organization with a basic capability to document and share best practices, process assets, and learning across the organization. [FM102.HDA102.HDB102.T101]

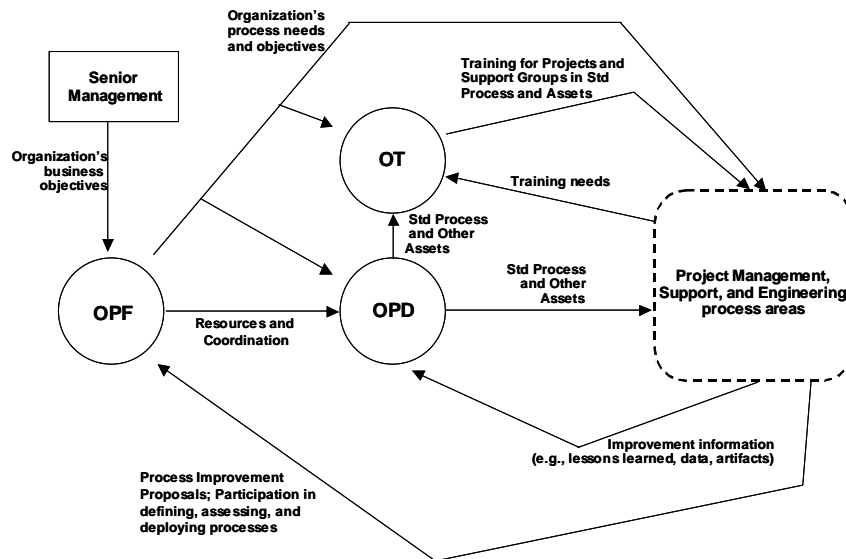
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Figure 2 provides a bird's-eye view of the interactions among the basic process management process areas. [FM102.HDA102.HDB102.T102]

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Figure 2: Basic Process Management Process Areas

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[FM102.HDA102.HDB102.T103]

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As illustrated in Figure 2, the Organizational Process Focus process area helps the organization establish and maintain an understanding of its processes and identify, plan, coordinate, and implement improvement. Candidate improvements to the organization's processes are obtained through various means. These include: process improvement proposals; measurement of the processes; lessons learned in implementing the processes; and results of process and product evaluation activities. [FM102.HDA102.HDB102.T104]

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2321 The Organizational Process Definition process area establishes and
2322 maintains the organization's set of standard processes and supporting
2323 assets based on the organizational process needs and objectives of the
2324 organization. These process and supporting assets include descriptions
2325 of processes and process elements, descriptions of life-cycle models,
2326 process tailoring guidelines, process related documentation, and data.
2327 The organization's set of standard processes is tailored by projects and
2328 support groups to create their defined processes. The other process
2329 and support assets support tailoring as well as implementation of the
2330 defined processes. Experiences and work products from performing
2331 these defined processes, including measurement data, process
2332 descriptions, process artifacts, and lessons learned are incorporated as
2333 appropriate into the organization's set of standard processes and
2334 supporting assets. [FM102.HDA102.HDB102.T105]

2335 IPPD standard processes and guidelines are included in the
2336 organization's process asset library, which is established and
2337 maintained in the Process Management process areas. These IPPD
2338 processes and guidelines require integrated processes that ensure that
2339 product-related life-cycle processes (such as manufacturing, code
2340 development, testing, deployment, training, and other support needs)
2341 are identified and planned concurrently with the product design. These
2342 integrated processes should also address relevant stakeholder
2343 involvement, customer satisfaction, and a continuous focus on the
2344 product life cycle. [FM102.HDA102.HDB102.T106]

2345 In an IPPD environment, product development processes shift
2346 emphasis from serial development to parallel collaborative development
2347 and the integration of the product set that includes all the products,
2348 services, and processes for the life cycle of the product. The tailoring of
2349 the organization's set of standard processes to IPPD guidelines and the
2350 addition of IPPD standard processes establishes the extent of process
2351 development that occurs concurrently with the product development on
2352 projects. For example, if the organization has a standard process for
2353 manufacturing a certain type or family of product components, then that
2354 process does not need to be redeveloped, but rather is tailored as the
2355 product is designed. The recommended process development decision
2356 in that case is to reuse and modify an existing process.
2357 [FM102.HDA102.HDB102.T107]

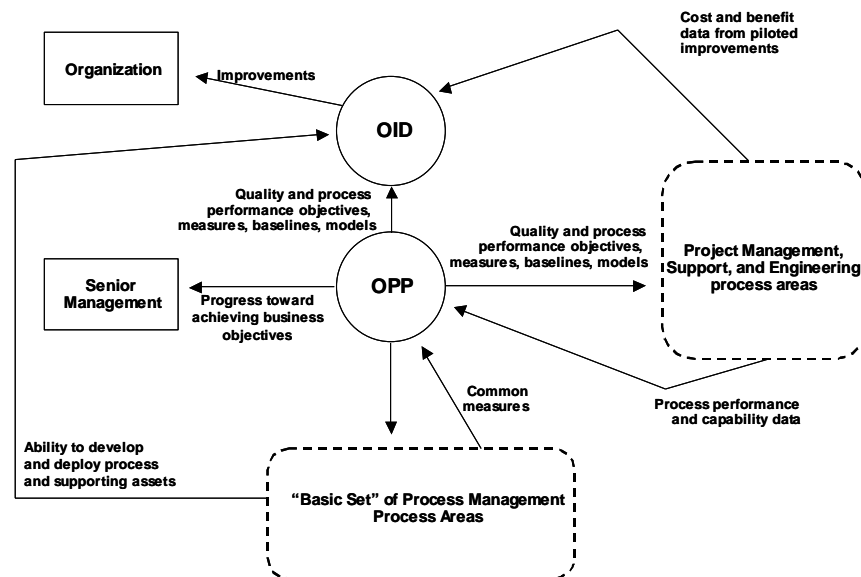
2358 The Organizational Training process area identifies the strategic
2359 training needs of the organization as well as tactical training needs that
2360 are common across projects and support groups. In particular, training
2361 is developed or obtained that develops the skills required to perform the
2362 organization's set of standard processes. The main components of
2363 training include a managed training development program, documented
2364 plans, personnel with appropriate knowledge, and mechanisms for
2365 measuring the effectiveness of the training program. [FM102.HDA102.HDB102.T108]

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Advanced Process Management Process Areas

The advanced process management process areas provide the organization with an advanced capability to achieve its quantitative objectives for quality and process performance. [FM102.HDA102.HDB103.T101]

Figure 3 provides a bird’s-eye view of the interactions among the advanced process management process areas. Each of the advanced process management process areas is strongly dependent on the ability to develop and deploy process and supporting assets. The basic process management process areas provide this ability. Thus, you should not try to reach a capability level for an advanced process management process area (up through capability level 3) prior to achieving that same capability level for all of the basic process management process areas. [FM102.HDA102.HDB103.T103]



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Figure 3: Advanced Process Management Process Areas

[FM102.HDA102.HDB103.T105]

As illustrated in Figure 3, the Organizational Process Performance process area derives quantitative objectives for quality and process performance from the organization’s business objectives. The organization provides projects and support groups with common measures, process performance baselines, and process performance models. These additional organizational support assets support quantitative project management and statistical management of critical subprocesses for both projects and support groups. The organization analyzes the process performance data collected from these defined processes to develop a quantitative understanding of product quality, service quality, and process performance of the organization’s set of standard processes. [FM102.HDA102.HDB103.T106]

2394 The Organizational Innovation and Deployment process area selects
2395 and deploys proposed incremental and innovative improvements that
2396 improve the organization's ability to meet its quality and process
2397 performance objectives. The identification of promising incremental and
2398 innovative improvements requires the participation of an empowered
2399 workforce aligned with the business values and objectives of the
2400 organization. The selection of improvements to deploy is based on a
2401 quantitative understanding of the potential benefits and costs from
2402 deploying candidate improvements, and the available funding for such
2403 deployment. [FM102.HDA102.HDB103.T107]

2404 **Achieving Capability Levels for Process Management Process Areas**

2405 Like any process area, the capability levels of process management
2406 process areas are achieved through the application of generic practices
2407 or suitable alternatives. There are a couple ways in which their
2408 application may not be immediately obvious: [FM102.HDA102.HDB104.T101]

- 2409 • Applying capability level 1 and 2 generic practices
- 2410 • Applying capability level 3, 4, and 5 generic practices

2411 Reaching capability level 1 for a process management process area is
2412 equivalent to saying you perform the process area, or more precisely,
2413 you are achieving the specific goals of the process area.

2414 [FM102.HDA102.HDB104.T102]

2415 Reaching capability level 2 for a process management process area is
2416 like saying you manage your performance of the process area. There is
2417 a policy that indicates you will perform it (that is, a process or processes
2418 that are intended to cover it). There is a plan for performing it, there are
2419 resources provided, responsibilities assigned, training on how to
2420 perform it, selected work products from performing the process area are
2421 controlled, etc. What this means in detail is spelled out in the generic
2422 practice elaborations for the capability level 2 generic practices that
2423 appear in the process area. In other words, an organizational activity
2424 can be planned and monitored just like any project or support activity.

2425 [FM102.HDA102.HDB104.T103]

2426 Reaching capability level 3 for a process management process area
2427 assumes that there is an organizational standard process, or processes
2428 that cover that process area that can be tailored to the specific need.

2429 There are two points to remember: [FM102.HDA102.HDB104.T104]

- 2430 • Tailoring may result in making no changes to the standard process.
2431 In other words, the defined process and standard process may be
2432 identical. Using the standard process "as is" is tailoring because
2433 the choice is made that no further modification is required.
- 2434 • Each process management process area covers multiple activities,
2435 some of which are repeatedly performed. You may need to tailor
2436 how one of these activities is performed to account for new

2437 capabilities or circumstances. For example, you may have a
2438 standard for developing or obtaining organizational training that
2439 does not consider training over the Web. When preparing to
2440 develop or obtain a course that will be delivered over the Web, you
2441 may need to tailor that standard process to account for the
2442 particular challenges and benefits of training delivered over the
2443 Web.

2444 Reaching capability level 4 or 5 for a process management process
2445 area is conceptually feasible but may not be economical except,
2446 perhaps, in situations where the product domain has become very
2447 stable for an extended period of time. [FM102.HDA102.HDB104.T105]

2448 Project Management Processes

2449 **The Scope of Project Management Processes**

2450 Project management process areas cover the project management
2451 activities related to planning, monitoring, and controlling the project. The
2452 project management process areas of CMMI are as follows:

2453 [FM102.HDA103.HDB101.T102]

- 2454 • Project Planning
- 2455 • Project Monitoring and Control
- 2456 • Supplier Agreement Management
- 2457 • Integrated Project Management (IPPD)
- 2458 • Risk Management
- 2459 • Integrated Teaming
- 2460 • Quantitative Project Management

2461 To describe the interactions among the project management process
2462 areas, it is most useful to address them in two process area groups:

2463 [FM102.HDA103.HDB101.T104]

- 2464 • The “basic” project management process areas are Project
2465 Planning, Project Monitoring and Control, and Supplier Agreement
2466 Management.
- 2467 • The “advanced” project management process areas are Integrated
2468 Project Management (IPPD), Risk Management, Integrated
2469 Teaming, and Quantitative Project Management.

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Basic Project Management Process Areas

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The basic project management process areas address the basic activities related to establishing and maintaining the project plan, establishing and maintaining commitments, monitoring progress against the plan, taking corrective action, and managing supplier agreements.

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[FM102.HDA103.HDB102.T101]

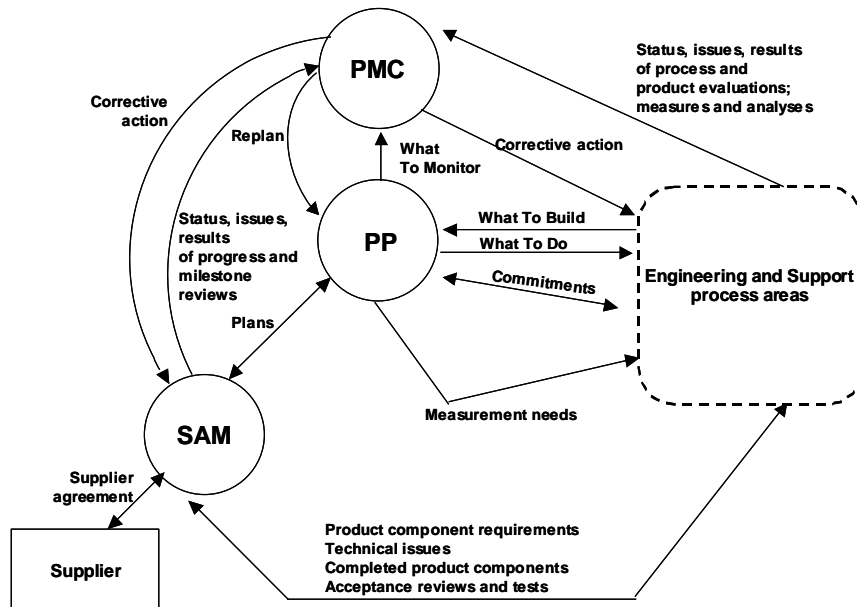
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Figure 4 provides a bird's-eye view of the interactions among the basic project management process areas and with other process areas.

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[FM102.HDA103.HDB102.T102]



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Figure 4: Basic Project Management Process Areas

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[FM102.HDA103.HDB102.T104]

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As illustrated in Figure 4, the Project Planning process area includes developing the project plan, involving stakeholders appropriately, obtaining commitment to the plan, and maintaining the plan. In an IPPD environment, stakeholders represent not just the technical expertise for product and process development, but also the business implications of the product and process development. [FM102.HDA103.HDB102.T106]

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Planning begins with requirements that define the product and project ("What to Build" in the figure). The project plan covers the various project management and engineering activities that will be performed by the project. The project will review subordinate plans from various support groups and establish commitments with those groups for their contributions to the project. These support group plans cover process and product evaluations, configuration management, and measurement and analysis. [FM102.HDA103.HDB102.T107]

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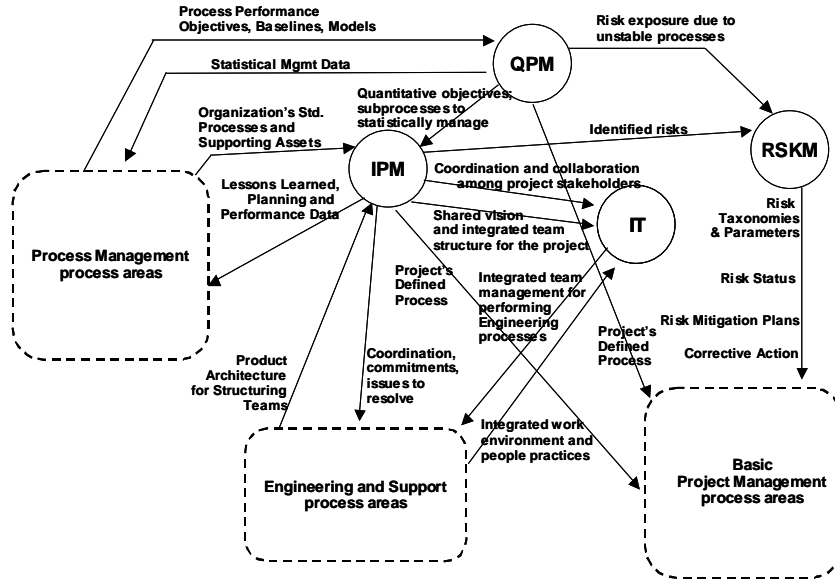
2496 The Project Monitoring and Control process area includes monitoring
2497 activities and taking corrective action. The project plan specifies the
2498 appropriate level of project monitoring, the frequency of progress
2499 reviews, and the measures used to monitor progress. Progress is
2500 primarily determined by comparing progress to the plan. When actual
2501 status deviates significantly from the expected values, corrective
2502 actions are taken as appropriate. These actions may include re-
2503 planning. [FM102.HDA103.HDB102.T108]

2504 The Supplier Agreement Management process area addresses the
2505 need of the project to effectively select and manage those portions of
2506 work that are produced by suppliers. Once a product component is
2507 identified and the supplier who will produce it is selected, a supplier
2508 agreement is established and maintained that will be used to manage
2509 the supplier. The supplier's progress and performance are monitored.
2510 Acceptance reviews and tests are conducted on the supplier-produced
2511 product component. [FM102.HDA103.HDB102.T109]

2512 **Advanced Project Management Process Areas**

2513 The advanced project management process areas address activities
2514 such as establishing a defined process that is tailored from the
2515 organization's set of standard processes, coordinating and collaborating
2516 with relevant stakeholders, risk management, forming and sustaining
2517 integrated teams for the conduct of projects, and quantitatively
2518 managing the project's defined process. [FM102.HDA103.HDB103.T102]

2519 Figure 5 provides a bird's-eye view of the interactions among the
2520 advanced project management process areas. Each of the advanced
2521 project management process areas is strongly dependent on the ability
2522 to plan, monitor, and control the project. (The basic project
2523 management process areas provide this ability.) [FM102.HDA103.HDB103.T103]



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Figure 5: Advanced Project Management Process Areas

[FM102.HDA103.HDB103.T105]

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As illustrated in Figure 5, the Integrated Project Management (IPPD) process area establishes and maintains the project's defined process that is tailored from the organization's set of standard processes. The project is managed using the project's defined process. The project uses and contributes to the organization's process and supporting assets. It also ensures that the principles of IPPD are incorporated into project planning and the project's defined process, and that the useful measures and process fragments developed when using the IPPD approach are included in the organization's process assets.

[FM102.HDA103.HDB103.T108]

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The project ensures that the relevant stakeholders associated with the project coordinate their efforts in a timely manner. It does this by providing for the management of stakeholder involvement; the identification, negotiation, and tracking of critical dependencies; and the resolution of coordination issues within the project with the stakeholders. These activities are all part of the cultural environment needed for implementation of IPPD. [FM102.HDA103.HDB103.T110]

2544 The Integrated Project Management (IPPD) process area also creates
 2545 the shared vision for the project. This shared vision needs to align both
 2546 horizontally and vertically with both the organization and integrated
 2547 team shared vision, created in the Organizational Environment for
 2548 Integration and Integrated Teaming process areas, respectively. These
 2549 shared visions collectively support the coordination and collaboration
 2550 among stakeholders. Lastly, the Integrated Project Management (IPPD)
 2551 process area implements an integrated team structure to perform the
 2552 work of the project in developing a product. This team structure is
 2553 typically based on a decomposition of the product itself, much like a
 2554 work breakdown structure. This activity is accomplished in conjunction
 2555 with the Integrated Teaming process area. [FM102.HDA103.HDB103.T111]

2556 Although risk identification and monitoring are covered in the Project
 2557 Planning and Project Monitoring and Control process areas, the Risk
 2558 Management process area takes a more continuous, forward-looking
 2559 approach to managing risks with activities that include identification of
 2560 risk parameters and taxonomies; risk assessments; and risk handling.
 2561 [FM102.HDA103.HDB103.T112]

2562 The Quantitative Project Management process area applies quantitative
 2563 and statistical techniques to manage process performance and product
 2564 quality. Quality and process performance objectives for the project are
 2565 based on those established by the organization. The project's defined
 2566 process established in the Integrated Project Management (IPPD) is
 2567 comprised, in part, of process elements and subprocesses whose
 2568 process performance can be predicted. At a minimum, the process
 2569 variation experienced by subprocesses that is critical to achieving the
 2570 project's quality and process performance objectives is understood.
 2571 Corrective action is taken when special causes of variation⁹ are
 2572 identified. [FM102.HDA103.HDB103.T114]

2573 While the integrated team structure is established within the Integrated
 2574 Project Management (IPPD) process area, the practices in the
 2575 Integrated Teaming process area provide for the formation and
 2576 sustainment of each integrated team in this structure. Part of sustaining
 2577 the team is developing the integrated team's shared vision, which must
 2578 align with the project and organization shared vision, developed in
 2579 Integrated Project Management (IPPD) and Organizational Environment
 2580 for Integration process areas, respectively. The specific practices in the
 2581 Organizational Environment for Integration and Integrated Teaming
 2582 process areas then set the environment for effecting the integrated
 2583 teamwork for completing projects. In addition, the Integrated Teaming
 2584 process area interacts with other Project Management processes by
 2585 supplying team commitments, work plans, and other information that
 2586 forms the basis for managing the project and supporting risk
 2587 management. [FM102.HDA103.HDB103.T116]

⁹ A special cause of process variation is a cause of a defect that is specific to some transient circumstance and not an inherent part of a process.

2589 The Scope of Engineering Processes

2590 Engineering process areas cover the development and maintenance
2591 practices that are shared across engineering disciplines (for example,
2592 systems engineering and software engineering). The six engineering
2593 process areas have inherent interrelationships. These interrelationships
2594 stem from applying a product development process rather than
2595 discipline-specific processes such as software engineering or systems
2596 engineering. [FM102.HDA104.HDB101.T101]

2597 The engineering process areas of CMMI are as follows:

2598 [FM102.HDA104.HDB101.T102]

- 2599 • Requirements Development
- 2600 • Requirements Management
- 2601 • Technical Solution
- 2602 • Product Integration
- 2603 • Verification
- 2604 • Validation

2605 Interactions Among Engineering Process Areas

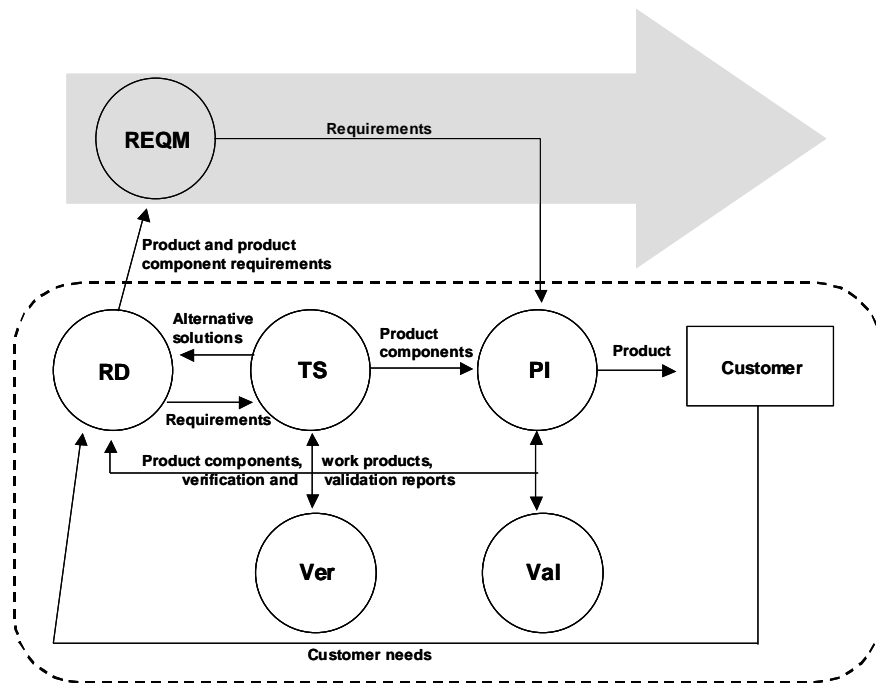
2606 The engineering process areas integrate software engineering and
2607 systems engineering processes into a product-oriented process
2608 improvement scenario. Improving product development processes
2609 targets essential business objectives, rather than specific disciplines.
2610 This approach to processes effectively avoids the tendency toward an
2611 organizational “stove-pipe” mentality. [FM102.HDA104.HDB102.T101]

2612 The technical foundation for IPPD is grounded in a robust systems
2613 engineering approach that encompasses development in the context of
2614 the product life cycle, such as that provided in the engineering process
2615 areas of the CMMI-SE/SW model. Thus, the implementation of the
2616 IPPD environment provides amplifications to specific practices in the
2617 Engineering process areas that emphasize the concurrent development
2618 and life-cycle focus. [FM102.HDA104.HDB102.T102]

2619 These engineering process areas apply to the development of any
2620 product or service in the engineering development domain (for example,
2621 software products, hardware products, services, or processes).

2622 [FM102.HDA104.HDB102.T103]

2623 Figure 6 provides a bird’s-eye view of the interactions among all
2624 engineering process areas. [FM102.HDA104.HDB102.T104]



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Figure 6: Engineering Process Areas [FM102.HDA104.HDB102.T106]

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The development of a product or service starts with the needs, expectations, and constraints of a customer. 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 entails decomposition (sometimes in multiple levels) until discipline-specific product components are identified. [FM102.HDA104.HDB102.T108]

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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 what the product's performance, design features, verification requirements, and so on, are in terms the developer understands and uses. [FM102.HDA104.HDB102.T109]

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The translation of customer needs into product requirements involves the simultaneous evolution of a preliminary functional architecture. This preliminary functional architecture assigns product requirements to functional entities; thus starting the functional decomposition necessary to eventually describe the product to be developed. [FM102.HDA104.HDB102.T110]

2645 The Requirements Development process area also supplies
2646 requirements to Technical Solution, where the requirements are
2647 converted into the product architecture, product component design, and
2648 the product component itself (for example, coding, fabrication). This
2649 information is fed to Product Integration, where product components are
2650 combined and interfaces are assured to meet the interface
2651 requirements supplied by Requirements Development.

2652 [FM102.HDA104.HDB102.T111]

2653 The Requirements Management process area maintains the
2654 requirements. It describes practices for obtaining and controlling
2655 requirement changes, and ensuring other relevant plans and data are
2656 kept current. It provides traceability of requirements from customer, to
2657 product, to product component. [FM102.HDA104.HDB102.T112]

2658 Requirements Management ensures that changes to requirements are
2659 reflected in project plans, activities, and work products. This cycle of
2660 changes may impact all the other engineering process areas, thus
2661 requirements management is a dynamic and often recursive sequence
2662 of events. Establishment and maintenance of the Requirements
2663 Management process area is fundamental to a controlled and
2664 disciplined engineering design process. [FM102.HDA104.HDB102.T113]

2665 The Technical Solution process area develops product component
2666 technical data packages and implements product components that will
2667 be used by the Product Integration process area. The examination of
2668 alternative solutions, with the intent of selecting the optimum design
2669 based upon established criteria, is expected. These criteria may be
2670 significantly different across products, depending on product type,
2671 operational environment, performance requirements, support
2672 requirements, and cost or delivery schedules. The task of selecting the
2673 final solution makes use of the practices in the Decision Analysis and
2674 Resolution process area. [FM102.HDA104.HDB102.T114]

2675 The Technical Solution process area relies on the practices in the
2676 Verification process area to perform design verification and peer
2677 reviews during design and prior to final build. [FM102.HDA104.HDB102.T115]

2678 The Verification process area ensures that selected work products meet
2679 the specified requirements. The Verification process area expects that a
2680 verification strategy is developed to ensure adequate verification. This
2681 verification strategy should be highly integrated with the Technical
2682 Solution process area and the Product Integration process area. It is
2683 generally an incremental process starting with product component
2684 verification and usually concludes with verification of fully assembled
2685 products. [FM102.HDA104.HDB102.T116]

2686 Verification also addresses peer reviews. Peer reviews are a proven
2687 method of defect reduction in product development and maintenance
2688 and provides valuable insight into the work products and product
2689 components being developed and maintained. [FM102.HDA104.HDB102.T117]

2690 The Validation process area validates products against the customer's
2691 needs. Validation may be performed in the operational environment or a
2692 simulated operational environment. Coordination with the customer on
2693 the validation requirements and the validation strategy is one of the
2694 most essential elements of this process area. [FM102.HDA104.HDB102.T118]

2695 The scope of the Validation process area includes validation of
2696 products, product components, and processes. The product, product
2697 component, or process may often require re-verification and re-
2698 validation and is therefore tightly coupled to the other engineering
2699 process areas. Issues discovered during validation are usually resolved
2700 in the Requirements Development or Technical Solution process areas.
2701 [FM102.HDA104.HDB102.T119]

2702 The Product Integration process area establishes the expected
2703 practices associated with generating the best possible integration
2704 strategy, integrating product components and delivering the product to
2705 the customer. [FM102.HDA104.HDB102.T120]

2706 Product Integration uses the practices of both Verification and
2707 Validation in implementing the product integration process. Verification
2708 verifies the interfaces and interface requirements between product
2709 components prior to product integration. This is an essential event in
2710 the integration process. During product integration in the operational
2711 environment, the practices of the Validation process area are used.
2712 [FM102.HDA104.HDB102.T121]

2713 Product Integration addresses the testing needed to ensure proper
2714 functional performance and acceptable physical attributes. After
2715 acceptance testing the product is properly packaged and shipped.
2716 [FM102.HDA104.HDB102.T122]

2717 **Engineering Process Areas and Recursion**

2718 All engineering process areas have been written to support recursion of
2719 the process(es) throughout the product architecture. There is no
2720 specific practice that forces recursive process application. Rather, the
2721 practices are written in a fashion that "expects" process application
2722 throughout the product architecture. You may be more comfortable
2723 viewing the approach as providing a sufficiently generic set of
2724 expectations that can be applied at any level of product detail rather
2725 than as "enabling recursive behavior of a process." Either view is
2726 appropriate. [FM102.HDA104.HDB103.T101]

2727 There are a number of advantages gained by this generality. For
2728 example, the engineering process areas can be applied to a product
2729 that has several layers of product components that address each layer.
2730 Thus, different segments of a very large project can be assessed using
2731 the same model. [FM102.HDA104.HDB103.T102]

2732 Support Processes

2733 **The Scope of Support**

2734 Support process areas cover the practices that support product
2735 development and maintenance and the establishment and maintenance
2736 of a work environment that facilitates and stimulates integration and
2737 manages people to enable and reward integrative behaviors. The
2738 support process areas of CMMI are as follows: [FM102.HDA105.HDB101.T102]

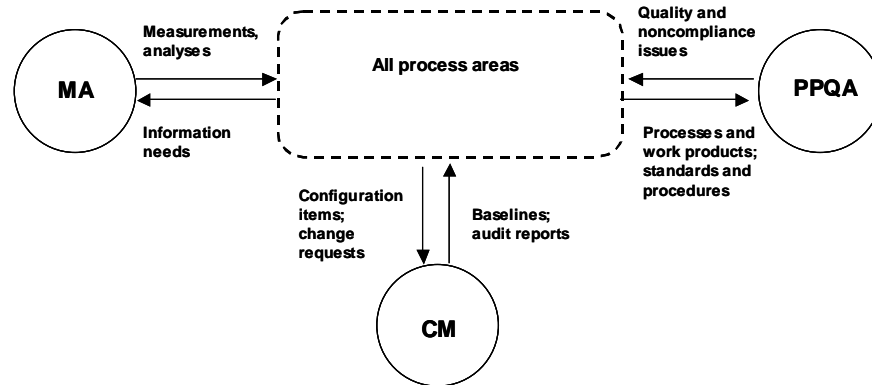
- 2739 • Configuration Management
- 2740 • Process and Product Quality Assurance
- 2741 • Measurement and Analysis
- 2742 • Organizational Environment for Integration
- 2743 • Decision Analysis and Resolution
- 2744 • Causal Analysis and Resolution

2745 The support process areas provide essential processes that are used
2746 by all of the CMMI process areas and are typically used in the context
2747 of performing other processes. In general the support process areas are
2748 targeted towards the project (except for Process and Product Quality
2749 Assurance and Organizational Environment for Integration) but can be
2750 applied more generally to the organization. For example, Process and
2751 Product Quality Assurance can be used with all the process areas to
2752 provide an objective review of the processes and work products
2753 described in all of the process areas. [FM102.HDA105.HDB101.T104]

2754 **Basic Support Process Areas**

2755 The basic support process areas address basic support functions that
2756 will be used by all of the process areas. Although all support process
2757 areas rely on the other process areas in the CMMI model for inputs, all
2758 of the basic support process areas provide support functions that are
2759 covered by generic practices. [FM102.HDA105.HDB102.T101]

2760 Figure 7 provides a bird's-eye view of the basic Support process areas'
2761 interactions. [FM102.HDA105.HDB102.T102]



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Figure 7: Basic Support Process Areas [FM102.HDA105.HDB102.T104]

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The Measurement and Analysis process area supports all process areas by providing practices that guide projects and organizations in aligning measurement needs and objectives with a measurement approach that will provide objective results that can be used in making informed decisions, and taking appropriate corrective actions.

[FM102.HDA105.HDB102.T105]

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The Process and Product Quality Assurance process area supports all process areas by providing practices for objectively evaluating performed processes, work products, and services against the applicable process descriptions, standards, and procedures and ensuring that any issues arising from these reviews are addressed. Process and Product Quality Assurance supports the delivery of high-quality products and services by providing the project staff and all levels of managers with appropriate visibility into, and feedback on, the processes and associated work products throughout the life cycle.

[FM102.HDA105.HDB102.T106]

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The Configuration Management process area supports all process areas by establishing and maintaining the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits. The work products placed under configuration management include the products that are delivered to the customer, designated internal work products, acquired products, tools, and other items that are used in creating and describing these work products. Examples of work products that may be placed under configuration management include plans, process descriptions, requirements, design data, drawings, product specifications, code, compilers, product data files, and product technical publications.

[FM102.HDA105.HDB102.T107]

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Advanced Support Process Areas

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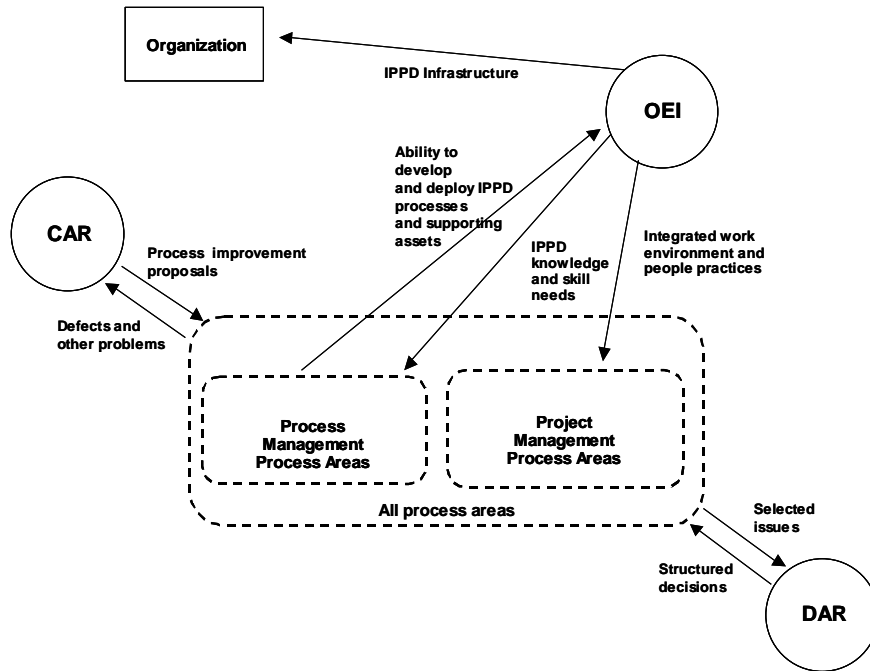
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The advanced support process areas provide the projects and organization with an advanced support capability. Each of these process areas rely on specific inputs or practices from other process areas. [FM102.HDA105.HDB103.T101]

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Figure 8 provides a bird's-eye view of the advanced Support process areas' interactions. [FM102.HDA105.HDB103.T102]



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Figure 8: Advanced Support Process Areas [FM102.HDA105.HDB103.T105]

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The Organizational Environment for Integration process area establishes the approach and environment for the implementation of IPPD. The environment is established by obtaining, adapting, or developing processes that facilitate effective integrated team behavior as well as stakeholder communication and collaboration, creating the organization's shared vision, and managing people to promote integrative behavior. Specific practices in the Organizational Environment for Integration process area promote both team and individual excellence while enabling and rewarding integration across all business and technical functions in the execution of the projects.

[FM102.HDA105.HDB103.T106]

2812 Using the Causal Analysis and Resolution process area, the project
2813 strives to understand the common causes of variation inherent in the
2814 process and remove them from the project's processes as well as using
2815 this knowledge to continually improve the organization's processes.
2816 Both the defined processes and the organization's set of standard
2817 processes are targets of these improvement activities.

2818 [FM102.HDA105.HDB103.T107]

2819 The Decision Analysis and Resolution process area supports all the
2820 process areas by providing a structured decision-making process that
2821 ensures that alternatives are compared and the best one is selected to
2822 accomplish the goals of the process areas. [FM102.HDA105.HDB103.T108]

2823 Applying Generic Practices to Process Areas

2824 Generic practices are model components that are present in both
2825 staged and continuous representations. Likewise, in both
2826 representations, a generic practice is applied to a process area in the
2827 same way. Think of generic practices as reminders. They serve a
2828 purpose of reminding you to do things right and are expected model
2829 components. [FM102.HDA106.T101]

2830 For example, when you are achieving the goals of the Project Planning
2831 process area, you are establishing and maintaining plans that define
2832 project activities. One of the generic practices that applies to the Project
2833 Planning process area is "Establish and maintain the requirements and
2834 objectives, and plans for performing the project planning process."
2835 When applied to this process area, this generic practice ensures that
2836 you planned the approach you were taking to create the plan for the
2837 project. [FM102.HDA106.T102]

2838 Although this sounds complicated, it is simply one of the things many
2839 project members typically do when creating a project plan. If all of your
2840 project plans are completely different and consequently don't contain
2841 common elements defined to be part of a project plan in your
2842 organization, you would not meet this expected generic practice.
2843 However, if you used the standard set up for creating project plans in
2844 your organization, you would meet this expected generic practice.

2845 [FM102.HDA106.T103]

2846 When you are achieving the goals of the Organizational Training
2847 process area, you are developing the skills and knowledge of people so
2848 they can perform their roles effectively and efficiently. One of the
2849 generic practices that applies to the Organizational Training process
2850 area is “Establish and maintain a organizational policy for planning and
2851 performing the process.” When applied to this process area, this
2852 generic practice ensures that you planned the approach you were
2853 taking to developing the skills and knowledge of people in the
2854 organization. [FM102.HDA106.T104]

2855 The generic goals and practices are the model components that provide
2856 commitment and consistency throughout an organization’s processes
2857 and practices. This consistency and commitment results in what is
2858 called “institutionalization.” In other words, the best practices that the
2859 CMMI models describe are anchored in the very existence and
2860 operation of the organization. [FM102.HDA106.T105]

2861 In a continuous representation of a CMMI model, generic practices
2862 appear in every process area under the five generic goals, although the
2863 subpractices of these generic practices appear only in the chapter four
2864 of the model. The name “generic” reflects the fact that these goals and
2865 practices are applied to every process area chosen by the organization
2866 for its process improvement efforts. [FM102.HDA106.T106]

2867 **Process Area and Generic Practice Interaction**

2868 In the continuous model, the process management process areas
2869 enable the application of most capability level 3 through 5 generic
2870 practices to particular process areas (hereafter called the “subject
2871 process area”). [FM102.HDA106.HDB101.T101]

2872 At capability level 3, the “Establish and Maintain a Defined Process”
2873 generic practice operates on a description of an organizational standard
2874 process covering the subject process area. For example, establishing a
2875 defined process for configuration management in the context of a
2876 particular project, or in the context of developing and maintaining the
2877 organization’s set of standard processes, requires a standard process
2878 and supporting assets for performing configuration management. While
2879 these could be developed for configuration management independently
2880 of those for other process areas, this is usually approached through a
2881 broader-based effort to define standard processes for several related
2882 processes to provide better visibility and control. The Organizational
2883 Process Definition process area provides this role. [FM102.HDA106.HDB101.T102]

2884 Likewise, the “Collect Improvement Information” generic practice
2885 assumes organizational assets that can capture what has been learned
2886 and shares that learning the next time a defined process that covers the
2887 subject process area is needed. For example, a defined process for
2888 configuration management generates progress and baseline accounting
2889 data and perhaps process artifacts that can be adapted the next time
2890 configuration management needs to be performed. The Organizational
2891 Process Definition process area again provides this role.

2892 [FM102.HDA106.HDB101.T103]

2893 Therefore, the capability level 3 generic practices are “enabled” by the
2894 Organizational Process Definition process area. [FM102.HDA106.HDB101.T104]

2895 The Integrated Project Management (IPPD) process area also supports
2896 the capability level 3 generic practices when they are applied to a
2897 project management, engineering, or support process area, but in a
2898 different way - it performs the generic practice for several process
2899 areas. The Integrated Project Management (IPPD) process area
2900 establishes the project’s defined process, which integrates defined
2901 processes covering the basic project management, engineering, and
2902 support process areas. Thus, if you have evolved one or more of these
2903 process areas to capability level 3, you are in fact accomplishing a
2904 significant portion of the first specific goal of Integrated Project
2905 Management (IPPD), and vice versa. [FM102.HDA106.HDB101.T106]

2906 The capability level 3 generic practices “subsume part of” the Integrated
2907 Project Management (IPPD) process area. Even if all basic project
2908 management, engineering, and support process areas are matured to
2909 capability level 3, the subsumption is not complete - the result may not
2910 be an integrated, defined process for the project. More importantly, the
2911 second specific goal has not necessarily been addressed.

2912 [FM102.HDA106.HDB101.T108]

2913 This “subsume part of” relationship is important to remember during
2914 assessments, as observations can be duplicated between the generic
2915 practices and their related process areas. (The actual generation of the
2916 information is described in the Integrated Project Management (IPPD)
2917 process area if the scope of the process area falls within projects.)

2918 [FM102.HDA106.HDB101.T110]

2919 At capability level 4, the “Establish Quality Objectives” generic practice
2920 assumes and benefits from an organizational process performance
2921 analysis that typically, though not necessarily, covers several related
2922 processes considered critical to process performance. Likewise, the
2923 “Stabilize Subprocess Performance” generic practice assumes
2924 additional supporting assets that provide insight into the expected
2925 performance of critical subprocesses addressed by the subject process
2926 area. The Organizational Process Performance process area provides
2927 both roles. [FM102.HDA106.HDB101.T111]

2928 The Organizational Innovation and Deployment process area actually
 2929 performs the “Ensure Continuous Process Improvement” generic
 2930 practice for other process areas. In both the generic practice and the
 2931 process area, a systematic approach is taken to identifying, evaluating,
 2932 and deploying improvements to both processes and technologies that
 2933 typically, though not necessarily, cover several related process areas.
 2934 Thus, the “Ensure Continuous Process Improvement” generic practice
 2935 subsumes part of the Organizational Innovation and Deployment
 2936 process area. There can of course be considerable benefit in taking a
 2937 more broad and integrated approach to organizational innovation and
 2938 deployment, but the generic practice helps track maturation of individual
 2939 process areas to capability level 5. [FM102.HDA106.HDB101.T112]

2940 Likewise, the “Correct Common Causes of Problems” generic practice
 2941 subsumes part of the Causal Analysis and Resolution process area.
 2942 There can be considerable benefit in taking a more broad and
 2943 integrated approach to causal analysis and resolution, but the generic
 2944 practice helps track maturation of individual process areas to capability
 2945 level 5. [FM102.HDA106.HDB101.T113]

2946 Given the above dependencies, to mature a process area to capability
 2947 level 3, it would be natural to expect, though not required, that the
 2948 Organizational Process Focus and Organizational Process Definition
 2949 process areas be implemented. Evolving a process area to capability
 2950 level 4 or 5, is typically achieved by implementing at least some parts of
 2951 process areas, as illustrated in Table 1. [FM102.HDA106.HDB101.T114]

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Generic Practice	Process area that enables (or is subsumed partly by) the generic practice
Both capability level 3 generic practices	Enabled by Organizational Process Definition Subsumes part of Integrated Project Management
Both capability level 4 generic practices	Enabled by Organizational Process Performance Subsumes part of Quantitative Project Management
Ensure Continuous Process Improvement generic practice (CL5)	Enabled by, and subsumes part of, Organizational Innovation and Deployment
Correct Common Causes of Problems generic practice (CL5)	Subsumes part of Causal Analysis and Resolution

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Table 1: Generic Practices and Related Process Areas

[FM102.HDA106.HDB101.T116]

2956 To raise a targeted set of process areas to capability levels 3, 4, or 5, it
2957 is necessary to implement both the generic practices and the enabling
2958 process areas in a way that covers the targeted set of process areas.
2959 When doing this, there is some advantage to implementing the process
2960 areas the generic practices partially subsume, because of the broader
2961 view they provide. Remember that when you implement one of these
2962 partially subsumed process areas, you are applying its corresponding
2963 generic practice across a large number of process areas, and thus
2964 there is an intended overlap. [FM102.HDA106.HDB101.T117]

2965 There are also a few of what may seem like overlaps, but are not. It
2966 may be natural to think that the application of the “Establish a Defined
2967 Process” generic practice applied to the Project Planning and Project
2968 Monitoring and Control process area gives the same effect as the first
2969 specific goal of Integrated Project Management (IPPD).
2970 [FM102.HDA106.HDB101.T119]

2971 Although it is true that there is some overlap, the application of the
2972 generic practice to these two process areas provides defined processes
2973 covering project planning and monitoring activities. These defined
2974 processes do not cover support activities (such as configuration
2975 management), other project management process areas (such as
2976 supplier agreement management), or the engineering process areas. In
2977 contrast, the project’s defined process, provided by the Integrated
2978 Project Management (IPPD) process area, covers all basic project
2979 management, engineering, and support process areas.
2980 [FM102.HDA106.HDB101.T121]

2981 Account for these overlaps when you are conducting assessments or
2982 planning improvements using the continuous representation.
2983 [FM102.HDA106.HDB101.T122]

2984 **Overlap of Generic Practices and Process Management Process Ar-** 2985 **reas**

2986 Table 1 indicates that there are overlaps between some process areas
2987 and some generic practices. [FM102.HDA106.HDB102.T101]

2988 To raise a targeted set of process areas to capability levels 3, 4, or 5, it
2989 is necessary to implement both the generic practices and the enabling
2990 process areas in a way that covers the targeted set of process areas.
2991 When doing this, there is some advantage to implementing the process
2992 areas the generic practices partially subsume, because of the broader
2993 view they provide. Remember that when you implement one of these
2994 partially subsumed process areas, you are applying its corresponding
2995 generic practice across a large number of process areas, and thus
2996 there is an intended overlap. [FM102.HDA106.HDB102.T102]

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6 Using the Model

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The CMMI project has worked to preserve the government and industry investments in process improvement and to enhance and replace the use of multiple models. In addition to improving the usability of CMM technology in a wider set of disciplines, the CMMI concept calls for use of common terminology, common components, common assessment methods, and common training materials. The objective is to reduce the cost of establishing and maintaining effective process improvement efforts across an enterprise using multiple disciplines to produce its products or services. This chapter describes how organizations may use the model for both process improvement and benchmarking.

[FM120.T101]

3009 Interpreting the Model

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Every CMMI model provides a set of publicly available criteria describing the characteristics of organizations that have successfully implemented process improvement. These criteria can be used by organizations to improve their processes for developing and maintaining products and services. While a new enterprise might wish to establish its processes using these concepts, it is most common to find organizations already doing business, but seeking to improve their process methodology. [FM120.HDA101.T101]

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Such organizations should use professional judgment to interpret CMMI practices. Although process areas depict behavior that should be exhibited in any organization, practices must be interpreted using an in-depth knowledge of the CMMI model, the organization, the business environment, and the specific circumstances involved. [FM120.HDA101.T102]

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CMMI practices purposely use nonspecific phrases such as “relevant stakeholders,” “as appropriate,” and “as necessary” to meet the needs of different organizations or projects. Specific needs may also differ at various points in a single project’s development life cycle. [FM120.HDA101.T103]

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To interpret practices, it is important to consider the overall context in which they are used and how well the practices satisfy the goals of a process area within that context. The CMMI model does not prejudge which processes are right for the organization or project. Instead, it establishes minimal criteria that processes must meet to be considered capable. [FM120.HDA101.T104]

3033 A capable process is defined, documented, practiced, supported,
3034 maintained, controlled, verified, validated, measured, and able to be
3035 improved. While process capability can be judged using a CMMI
3036 model, process effectiveness requires specific consideration of the
3037 business environment of the organization and its projects.

3038 [FM120.HDA101.T106]

3039 The CMMI models have resulted from studying the practices and needs
3040 of highly structured, large, and complex projects. While they are also
3041 appropriate for smaller organizations, some of the processes described
3042 in the model will not suit the needs of smaller companies or projects
3043 without tailoring or interpretation. For example, in a small organization
3044 the processes performed by a “group” in the model may instead be the
3045 responsibility of a single individual. [FM120.HDA101.T107]

3046 Assessing for Process Improvement and Benchmarking

3047 Process assessments focus on identifying improvement opportunities.
3048 The organization should set its priorities based on its business and
3049 process improvement objectives, as well as its collection of business
3050 and technical processes. Assessment teams use the CMMI models to
3051 guide them in identifying and prioritizing findings. These findings, with
3052 guidance provided by the practices in the CMMI models, are used (by
3053 an engineering process group, for example) to plan an improvement
3054 strategy for the organization. In addition, many organizations find value
3055 in benchmarking their progress in process improvement for both internal
3056 purposes and with external customers and suppliers. [FM120.HDA102.T101]

3057 For organizations that wish to assess multiple disciplines (for example,
3058 software engineering and system engineering), the unified CMMI
3059 approach permits some economy of scale in model training and
3060 assessment training. One assessment method can provide separate or
3061 combined results for multiple disciplines. [FM120.HDA102.T102]

3062 Alternatively, an organization may wish to use, for example, a limited
3063 Class B or C assessment method¹⁰ with the continuous representation
3064 to focus on individual process areas of most significant business value.
3065 It might then employ a Class A staged Standard CMMI Assessment
3066 Method for Process Improvement (SCAMPI) on a less frequent basis to
3067 benchmark the entire organization. [FM120.HDA102.T103]

3068 The CMMI assessment products will also allow the assessment of a
3069 single discipline, as in the past. CMMI assessment products provide
3070 consistent findings for staged and continuous representations with
3071 equivalent staging. [FM120.HDA102.T105]

¹⁰ See Assessment Requirements for CMMI (ARC) and Standard CMMI Assessment Method for Process Improvement (SCAMPI) for more information about classes of assessment methods.

3072 The assessment principles for the CMMI Product Suite remain the
3073 same as those used in past assessments using the SW-CMM and the
3074 Systems Engineering Capability Model (SECM): [FM120.HDA102.T106]

- 3075 • senior management sponsorship
- 3076 • a focus on the organization's business objectives
- 3077 • confidentiality for interviewees
- 3078 • use of a documented assessment method
- 3079 • use of a process reference model (for example, a CMMI model) as
- 3080 a base
- 3081 • a collaborative team approach
- 3082 • a focus on actions for process improvement

3083 Over time, a suite of assessment techniques is expected to be
3084 available. New techniques will be developed and existing ones
3085 improved to meet various needs for building internal improvement and
3086 external confidence. The CMMI project has produced one method to
3087 meet the need for a rigorous assessment tool for benchmarking and a
3088 set of guidelines for future additions to the suite for other process
3089 improvement assessments requiring less rigor and repeatability. This
3090 first and most rigorous version has been named the Standard CMMI
3091 Assessment Method for Process Improvement, or SCAMPI. Details on
3092 this method are available on the Software Engineering Institute Web
3093 site. [FM120.HDA102.T107]

3094 For benchmarking against other organizations, assessments must
3095 ensure consistent ratings. The achievement of a specific maturity level
3096 or the satisfaction of a specific process area must mean the same thing
3097 for different assessed organizations. Rules for ensuring this consistency
3098 are provided in the documents mentioned above. SCAMPI is the only
3099 assessment method initially considered to be suitable for rendering
3100 ratings for benchmarking the CMMI model. The SEI, as steward of the
3101 CMMI Product Suite, will assure that any public comments or
3102 statements about maturity levels or ratings resulting from a SCAMPI
3103 meet quality and consistency criteria. [FM120.HDA102.T108]

3104 SCAMPI was written to conform to the emerging International
3105 Organization for Standardization and the International/Electrotechnical
3106 Commission (ISO/IEC) 15504 technical report. ISO/IEC 15504 is an
3107 international collaboration to develop a standard set of technical reports
3108 on software process assessment that has been underway since June
3109 1993 under the auspices of the ISO/IEC. For those sponsors interested
3110 in performing a ISO/IEC 15504-conformant assessment, SCAMPI will
3111 support these needs. [FM120.HDA102.T109]

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Assessment Requirements for CMMI

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The Assessment Requirements for CMMI (ARC) is a set of criteria for developing, defining, and using assessment methods based on CMMI products. The ARC provides requirements for multiple types of assessment methods with guidelines for determining the suitability of a particular assessment method. Suitability addresses the accuracy and repeatability of assessment results. [FM120.HDA102.HDB101.T101]

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The ARC uses the CMMI models as its associated reference models. The CMM Appraisal Framework (CAF) v1.0 was originally produced to address assessment methods associated with the CMM for Software only. With the incorporation of CMMs into the CMMI architecture, the ARC has been created to address these new models and the resulting impacts of the staged and continuous representations of each model.

[FM120.HDA102.HDB101.T102]

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The ARC was designed to help improve consistency across multiple disciplines and assessment methods, and to help assessment method developers, sponsors, and users understand the trade-offs associated with various methods. More information and a matrix detailing ARC requirements is available on the Software Engineering Institute Web site. [FM120.HDA102.HDB101.T103]

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Other CMMI-based assessment methods may be appropriate for a given set of sponsor needs, including self-assessments, initial assessments, quick-look or mini-assessments, incremental assessments, and external audit evaluations. Method developers are expected and encouraged to develop a variety of assessment methods to meet these needs. [FM120.HDA102.HDB101.T104]

3138 Making the Transition to CMMI

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This section briefly describes three transition scenarios. The first two assume the organization has already begun its improvement efforts using either the SECM or the Software CMM. The third scenario assumes that the organization has not used a particular reference model for current improvement efforts, or that there have been no improvement efforts to date. [FM120.HDA103.T101]

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Organizations with SECM Experience

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Organizations that have framed their process improvement efforts around systems engineering models have similar choices to make, depending upon their progress on current improvement efforts. The process capability focus of this set of models makes transition choices more varied than if multiple process areas were spotlighted as in the SW-CMM. [FM120.HDA103.HDB101.T101]

3152 The evolution from EIA/IS 731 involves both: (1) some reorganization of
3153 specific practices under goals and process areas and (2) the addition of
3154 informative material. Initial transition steps therefore might be to
3155 compare current specific practice improvement efforts against those
3156 now expected in the CMMI models. [FM120.HDA103.HDB101.T102]

3157 **Organizations with Software CMM Experience**

3158 Most organizations initially making the transition to CMMI will likely be
3159 seeking to update their process improvement efforts to incorporate the
3160 Version 2.0 draft C improvements and to gain the additional breadth of
3161 organizational and life-cycle coverage afforded in the CMMI model.
3162 Many of these organizations will need to decide the best timing for
3163 transition to preserve the value of plans toward, for example, a
3164 particular maturity level achievement. (See the staged representation
3165 for more information on maturity levels.) [FM120.HDA103.HDB102.T101]

3166 Organizations that have already achieved a high level of maturity may
3167 wish to make the transition more quickly to take advantage of the
3168 additional organizational coverage described in the CMMI model. These
3169 organizations will find strong commonality between this and the heritage
3170 model. There is also significant improvement in coverage of the
3171 engineering dimension, more detailed coverage of risk management
3172 and measurement, and analysis that was less specific in the Software
3173 CMM. [FM120.HDA103.HDB102.T102]

3174 The practices at levels 4 and 5 have been improved based on
3175 experience gained since the publication of SW-CMM Version 2 draft C.
3176 These practices have been further refined from the source model based
3177 on studies conducted by the SEI that analyzed the implementation of
3178 level 4 and 5 practices by leading organizations. [FM120.HDA103.HDB102.T103]

3179 Organizations that have begun significant movement toward a maturity
3180 level 2, 3, or 4 assessment must weigh the costs of making the
3181 transition against the benefits of the improved coverage the integrated
3182 model offers. [FM120.HDA103.HDB102.T104]

3183 Organizations may wish to consider the versatility offered by the
3184 continuous and staged representations in planning their long-term
3185 assessment strategy. If the costs of total transition appear high, an
3186 interim strategy might be to augment the current plan with selected
3187 process areas of greatest business value. [FM120.HDA103.HDB102.T106]

3188 For example, a company with several months remaining before a
3189 maturity level 4 assessment might want to charter small teams to
3190 investigate Risk Management and Measurement and Analysis, and add
3191 them to the assessment scope to begin the transition without affecting
3192 current efforts. This strategy allows members of the organization to
3193 have a “first look” at new process areas to gain insight that helps them
3194 build business value in these two key areas as well as preparing them
3195 for future CMMI assessments. [FM120.HDA103.HDB102.T107]

3196 **Organizations Without Experience in Either Model**

3197 Organizations without experience in either model are assumed to be in
3198 one of two categories. They may have process improvement efforts
3199 under other quality initiatives such as ISO 9000 or Malcolm Baldrige; or
3200 they may be considering such efforts due to the mounting evidence of
3201 business value resulting from such a commitment. [FM120.HDA103.HDB104.T101]

3202 Both categories of organizations will find familiar relationships to other
3203 quality efforts in this Product Suite. They also gain a reference model of
3204 effective practices that can be applied—across the value chain—to
3205 enhance the development of software-intensive products and
3206 associated services. [FM120.HDA103.HDB104.T102]

3207 These organizations might wish to begin by considering whether
3208 approaching improvement is better served by emphasizing process
3209 capability or organizational maturity. Each approach is complementary.
3210 A focus on process capability allows the building of organizational
3211 maturity, and a focus on organizational maturity allows concentration on
3212 particular process capabilities. Neither is mutually exclusive, but the
3213 choice will determine which representation will best fit the needs of the
3214 organization for training and assessment. [FM120.HDA103.HDB104.T103]

3215 Once your organization has decided which representation is the best fit,
3216 planning can begin with an improvement strategy such as the IDEAL
3217 (initiating, diagnosing, establishing, acting, leveraging) model. Research
3218 has shown that the most powerful initial step to process improvement is
3219 to build a strong organizational sponsorship during an initiating phase
3220 prior to significant diagnostic efforts. [FM120.HDA103.HDB104.T104]

3221 Given sufficient senior management sponsorship, establishing a
3222 specific, technically competent group to guide process improvement
3223 efforts has proven to be a best practice. For an organization whose
3224 mission is to develop software-intensive systems, the group might
3225 include systems engineers and software engineers from projects across
3226 the organization, and selected other membership based on the
3227 business needs driving improvement. For example, a systems
3228 administrator focused on Information Technology support and a
3229 marketing representative concerned with integrating customer needs
3230 could make powerful additions to the engineering process group (EPG).

3231 [FM120.HDA103.HDB104.T105]

3232 **Training**

3233 Training is a key element in the ability of organizations to adopt CMMI
3234 and is therefore a key part of the Product Suite. While an initial set of
3235 courses will be provided by the SEI and its transition partners, your
3236 organization may wish to supplement these courses with internal
3237 instruction. This approach allows the focus of organizational attention to
3238 be placed on the areas marked for greater attention due to the linkage
3239 to the product development value chain. [FM120.HDA103.HDB105.T101]

3240 Initial training will be available for both representations of CMMI models,
3241 with additional training provided to assist those who will need to guide
3242 improvement on the EPG, or those seeking to become lead assessors.
3243 [FM120.HDA103.HDB105.T102]

3244 **Tailoring Criteria**

3245 Tailoring the CMMI model is a process whereby only a subset of the
3246 model is used to make it suitable for a specific application.
3247 [FM120.HDA104.T101]

3248 Tailoring the CMMI assessment method is the selection of options for
3249 use in a specific assessment. In both cases, the intent of tailoring is to
3250 assist an organization or project in aligning the CMMI products with its
3251 business needs and objectives, and thus focus on those aspects of the
3252 products and services that are most beneficial to the organization.
3253 [FM120.HDA104.T102]

3254 The tailoring discussed in this section does not address adaptation of
3255 an organization's set of standard processes for use on a specific
3256 project. Such tailoring is driven by tailoring guidelines defined by an
3257 organization and is further addressed in the Integrated Project
3258 Management (IPPD) process area. [FM120.HDA104.T104]

3259 Tailoring should be done knowing that it can result in significant gaps in
3260 efforts to improve or assess an organization's or project's capabilities.
3261 [FM120.HDA104.T105]

3262 **Model Tailoring Perspectives**

3263 Tailoring of the CMMI model can be viewed from two perspectives:
3264 [FM120.HDA104.HDB101.T101]

- 3265 • Tailoring related to use of the model for process improvement
- 3266 • Tailoring related to use of the model for benchmarking

3267 Many organizations will use the model for benchmarking as well as
3268 process improvement, so the appropriate tailoring will be constrained by
3269 the intersection of criteria outlined below. [FM120.HDA104.HDB101.T102]

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Model Tailoring Criteria for Internal Process Improvement

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For internal process improvement, it is appropriate to restrict or expand the scope of an organization's or project's improvement effort (including assessments). The tailoring may address individual disciplines, process areas, maturity levels, and/or capability levels. Tailoring of the model should focus on identifying the process areas and practices that support the business needs and objectives. [FM120.HDA104.HDB102.T101]

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Care must be taken when considering tailoring out portions of the model. Given the model's focus on the essential characteristics of an effective process, the majority of the process areas and practices in the model typically would be addressed. In fact, the folly of wholesale exclusion of fundamental processes and/or practices (in particular at maturity levels 2 and 3) is clear given the prevalence of data indicating that following CMM-based improvement efforts will significantly improve attainment of business objectives. Cited improvements in the literature include the increased likelihood that an organization or project will achieve its cost and/or schedule objectives. [FM120.HDA104.HDB102.T102]

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Organizations and/or projects implementing less than a full set of process areas, goals, or practices can still achieve significant value from the CMMI model. However, due to the significant interrelationship of model components, exclusion of a significant number of process areas, goals, and/or practices may constrain the benefits achieved. In addition, the degree of comparability of assessment results is directly related to the extent to which the model and assessment method have been tailored. [FM120.HDA104.HDB102.T103]

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Model Tailoring Criteria for Benchmarking

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Use of the CMMI model for benchmarking purposes allows for comparison of process assessment results across industry via state-of-the-practice reports or across a group of organizations such as potential suppliers. Any tailoring applied in this way must ensure consistency in the ratings and/or findings resulting from use of the model in multiple assessments. As a result, model tailoring for benchmarking is significantly constrained, especially where maturity levels resulting from assessments are disseminated publicly for marketing purposes.

[FM120.HDA104.HDB103.T101]

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Keep in mind that the disciplines chosen for an assessment also affects the context of benchmarking. If one organization chooses to assess only software engineering while another chooses to assess software and systems engineering, comparing the two would not be fair or accurate. Model tailoring criteria for benchmarking are defined as follows: [FM120.HDA104.HDB103.T102]

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- Process areas include required and expected components and thus may not be excluded (that is, tailored out) other than to delete

3313 those that are outside the scope of an assessment. For example,
 3314 process areas at maturity levels 4 and 5 may be omitted for an
 3315 assessment focused on maturity level 3, where all process areas
 3316 for levels 2 and 3 would typically be selected.

- 3317 • Process areas, in some unique circumstances, may be determined
 3318 to be "not applicable" if the process area is, in fact, outside of the
 3319 organization's scope of work. Typically, very few process areas are
 3320 eligible for exclusion in this manner. An example of a process area
 3321 that might be excluded would be Supplier Agreement
 3322 Management, a process area that may be inapplicable in the
 3323 absence of suppliers of products and services external to the
 3324 organization that are critical to the development effort. A maturity
 3325 level rating could still be determined, with the identification of the
 3326 "not applicable" process area.
- 3327 • A process area is designated as "not rated" if it is outside of the
 3328 assessment scope or if insufficient data is available to satisfy the
 3329 data coverage criteria. A maturity level cannot be determined if
 3330 process areas at that level (or below) are "not rated."
- 3331 • Goals, are required and thus are not excluded from those process
 3332 areas included in the scope of a process improvement or
 3333 assessment effort. Goals reflect the minimum requirements for
 3334 satisfying a process area at their defined capability levels. If a
 3335 process area is applicable, each of its goals is applicable at defined
 3336 capability levels. Goals work together to support a process area
 3337 and may not be individually designated as "not applicable."
- 3338 • Specific practices and generic practices are expected to be
 3339 implemented as typical activities necessary to implement and
 3340 institutionalize the goals or capability levels. However, appropriate
 3341 alternative practices may be substituted for specific practices
 3342 and/or generic practices if the alternatives are effective in
 3343 implementing and institutionalizing the goals. Infrequently, a
 3344 specific practice may be determined during an assessment to be
 3345 "not applicable" and thus excluded from coverage.
- 3346 • All other model components (subpractices, examples,
 3347 amplifications, elaborations and/or references) contained in CMMI
 3348 models are informative and are provided solely for guidance in
 3349 implementation.

3350 **Model Tailoring for Smaller Projects**

3351 The CMMI models were written for use by all types of organizations;
 3352 however, for small organizations a CMMI model must be interpreted. In
 3353 the case of small 3- to 6-month projects, a high-level plan is typically
 3354 available that has been developed for a group of projects. This high-
 3355 level plan defines the organization, resources, training, management
 3356 participation, and quality assurance reporting descriptions for all
 3357 member projects. [FM120.HDA104.HDB104.T101]

3358 Conversely, in the project plan, the details of what the project is
3359 developing, the development process, the schedule, and staff assigned
3360 to each task are defined. Often this plan also captures the development
3361 plan, quality assurance plan, and configuration management plan. A
3362 four-person project development group might expect to develop a five-
3363 page project plan. Dynamic parts of the plan, such as the schedule and
3364 list of deliverables are in the plan's appendix. [FM120.HDA104.HDB104.T102]

3365 Project specifics, such as special customer requirements, may be
3366 covered in the project plan. Usually, the bulk of the project plan is a
3367 detailed schedule in which resources are assigned and tracked. The
3368 global development and test environment, quality assurance review
3369 process, configuration management, delivery processes, and customer
3370 and internal review processes are in the higher-level management plan.
3371 [FM120.HDA104.HDB104.T103]

3372 In small projects, meetings take place more frequently, take less time,
3373 and cover more details. The schedule may contain daily activities, and
3374 may be monitored in weekly meetings. The schedule may change
3375 weekly. A configuration management function keeps every version of
3376 the schedule in the project library. [FM120.HDA104.HDB104.T104]

3377 In a small team, the customer usually knows the entire team and feels
3378 comfortable calling any member of the team to propose or discuss a
3379 change. The team must decide up front how to handle these informal
3380 calls from the customer. Once they have decided on an approach, it
3381 should be captured in the project plan details, and communicated to the
3382 customer. [FM120.HDA104.HDB104.T105]

3383 The work of a small team may be highly collaborative; thus, a formal
3384 peer review may not provide a high return on investment. The checklist
3385 for the review by a peer is just as comprehensive in this small team
3386 approach as it would be for a larger team. All of the standards are
3387 enforced by all of the members of the team. [FM120.HDA104.HDB104.T106]

3388 Periodically, reviews of the project plans and lessons learned may be
3389 funneled to a higher-level of the organization. This review ensures that
3390 the higher level documentation and direction is continually improved.
3391 Best business practices are identified and fed back into the
3392 organization's process asset library, and the organizational processes,
3393 plans, and templates are modified to reflect the improvements used by
3394 the project. The next time the project begins work with a new set of
3395 requirements, it tailors the updated organizational assets.
3396 [FM120.HDA104.HDB104.T107]

3397 **Assessment Tailoring Criteria**

3398 The major tailoring options for a CMMI assessment include:
3399 [FM120.HDA104.HDB105.T101]

- 3400 • Establishing the assessment scope, including the organizational
- 3401 entity to be assessed, the CMMI process areas to be investigated,
- 3402 and the capability level to be assessed
- 3403 • Selecting the assessment method
- 3404 • Selecting the assessment team members
- 3405 • Selecting assessment participants from the assessment entity to
- 3406 be interviewed
- 3407 • Establishing assessment outputs (for example, ratings, project-
- 3408 specific findings)
- 3409 • Establishing assessment constraints (for example, time spent on
- 3410 site)

3411 In addition to these tailoring options, the CMMI assessment method
3412 description details a number of specific tailoring options driven by
3413 considering the objectives of a particular assessment and the business
3414 objectives of the organization and/or project. Documentation of CMMI
3415 assessment plans and results must always include a description of the
3416 tailoring options selected, as well as any model tailoring. Such
3417 documentation will enable a determination to be made of the
3418 comparability of assessment results across organizations.

3419 [FM120.HDA104.HDB105.T102]

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7 Process Areas

3421 PROCESS MANAGEMENT

3422 The following section contains all of the process areas that belong to
3423 the Process Management process area category. The process
3424 Management process areas of CMMI are as follows: [FM104.T101]

- 3425 • Organizational Process Focus
- 3426 • Organizational Process Definition
- 3427 • Organizational Training
- 3428 • Organizational Process Performance
- 3429 • Organizational Innovation and Deployment

3430 *Refer to the Understanding the Model chapter of the Overview section*
3431 *for more information about the Process Management process areas*
3432 *and how they interact. [FM104.T101.R101]*

3433 ORGANIZATIONAL PROCESS FOCUS

3434 Process Management

3435 Purpose

3436 The purpose of Organizational Process Focus is to establish and
3437 maintain an understanding of the organization's processes and process
3438 assets, and to identify, plan, and implement the organization's process
3439 improvement activities. [PA152]

3440 Introductory Notes

3441 The organization's processes include the organization's set of standard
3442 processes and the defined processes derived from them. The
3443 organization's process assets are artifacts that relate to describing,
3444 implementing, and improving processes (e.g., policies, process
3445 descriptions, support environments, and process implementation
3446 support tools). [PA152.N101]

3447 Candidate improvements to the organization's process assets are
3448 obtained from various sources, including measurement of the
3449 processes, lessons learned in implementing the processes, results of
3450 process assessments, results of process and product verification
3451 activities, results of benchmarking against other organizations'
3452 processes, and recommendations from other improvement initiatives in
3453 the organization. [PA152.N102]

3454 Process improvement occurs within the context of the organization's
3455 needs and is used to address the organization's objectives. The
3456 responsibility of facilitating and managing the organization's process
3457 improvement activities is typically assigned to a process group. The
3458 organization provides the long-term commitment and resources
3459 required to sponsor this group. [PA152.N103]

3460 Careful planning is required to ensure that process improvement efforts
3461 across the organization are adequately managed and implemented. At
3462 the highest level, the organization's planning for Process Improvement
3463 results in a Process Improvement Plan. This plan provides the overall
3464 process improvement strategy that the organization will use. This
3465 strategy may call for more focused, detailed implementation plans such
3466 as Assessment Plans, Process Action Plans, Pilot Plans, and
3467 Deployment Plans. Assessment Plans describe the assessment
3468 timeline and schedule, the scope of the assessment, the resources
3469 required to perform the assessment, the reference model against which
3470 the assessment will be performed, the logistics for the assessment, etc.
3471 Process Action Plans usually result from assessments or evaluations,
3472 and document how specific improvements targeting the weaknesses
3473 uncovered by an assessment will be implemented. In cases in which it
3474 is determined that the improvement described in the Process Action
3475 Plan should be tested on a small group before deploying it across the
3476 organization, a Pilot Plan is generated. Finally, when the improvement
3477 is ready for deployment, a Deployment Plan is used. This plan
3478 describes when and how the improvement will be deployed across the
3479 organization. [PA152.N104]

3480 The organization's process assets are used to establish, maintain,
3481 implement, and improve the defined processes that are tailored from
3482 the organization's set of standard processes. [PA152.N105]

3483 Related Process Areas

3484 *Refer to the Organizational Process Definition process area for more*
3485 *information about the organization's process assets.* [PA152.R101]

3486 Specific Goals

3487 **SG 1 Determine Process Improvement Opportunities** [PA152.IG101]

3488 ***Strengths, weaknesses, and improvement opportunities for the organization's***
3489 ***processes are identified periodically and as needed.***

3490 **SG 2 Plan and Implement Process Improvement Activities** [PA152.IG102]

3491 ***Improvements are planned and implemented, process assets are deployed,***
3492 ***and process-related experiences are incorporated into the organization's***
3493 ***process assets.***

3494 Generic Goals

3495 **GG 1** **Achieve Specific Goals** [CL102.GL101]

3496 *The process supports and enables achievement of the specific goals of the*
3497 *process area by transforming identifiable input work products to produce*
3498 *identifiable output work products.*

3499 **GG 2** **Institutionalize a Managed Process** [CL103.GL101]

3500 *The process is institutionalized as a managed process.*

3501 **GG 3** **Institutionalize a Defined Process** [CL104.GL101]

3502 *The process is institutionalized as a defined process.*

3503 **GG 4** **Institutionalize a Quantitatively Managed Process** [CL105.GL101]

3504 *The process is institutionalized as a quantitatively managed process.*

3505 **GG 5** **Institutionalize an Optimizing Process** [CL106.GL101]

3506 *The process is institutionalized as an optimizing process.*

3507 Practice to Goal Relationship Table

- 3508 SG 1 Determine Process Improvement Opportunities [PA152.IG101]
 3509 SP 1.1-1 Establish Organizational Process Needs
 3510 SP 1.2-1 Assess the Organization's Processes
 3511 SP 1.3-1 Identify the Organization's Process Improvements
- 3512 SG 2 Plan and Implement Process Improvement Activities [PA152.IG102]
 3513 SP 2.1-1 Establish Process Action Plans
 3514 SP 2.2-1 Implement Process Action Plans
 3515 SP 2.3-1 Deploy Process and Related Process Assets
 3516 SP 2.4-1 Incorporate Process-Related Experiences into the Organization's Process Assets
 3517
- 3518 GG 1 Achieve Specific Goals [CL102.GL101]
 3519 GP 1.1 Identify Work Scope
 3520 GP 1.2 Perform Base Practices
- 3521 GG 2 Institutionalize a Managed Process [CL103.GL101]
 3522 GP 2.1 Establish an Organizational Policy
 3523 GP 2.2 Plan the Process
 3524 GP 2.3 Provide Resources
 3525 GP 2.4 Assign Responsibility
 3526 GP 2.5 Train People
 3527 GP 2.6 Manage Configurations
 3528 GP 2.7 Identify and Involve Relevant Stakeholders
 3529 GP 2.8 Monitor and Control the Process
 3530 GP 2.9 Objectively Evaluate Adherence
 3531 GP 2.10 Review Status with Higher-Level Management
- 3532 GG 3 Institutionalize a Defined Process [CL104.GL101]
 3533 GP 3.1 Establish a Defined Process
 3534 GP 3.2 Collect Improvement Information
- 3535 GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]
 3536 GP 4.1 Establish Quality Objectives
 3537 GP 4.2 Stabilize Subprocess Performance
- 3538 GG 5 Institutionalize an Optimizing Process [CL106.GL101]
 3539 GP 5.1 Ensure Continuous Process Improvement
 3540 GP 5.2 Correct Common Cause of Problems

3541 Specific Practices by Goal

3542 SG 1 Determine Process Improvement Opportunities [PA152.IG101]

3543 ***Strengths, weaknesses, and improvement opportunities for the organization's***
 3544 ***processes are identified periodically and as needed.***

3545 Strengths, weaknesses, and improvement opportunities may be
3546 determined relative to a process standard or model such as a Capability
3547 Maturity Model-Integrated (CMMI) model or International Organization
3548 for Standardization (ISO) standard. The process improvements should
3549 be selected specifically to address the organization's needs.

3550 [PA152.IG101.N101]

3551 **SP 1.1-1 Establish Organizational Process Needs**

3552 ***Establish and maintain the description of the process needs and***
3553 ***objectives for the organization.*** [PA152.IG101.SP101]

3554 ***For Integrated Product and Process Development***

3555 *Integrated processes that emphasize parallel rather than serial*
3556 *development are a cornerstone of IPPD implementation.*
3557 *Product development processes and product-related process-*
3558 *development processes, such as the manufacturing process*
3559 *development and the support process development*
3560 *processes, are conducted concurrently. Such integrated*
3561 *processes need to accommodate the information provided by*
3562 *stakeholders representing all phases of the product life cycle*
3563 *from both business and technical functions. Processes for*
3564 *effective teamwork will also be needed.* [PA152.IG101.SP101.AMP101]

3565 ***For Integrated Product and Process Development***

3566 ***Examples of processes for effective teamwork include:***
3567 [PA152.IG101.SP101.AMP102]

- 3568 • *Communications*
- 3569 • *Collaborative decision-making*
- 3570 • *Issue resolution*
- 3571 • *Team-building*

3572

3573 The organization's processes operate in a business context that must
3574 be understood. The organization's business objectives, needs, and
3575 constraints determine the needs and objectives for the organization's
3576 processes. Typically, the financial, technological, quality, human
3577 resource, and marketing issues are important process considerations.

3578 [PA152.IG101.SP101.N101]

3579 The organization's process needs and objectives cover aspects that
3580 include the following: [PA152.IG101.SP101.N102]

- 3581 • Characteristics of the processes
- 3582 • Process performance objectives, such as time-to-market and
3583 product quality

- 3584
- Process effectiveness

3585 **Typical Work Products**

- 3586 1. Organization's process needs and objectives [PA152.IG101.SP101.W101]

3587 **Subpractices**

- 3588 1. Identify the policies, standards, and business objectives that are
3589 applicable to the organization's processes. [PA152.IG101.SP101.SubP101]
- 3590 2. Examine relevant process standards and models for standard and
3591 best practices. [PA152.IG101.SP101.SubP102]
- 3592 3. Determine the organization's process performance objectives.
3593 [PA152.IG101.SP101.SubP103]

3594 Process performance objectives may be expressed in quantitative or qualitative
3595 terms. [PA152.IG101.SP101.SubP103.N101]

3596 Examples of process performance objectives include the following:

3597 [PA152.IG101.SP101.SubP103.N102]

- 3598
- Cycle time
 - Defect removal rates
 - Productivity
- 3600

- 3601
- 3602 4. Define the essential characteristics of the organization's processes.
3603 [PA152.IG101.SP101.SubP104]

3604 The essential characteristics of the organization's processes are determined
3605 based on the following: [PA152.IG101.SP101.SubP104.N101]

- 3606
- Processes currently being used in the organization
 - Process standards and product standards imposed by the organization
 - Process standards and product standards commonly imposed by customers of the organization
- 3609

3610 Examples of process characteristics include the following: [PA152.IG101.SP101.SubP104.N102]

- 3611
- Level of detail used to describe the processes
 - Process notation used
 - Granularity of the processes
- 3613

- 3614
- 3615 5. Document the organization's process needs and objectives.
3616 [PA152.IG101.SP101.SubP105]

- 3617 6. Revise the organization's process needs and objectives as
3618 needed. [PA152.IG101.SP101.SubP106]

3619 **SP 1.2-1 Assess the Organization's Processes**

3620 ***Assess the processes of the organization periodically and as***
3621 ***needed to maintain an understanding of their strengths and***
3622 ***weaknesses.*** [PA152.IG101.SP102]

3623 Process assessments may be performed for the following reasons:

3624 [PA152.IG101.SP102.N101]

- 3625 • To identify processes that should be improved
- 3626 • To verify progress and make the benefits of process improvement
3627 visible
- 3628 • To satisfy the needs of a customer-supplier relationship
- 3629 • To motivate and facilitate buy-in

3630 The buy-in gained during a process assessment can be eroded
3631 significantly if it is not followed by an assessment-based action plan.

3632 [PA152.IG101.SP102.N102]

3633 **Typical Work Products**

- 3634 1. Plans for the organization's process assessments

3635 [PA152.IG101.SP102.W101]

- 3636 2. Assessment findings that address strengths and weaknesses of
3637 the organization's processes [PA152.IG101.SP102.W102]

- 3638 3. Improvement recommendations for the organization's processes

3639 [PA152.IG101.SP102.W103]

3640 **Subpractices**

- 3641 1. Obtain sponsorship of the process assessment from senior
3642 management. [PA152.IG101.SP102.SubP101]

3643 Senior management sponsorship includes the commitment to have the
3644 organization's managers and staff participate in the process assessment and to
3645 provide the resources and funding to analyze and communicate the findings of the
3646 assessment. [PA152.IG101.SP102.SubP101.N101]

- 3647 2. Define the scope of the process assessment. [PA152.IG101.SP102.SubP102]

3648 Process assessments may be performed on the entire organization or may be
3649 performed on a smaller part of an organization such as a single project or
3650 business area. [PA152.IG101.SP102.SubP102.N101]

3651 The scope of the process assessment addresses the following:

3652 [PA152.IG101.SP102.SubP102.N102]

- 3653 • Definition of the organization (e.g., sites or business areas) that will be covered by
3654 the assessment

- 3655 • Identification of the project and support functions that will represent the
- 3656 organization in the assessment
- 3657 • Processes or process areas that will be assessed
- 3658 3. Determine the method and criteria for process assessment.
- 3659 [PA152.IG101.SP102.SubP103]
- 3660 Process assessments can occur in many forms. Process assessments need to
- 3661 address the needs and objectives of the organization, which may change over
- 3662 time. For example, the assessment may be based on a process model, such as a
- 3663 CMMI model, or on a national or international standard, such as ISO 9001. The
- 3664 assessments may also be based on a benchmark comparison with other
- 3665 organizations. The assessment method may assume a variety of characteristics in
- 3666 terms of time and effort expended, makeup of the assessment team, and the
- 3667 method and depth of investigation, for example. [PA152.IG101.SP102.SubP103.N101]
- 3668 4. Plan, schedule, and prepare for the process assessment.
- 3669 [PA152.IG101.SP102.SubP104]
- 3670 5. Conduct the process assessment. [PA152.IG101.SP102.SubP105]
- 3671 6. Document the assessment activities and findings.
- 3672 [PA152.IG101.SP102.SubP106]

SP 1.3-1 Identify the Organization's Process Improvements

Identify improvements to the organization's processes and related process assets. [PA152.IG101.SP103]

Typical Work Products

- 3676 1. Analysis of candidate process improvements [PA152.IG101.SP103.W101]
- 3677 2. Identification of improvements for the organization's processes
- 3678 [PA152.IG101.SP103.W102]
- 3679

Subpractices

- 3680 1. Determine candidate process improvements. [PA152.IG101.SP103.SubP101]
- 3681

Candidate process improvements are typically determined by doing the following:

[PA152.IG101.SP103.SubP101.N101]

- 3684 • Measure and analyze the processes
- 3685 • Review the processes for effectiveness and suitability
- 3686 • Review the lessons learned from tailoring the organization's set of standard
- 3687 processes
- 3688 • Review the lessons learned from implementing the processes
- 3689 • Review process improvement proposals submitted by the organization's
- 3690 managers and staff, and other stakeholders

- 3691 • Solicit inputs on process improvements from the senior management and leaders
- 3692 in the organization
- 3693 • Examine the results of process assessments and other process-related reviews
- 3694 • Review results of other organization improvement initiatives

2. Prioritize the candidate process improvements. [PA152.IG101.SP103.SubP102]

Criteria for prioritization are as follows: [PA152.IG101.SP103.SubP102.N101]

- 3697 • Consider the estimated cost and effort to implement the process improvements
- 3698 • Evaluate the expected improvement against the organization's improvement
- 3699 objectives and priorities
- 3700 • Determine the potential barriers to the process improvements and strategies for
- 3701 overcoming these barriers

Examples of techniques to help determine and prioritize the possible improvements to be implemented include the following: [PA152.IG101.SP103.SubP102.N102]

- 3704 • A gap analysis looking at the current conditions in the organization versus the
- 3705 optimal conditions
- 3706 • Force-field analysis of potential improvements to identify potential barriers and
- 3707 strategies for overcoming those barriers Cause/effect analyses to provide
- 3708 information on the potential effects of different improvements that can then be
- 3709 compared

3. Identify and document the process improvements that will be implemented. [PA152.IG101.SP103.SubP103]

4. Revise the list of planned process improvements to keep it current. [PA152.IG101.SP103.SubP104]

3715 **SG 2 Plan and Implement Process Improvement Activities** [PA152.IG102]

3716 ***Improvements are planned and implemented, process assets are deployed,***

3717 ***and process-related experiences are incorporated into the organization's***

3718 ***process assets.***

3719 Successful implementation of improvements requires participation in the

3720 process definition and improvement activities by process owners, those

3721 performing the process, and support organizations. [PA152.IG102.N101]

3722 **SP 2.1-1 Establish Process Action Plans**

3723 ***Establish and maintain process action plans to address***

3724 ***improvements to the organization's processes and related process***

3725 ***assets.*** [PA152.IG102.SP101]

3726 Establishing and maintaining process action plans typically involves the
3727 following roles: [PA152.IG102.SP101.N101]

- 3728 • Management steering committees to set strategies and oversee
3729 process improvement activities
- 3730 • Process group staff to facilitate and manage the process
3731 improvement activities
- 3732 • Process action teams to define and implement the improvement
- 3733 • Process owners to manage the deployment
- 3734 • Practitioners to perform the process

3735 This involvement helps to obtain buy-in on the process improvements
3736 and increases the likelihood of effective deployment. [PA152.IG102.SP101.N102]

3737 Process action plans are detailed implementation plans. These plans
3738 differ from the Organization's Process Improvement Plan in that they
3739 are plans targeting specific improvements that have been defined to
3740 address weaknesses usually uncovered by assessments or
3741 evaluations. [PA152.IG102.SP101.N103]

3742 **Typical Work Products**

- 3743 1. Organization's approved process action plans [PA152.IG102.SP101.W101]

3744 **Subpractices**

- 3745 1. Identify strategies, approaches, and actions to address the
3746 identified process improvements. [PA152.IG102.SP101.SubP101]

3747 New, unproven, and major changes are piloted before they are incorporated into
3748 normal practice. [PA152.IG102.SP101.SubP101.N101]

- 3749 2. Establish process action teams to implement the actions.
3750 [PA152.IG102.SP101.SubP102]

3751 The teams and people performing the process improvement actions are called
3752 "process action teams." Process action teams typically include process owners
3753 and those who perform the process. [PA152.IG102.SP101.SubP102.N101]

- 3754 3. Document process action plans. [PA152.IG102.SP101.SubP103]

3755 Process action plans typically cover the following: [PA152.IG102.SP101.SubP103.N101]

- 3756 • Process improvement infrastructure
- 3757 • Process improvement objectives
- 3758 • Process improvements that will be addressed
- 3759 • Procedures for planning and tracking process actions
- 3760 • Strategies for implementing the process actions
- 3761 • Responsibility and authority for implementing the process actions

- 3762 • Resources, schedules, and assignments for implementing the process actions
- 3763 • Methods for determining the effectiveness of the process actions
- 3764 • Risks associated with process action plans
- 3765 4. Review and negotiate process action plans with relevant
- 3766 stakeholders. [PA152.IG102.SP101.SubP104]
- 3767 5. Review process action plans as necessary. [PA152.IG102.SP101.SubP105]

SP 2.2-1 Implement Process Action Plans

Implement process action plans across the organization.

[PA152.IG102.SP102]

Typical Work Products

- 3771 1. Commitments among the various process action teams
- 3772 [PA152.IG102.SP102.W101]
- 3773
- 3774 2. Status and results of implementing process action plans
- 3775 [PA152.IG102.SP102.W102]
- 3776 3. Plans for pilots [PA152.IG102.SP102.W103]

Subpractices

- 3777 1. Make process action plans readily available to relevant
- 3778 stakeholders. [PA152.IG102.SP102.SubP101]
- 3779
- 3780 2. Negotiate and document commitments among the process action
- 3781 teams and revise their process action plans as necessary.
- 3782 [PA152.IG102.SP102.SubP102]
- 3783 3. Track progress and commitments against process action plans.
- 3784 [PA152.IG102.SP102.SubP103]
- 3785 4. Conduct joint reviews with the process action teams and others
- 3786 affected to monitor the progress and results of the process actions.
- 3787 [PA152.IG102.SP102.SubP104]
- 3788 5. Plan pilots needed to test selected process improvements.
- 3789 [PA152.IG102.SP102.SubP105]
- 3790 6. Review the activities and work products of process action teams.
- 3791 [PA152.IG102.SP102.SubP106]
- 3792 7. Identify, document, and track to closure issues in implementing
- 3793 process action plans. [PA152.IG102.SP102.SubP107]
- 3794 8. Ensure that the results of implementing process action plans
- 3795 satisfy the organization's process improvement objectives.
- 3796 [PA152.IG102.SP102.SubP108]

3797 **SP 2.3-1 Deploy Process and Related Process Assets**

3798 ***Deploy the process and related process assets across the***
3799 ***organization.*** [PA152.IG102.SP103]

3800 Deployment of a process and related process assets or of changes to
3801 an existing process and related process assets should be performed in
3802 an orderly manner. Some process assets or changes to process assets
3803 may not be appropriate for implementation in some parts of the
3804 organization (for example, because of customer requirements or the
3805 current life-cycle phase being implemented). It is therefore important
3806 that those that are or will be executing the process, as well as other
3807 organization functions (such as training and quality assurance) be
3808 involved in the deployment, as necessary. [PA152.IG102.SP103.N101]

3809 *Refer to the Organizational Process Definition process area for more*
3810 *information about how the deployment of process assets is supported*
3811 *and enabled by the existence of an Organizational Support*
3812 *Environment and an Organizational Process Asset Library .*

3813 [PA152.IG102.SP103.N101.R101]

3814 **Typical Work Products**

- 3815 1. Plans for deploying the process assets and changes to process
3816 assets [PA152.IG102.SP103.W101]
- 3817 2. Training materials for deploying the process assets and changes to
3818 process assets [PA152.IG102.SP103.W102]
- 3819 3. Documentation of changes to the process assets [PA152.IG102.SP103.W103]
- 3820 4. Support materials for deploying the process assets and changes to
3821 process assets [PA152.IG102.SP103.W104]

3822 **Subpractices**

- 3823 1. Deploy process assets and associated methods and tools.

3824 [PA152.IG102.SP103.SubP101]

3825 Typical activities performed as a part of this deployment include the following:

3826 [PA152.IG102.SP103.SubP101.N101]

- 3827
- 3828 • Planning the deployment
 - 3829 • Identifying the process assets that should be adopted by those who will be
3830 performing the process
 - 3831 • Ensuring that training for the process assets that are being deployed is available
 - 3832 • Identifying the support resources (e.g., tools) needed to transition the deployed
3833 process assets
 - 3834 • Determining the schedule for deploying the process assets

3834 *Refer to the Organizational Training process area for more information*
3835 *about coordination of training.* [PA152.IG102.SP103.SubP101.N101.R101]

- 3836 2. Deploy the changes that were made to the process assets.
3837 [PA152.IG102.SP103.SubP102]
- 3838 Typical activities performed as a part of this deployment include the following:
3839 [PA152.IG102.SP103.SubP102.N101]
- 3840 • Planning the deployment
 - 3841 • Determining which changes are appropriate for those that are or will be
3842 performing the process
 - 3843 • Determining the time frame for deploying the changes
 - 3844 • Arranging for the associated support needed to successfully transition the
3845 changes
- 3846 3. Document the changes to the process assets. [PA152.IG102.SP103.SubP103]
- 3847 The documentation of changes is used to understand the relationship of the
3848 changes to resulting changes in process performance and results.
3849 [PA152.IG102.SP103.SubP103.N101]
- 3850 4. Provide guidance and consultation on the use of the process
3851 assets. [PA152.IG102.SP103.SubP104]

3852 **SP 2.4-1 Incorporate Process-Related Experiences into the Organization's**
3853 **Process Assets**

3854 ***Incorporate process-related work products, measures, and***
3855 ***improvement information derived from planning and performing***
3856 ***the process into the organization's process assets.*** [PA152.IG102.SP104]

3857 **Typical Work Products**

- 3858 1. Process improvement proposals [PA152.IG102.SP104.W101]
- 3859 2. Process lessons learned [PA152.IG102.SP104.W102]
- 3860 3. Measurements on the organization process assets
3861 [PA152.IG102.SP104.W103]
- 3862 4. Improvement recommendations for the organization's process
3863 assets [PA152.IG102.SP104.W104]
- 3864 5. Records of the organization's process improvement activities
3865 [PA152.IG102.SP104.W105]
- 3866 6. Information on the organization's process assets and
3867 improvements to them [PA152.IG102.SP104.W106]

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Subpractices

1. Conduct periodic reviews of the effectiveness and suitability of the organization's set of standard processes and related process assets that are relative to the organization's business objectives.
[PA152.IG102.SP104.SubP101]
2. Obtain feedback about the use of the process assets.
[PA152.IG102.SP104.SubP102]
3. Derive lessons learned from defining, piloting, implementing, and deploying the process assets. [PA152.IG102.SP104.SubP103]
4. Make lessons learned available to the people in the organization as appropriate. [PA152.IG102.SP104.SubP104]

Actions may have to be taken to ensure that lessons learned are used appropriately. [PA152.IG102.SP104.SubP104.N101]

Examples of inappropriate use of lessons learned include the following:
[PA152.IG102.SP104.SubP104.N102]

- To evaluate the performance of people
- To judge process performance or results

Examples of ways to prevent inappropriate use of lessons learned include the following: [PA152.IG102.SP104.SubP104.N103]

- Controlling access to the lessons learned
- Educating people about the appropriate use of lessons learned

5. Analyze the organization's common set of measures.
[PA152.IG102.SP104.SubP105]

Refer to the Measurement and Analysis process area for more information about analyzing measures. [PA152.IG102.SP104.SubP105.R101]

Refer to the Organizational Process Definition process area for more information about establishing an organizational measurement repository, including common measures [PA152.IG102.SP104.SubP105.R102]

6. Evaluate the processes, methods, and tools in use in the organization and develop recommendations for improving the organization's process assets. [PA152.IG102.SP104.SubP106]

This evaluation typically includes the following: [PA152.IG102.SP104.SubP106.N101]

- Determining which of the processes, methods, and tools are of potential use to other parts of the organization
- Evaluating the quality and effectiveness of the organization's process assets

- 3905 • Identifying candidate improvements to the organization's process assets
- 3906 • Determining compliance with the organization's set of standard processes and
- 3907 tailoring guidelines
- 3908 7. Make the best use of the organization's processes, methods, and
- 3909 tools available to the people in the organization as appropriate.
- 3910 [PA152.IG102.SP104.SubP107]
- 3911 8. Manage process improvement proposals. [PA152.IG102.SP104.SubP108]
- 3912 The activities for managing process improvement proposals typically include the
- 3913 following: [PA152.IG102.SP104.SubP108.N101]
- 3914 • Soliciting process improvement proposals
- 3915 • Collecting process improvement proposals
- 3916 • Reviewing the process improvement proposals
- 3917 • Selecting the process improvement proposals that will be implemented
- 3918 • Tracking the implementation of the process improvement proposals
- 3919 Process improvement proposals are documented as process change requests or
- 3920 problem reports, as appropriate. [PA152.IG102.SP104.SubP108.N102]
- 3921 Some process improvement proposals may be incorporated into the
- 3922 organization's process action plans. [PA152.IG102.SP104.SubP108.N103]
- 3923 9. Establish and maintain records of the organization's process
- 3924 improvement activities. [PA152.IG102.SP104.SubP109]

3925 Generic Practices by Goal

3926 **GG 1 Achieve Specific Goals**

3927 *The process supports and enables achievement of the specific goals of the*
 3928 *process area by transforming identifiable input work products to produce*
 3929 *identifiable output work products.*

3930 **GP 1.1 Identify Work Scope**

3931 *Identify the scope of the work to be performed and work products*
 3932 *to be produced for organizational process focus, and*
 3933 *communicate this information to those performing the work.* [GP101]

3934 **GP 1.2 Perform Base Practices**

3935 *Perform the base practices of the organizational process focus*
 3936 *process to develop work products and provide services to achieve*
 3937 *the specific goals of the process area.* [GP102]

3938 **GG 2 Institutionalize a Managed Process**

3939 ***The process is institutionalized as a managed process.***

3940 **GP 2.1 Establish an Organizational Policy**

3941 ***Establish and maintain an organizational policy for planning and***
3942 ***performing the organizational process focus process. [GP103]***

3943 Elaboration:

3944 This policy establishes organizational expectations for determining
3945 process improvement opportunities of the processes being used, and
3946 planning and implementing process improvement activities across the
3947 organization. [PA152.EL101]

3948 **GP 2.2 Plan the Process**

3949 ***Establish and maintain the requirements and objectives, and plans***
3950 ***for performing the organizational process focus process. [GP104]***

3951 Elaboration:

3952 These requirements, objectives, and plans are described in the
3953 organization's plan for process improvement (Process Improvement
3954 Plan). This plan for process improvement differs from the process
3955 action plans described in the specific practices in this PA. The process
3956 action plans address the tactical, short-term improvements for the
3957 organization; whereas the plan for process improvement addresses the
3958 overall process improvement strategy for the organization. [PA152.EL103]

3959 **GP 2.3 Provide Resources**

3960 ***Provide adequate resources for performing the organizational***
3961 ***process focus process, developing the work products and***
3962 ***providing the services of the process. [GP105]***

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Elaboration:

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Examples of tools used in performing the activities of the Organizational Process Focus process area include the following: [PA152.EL106]

- Database management systems
- Process improvement tools
- Web page builders and browsers
- Groupware
- Quality improvement tools (e.g., quality improvement tools, cause-and-effect diagrams, affinity diagrams, Pareto charts)

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GP 2.4 Assign Responsibility

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

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Elaboration:

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Two groups are typically established and assigned responsibility for process improvement: (1) a management steering committee for process improvement to provide senior management sponsorship; and (2) a Process Group (e.g., the Engineering Process Group or EPG) to facilitate and manage the process improvement activities. [PA152.EL120]

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GP 2.5 Train People

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Train the people performing or supporting the organizational process focus process as needed. [GP107]

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Elaboration:

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Examples of training topics include the following: [PA152.EL107]

- CMMI and other process and process improvement reference models
- Planning and managing process improvement
- Tools, methods, and analysis techniques
- Process modeling
- Facilitation techniques
- Change management

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GP 2.6 Manage Configurations

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

Elaboration:

Examples of work products placed under configuration management include the following: [PA152.EL108]

- Process improvement proposals
- Organization's approved process action plans
- Training materials for deploying process assets
- Plans for the organization's process assessments

GP 2.7 Identify and Involve Relevant Stakeholders

Identify and involve the relevant stakeholders of the organizational process focus process as planned. [GP124]

Elaboration:

Examples of activities for stakeholder involvement include: [PA152.EL119]

- Coordinating and collaborating on process improvement activities with process owners, those that are or will be performing the process, and support organizations (e.g., training staff and quality assurance representatives)
- Establishing the organizational process needs and objectives
- Assessing the organization's processes
- Implementing process action plans
- Coordinating and collaborating on the execution of pilots to test selected improvements
- Deploying process assets and changes to process assets
- Communicating the plans, status, activities, and results related to the implementation of process improvement activities

GP 2.8 Monitor and Control the Process

Monitor and control the organizational process focus process against the plan and take appropriate corrective action. [GP110]

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Elaboration:

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Examples of measures used in monitoring and controlling the activities of the Organizational Process Focus process area include the following:

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[PA152.EL113]

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- Number of process improvement proposals submitted, accepted or implemented

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- CMMI maturity level or capability level

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GP 2.9 Objectively Evaluate Adherence

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Objectively evaluate adherence of the organizational process focus process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

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Elaboration:

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Examples of activities reviewed include the following: [PA152.EL115]

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- Determining process improvement opportunities
- Planning and coordinating process improvement activities

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Examples of work products reviewed include the following: [PA152.EL118]

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- Process improvement plans
- Process action plans
- Plans for the organization's process assessments

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GP 2.10 Review Status with Higher-Level Management

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Review the activities, status, and results of the organizational process focus process with higher-level management and resolve issues. [GP112]

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Elaboration:

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These reviews are typically in the form of a briefing presented to the Management Steering Committee by the Process Group and the process action teams. [PA152.EL116]

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- Examples of presentation topics include the following: [PA152.EL121]
- Status of Improvements being developed by process action teams
 - Results of pilots
 - Results of deployments
 - Schedule status for achieving significant milestones (e.g., readiness for an assessment, or progress towards achieving a pre-defined organizational maturity or process capability level)

4068 **GG 3 Institutionalize a Defined Process**

4069 *The process is institutionalized as a defined process.*

4070 **GP 3.1 Establish a Defined Process**

4071 *Establish and maintain the description of a defined organizational*
4072 *process focus process.* [GP114]

4073 **GP 3.2 Collect Improvement Information**

4074 *Collect work products, measures, measurement results, and*
4075 *improvement information derived from planning and performing*
4076 *the organizational process focus process to support the future use*
4077 *and improvement of the organization's processes and process*
4078 *assets.* [GP117]

4079 **GG 4 Institutionalize a Quantitatively Managed Process**

4080 *The process is institutionalized as a quantitatively managed process.*

4081 **GP 4.1 Establish Quality Objectives**

4082 *Establish and maintain quantitative objectives for the*
4083 *organizational process focus process about quality and process*
4084 *performance based on customer needs and business objectives.*
4085 [GP118]

4086 **GP 4.2 Stabilize Subprocess Performance**

4087 *Stabilize the performance of one or more subprocesses of the*
4088 *organizational process focus process to determine its ability to*
4089 *achieve the established quantitative quality and process*
4090 *performance objectives.* [GP119]

4091 **GG 5 Institutionalize an Optimizing Process**

4092 ***The process is institutionalized as an optimizing process.***

4093 **GP 5.1 Ensure Continuous Process Improvement**

4094 ***Ensure continuous improvement of the organizational process***
4095 ***focus process in fulfilling the relevant business goals of the***
4096 ***organization.*** [GP125]

4097 **GP 5.2 Correct Common Cause of Problems**

4098 ***Identify and correct the root causes of defects and other problems***
4099 ***in the organizational process focus process.*** [GP121]

4100 ORGANIZATIONAL PROCESS DEFINITION

4101 Process Management

4102 Purpose

4103 The purpose of Organizational Process Definition is to establish and
4104 maintain a usable set of organizational process assets. [PA153]

4105 Introductory Notes

4106 These process assets include the organization's set of standard
4107 processes and supporting assets. These assets enable consistent
4108 process performance across the organization and provide a basis for
4109 cumulative, long-term benefits to the organization. [PA153.N101]

4110 The organization's process assets are artifacts that relate to describing,
4111 implementing, and improving processes (e.g., policies, process
4112 descriptions, and process implementation support tools). The term
4113 "process assets" is used to indicate that these artifacts are developed
4114 or acquired to meet the business objectives of the organization, and
4115 they represent investments by the organization that are expected to
4116 provide current and future business value. [PA153.N102]

4117 The organization's process asset library is a collection of items
4118 maintained by the organization, for use by the people in the
4119 organization in developing, tailoring, maintaining, implementing,
4120 managing, and improving their processes. These process assets
4121 include descriptions of processes and process elements, descriptions of
4122 life-cycle models, process tailoring guidelines, process-related
4123 documentation, and data. These process assets support organizational
4124 learning and process improvement by allowing the sharing of "best
4125 practices" process assets, and lessons learned across the organization.

4126 [PA153.N103]

4127 The organization's set of standard processes is tailored by projects to
4128 create their defined processes. The other process assets are used to
4129 support tailoring as well as the implementation of the defined
4130 processes. [PA153.N104]

4131 A standard process is composed of other processes or process
4132 elements. A process element is the fundamental (e.g., atomic) unit of
4133 process definition and describes the activities and tasks to consistently
4134 perform work. Process architecture provides rules for connecting the
4135 process elements of a standard process. The organization's set of
4136 standard processes may include multiple process architectures and
4137 standard processes. [PA153.N105]

4138 The organization's process assets may be organized in many ways,
4139 depending on the implementation of the Organizational Process
4140 Definition process area. Examples include the following: [PA153.N106]

- 4141 • Descriptions of life-cycle models may be documented as part of the
4142 organization's set of standard processes or they may be
4143 documented separately.
- 4144 • The organization's set of standard processes may be stored in the
4145 organization's library of process-related assets or they may be
4146 stored separately.
- 4147 • A single repository may contain both the measurements and the
4148 process-related documentation, or they may be stored separately.

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4150 Related Process Areas

4151 *Refer to the Organizational Process Focus process area for more*
4152 *information about organizational process-related matters.* [PA153.R101]

4153 Specific Goals

4154 **SG 1 Create Organizational Process Assets** [PA153.IG101]

4155 ***A set of organizational process assets is available.***

4156 **SG 2 Make Supporting Process Assets Available** [PA153.IG102]

4157 ***Process assets that support the use of the organization's set of standard***
4158 ***processes are available.***

4159 Generic Goals

4160 **GG 1 Achieve Specific Goals** [CL102.GL101]

4161 ***The process supports and enables achievement of the specific goals of the***
4162 ***process area by transforming identifiable input work products to produce***
4163 ***identifiable output work products.***

4164 **GG 2** Institutionalize a Managed Process [CL103.GL101]

4165 *The process is institutionalized as a managed process.*

4166 **GG 3** Institutionalize a Defined Process [CL104.GL101]

4167 *The process is institutionalized as a defined process.*

4168 **GG 4** Institutionalize a Quantitatively Managed Process [CL105.GL101]

4169 *The process is institutionalized as a quantitatively managed process.*

4170 **GG 5** Institutionalize an Optimizing Process [CL106.GL101]

4171 *The process is institutionalized as an optimizing process.*

4172 Practice to Goal Relationship Table

- 4173 SG 1 Create Organizational Process Assets [PA153.IG101]
- 4174 SP 1.1-1 Establish Standard Processes
- 4175 SP 1.2-1 Establish Life-Cycle Model Descriptions
- 4176 SP 1.3-1 Establish Tailoring Criteria and Guidelines
- 4177 SG 2 Make Supporting Process Assets Available [PA153.IG102]
- 4178 SP 2.1-1 Establish an Organizational Measurement Repository
- 4179 SP 2.2-1 Establish an Organizational Process Asset Library
- 4180 GG 1 Achieve Specific Goals [CL102.GL101]
- 4181 GP 1.1 Identify Work Scope
- 4182 GP 1.2 Perform Base Practices
- 4183 GG 2 Institutionalize a Managed Process [CL103.GL101]
- 4184 GP 2.1 Establish an Organizational Policy
- 4185 GP 2.2 Plan the Process
- 4186 GP 2.3 Provide Resources
- 4187 GP 2.4 Assign Responsibility
- 4188 GP 2.5 Train People
- 4189 GP 2.6 Manage Configurations
- 4190 GP 2.7 Identify and Involve Relevant Stakeholders
- 4191 GP 2.8 Monitor and Control the Process
- 4192 GP 2.9 Objectively Evaluate Adherence
- 4193 GP 2.10 Review Status with Higher-Level Management
- 4194 GG 3 Institutionalize a Defined Process [CL104.GL101]
- 4195 GP 3.1 Establish a Defined Process
- 4196 GP 3.2 Collect Improvement Information
- 4197 GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]
- 4198 GP 4.1 Establish Quality Objectives
- 4199 GP 4.2 Stabilize Subprocess Performance
- 4200 GG 5 Institutionalize an Optimizing Process [CL106.GL101]
- 4201 GP 5.1 Ensure Continuous Process Improvement
- 4202 GP 5.2 Correct Common Cause of Problems

4203 Specific Practices by Goal

4204 **SG 1 Create Organizational Process Assets** [PA153.IG101]

4205 ***A set of organizational process assets is available.***

4206 **For Integrated Product and Process Development**
4207 *Integrated processes that emphasize parallel, rather than*
4208 *serial development, are a cornerstone of IPPD implementation.*
4209 *Product development processes and product-related process-*
4210 *development processes, such as the manufacturing process*
4211 *development and the support process development*
4212 *processes, are conducted concurrently. Such integrated*
4213 *processes need to accommodate the information provided by*
4214 *stakeholders representing all phases of the product life cycle*
4215 *from both business and technical functions. Processes for*
4216 *effective teamwork are also needed. [PA153.IG101.AMP101]*

4217 **SP 1.1-1 Establish Standard Processes**

4218 **Establish and maintain the organization's set of standard**
4219 **processes. [PA153.IG101.SP101]**

4220 **For Integrated Product and Process Development**
4221 *In an IPPD environment, the organization's shared vision is*
4222 *included in the organization's process assets.*
4223 *[PA153.IG101.SP101.AMP101]*

4224 Standard processes may be defined at multiple levels in an enterprise
4225 and they may be related in a hierarchical manner. For example, an
4226 enterprise may have a set of standard processes that are tailored by
4227 individual organizations (e.g., division or site) in the enterprise to
4228 establish their set of standard processes. Within an organization there
4229 may be a different set of standard processes, tailored for each of the
4230 business areas or product lines. The organization's set of standard
4231 processes refers to the standard processes established at the
4232 organization level and standard processes that may be established at
4233 lower-levels in the organization (e.g., business areas or product lines).
4234 Some organizations may only have a single level of standard processes
4235 for the organization. [PA153.IG101.SP101.N101]

4236 Multiple standard processes may be needed to address the needs of
4237 different application domains, life cycles, methodologies, and tools. The
4238 organization's set of standard processes contains process elements
4239 (e.g., a work product size-estimating element) that may be
4240 interconnected according to one or more process architectures that
4241 describe the relationships among these process elements. Processes
4242 may be composed of other processes or process elements. A process
4243 element is the atomic unit of a process definition. [PA153.IG101.SP101.N102]

4244 The organization's set of standard processes typically includes
4245 technical, management, administrative, support, and organizational
4246 processes. [PA153.IG101.SP101.N103]

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Typical Work Products

1. Organization's set of standard processes [PA153.IG101.SP101.W101]

Subpractices

1. Decompose each standard process into constituent process elements to the detail needed to understand and describe the process. [PA153.IG101.SP101.SubP101]

Each process element covers a bounded and closely related set of activities. The descriptions of the process elements may be templates to be filled in, fragments to be completed, abstractions to be refined, or complete descriptions to be tailored or used unmodified. These elements are described in sufficient detail such that the process, when fully defined, can be consistently performed by appropriately trained and skilled people. [PA153.IG101.SP101.SubP101.N101]

Examples of process elements include the following: [PA153.IG101.SP101.SubP101.N102]

- Template for generating work product size estimates
- Description of work product design methodology
- Tailorable peer review methodology
- Template for conduct of management reviews

2. Specify the critical attributes of each process element.

[PA153.IG101.SP101.SubP102]

Examples of critical attributes include the following: [PA153.IG101.SP101.SubP102.N101]

- Process roles
- Applicable process and product standards
- Applicable procedures, methods, tools, and resources
- Process performance objectives
- Entry criteria
- Inputs
- Product and process measures to be collected and used
- Verification points (e.g., peer reviews)
- Outputs
- Interfaces
- Exit criteria

3. Specify the relationships of the process elements.

[PA153.IG101.SP101.SubP103]

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Examples of relationships include the following: [PA153.IG101.SP101.SubP103.N101]

- Ordering of the process elements
- Interfaces among the process elements
- Interfaces with external processes
- Interdependencies among the process elements

In these practices, the rules for describing the relationships among process elements are referred to as a "process architecture." The process architecture covers the essential requirements and guidelines. The detailed specifications of these relationships are covered in the descriptions of the defined processes that are tailored from the organization's set of standard processes.

[PA153.IG101.SP101.SubP103.N102]

4. Ensure that the organization's set of standard processes adhere to the applicable policies, process standards, and product standards.

[PA153.IG101.SP101.SubP104]

Examples of requirements include the following: [PA153.IG101.SP101.SubP104.N101]

- Interoperability of tools
- Criteria for revising and retiring process elements
- Use of common terminology
- Consistency with designated style manual
- Use of common phrases (e.g., "in accordance with")
- Use of abbreviations
- Security classification markings
- Format/packaging of process documentation

5. Ensure that the organization's set of standard processes satisfy the process needs and objectives of the organization.

[PA153.IG101.SP101.SubP105]

Refer to the Organizational Process Focus process area for more information about establishing and maintaining the organization's process needs and objectives. [PA153.IG101.SP101.SubP105.R101]

6. Ensure that each of the organization's set of standard processes integrate appropriately with other standard processes.

[PA153.IG101.SP101.SubP106]

7. Document the organization's set of standard processes.

[PA153.IG101.SP101.SubP107]

8. Conduct peer reviews on the organization's set of standard processes. [PA153.IG101.SP101.SubP108]

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Refer to the Verification process area for more information about peer review. [PA153.IG101.SP101.SubP108.R101]

9. Revise the organization's set of standard processes as necessary. [PA153.IG101.SP101.SubP109]

SP 1.2-1 Establish Life-Cycle Model Descriptions

Establish and maintain descriptions of the life-cycle process models approved for use in the organization. [PA153.IG101.SP102]

Life-cycle models may be developed for a variety of customers or in a variety of situations, since one life-cycle model may not be appropriate for all situations. The organization may identify more than one life-cycle model for use. [PA153.IG101.SP102.N101]

Life cycle models partition the product life cycle into phases for which activities and requirements can be defined to promote a complete solution from initiating development of the product to its ultimate disposal. These help guide projects through the major steps of identifying customer needs; planning; defining and designing the products and services; developing the products; verifying; validating; providing the products and services; and installing, operating, supporting and retiring the product. [PA153.IG101.SP102.N102]

Typical Work Products

1. Descriptions of life-cycle models [PA153.IG101.SP102.W101]

Subpractices

1. Select life-cycle models based on the process-related needs of the project and the needs of the organization. [PA153.IG101.SP102.SubP101]

Examples of development life-cycle models include the following:

[PA153.IG101.SP102.SubP101.N101]

- Waterfall
- Spiral
- Evolutionary
- Incremental
- Iterative

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Examples of project characteristics that could affect the life-cycle models include the following: [PA153.IG101.SP102.SubP101.N102]

- Size of the project
- Experience and familiarity of project staff in implementing the process
- Developmental constraints such as cycle time and acceptable defect levels

2. Document the descriptions of the life-cycle models.

[PA153.IG101.SP102.SubP102]

The life-cycle models may be documented as part of the organization's standard process descriptions or they may be documented separately.

[PA153.IG101.SP102.SubP102.N101]

3. Conduct peer reviews on the life-cycle models. [PA153.IG101.SP102.SubP103]

Refer to the Verification process area for more information about conducting peer reviews. [PA153.IG101.SP102.SubP103.R101]

4. Revise the descriptions of the life-cycle models as necessary.

[PA153.IG101.SP102.SubP104]

SP 1.3-1 Establish Tailoring Criteria and Guidelines

Establish and maintain the tailoring criteria and guidelines for the organization's set of standard processes. [PA153.IG101.SP103]

For Integrated Product and Process Development

In creating the tailoring criteria and guidelines, include considerations for concurrent development and operating with integrated teams. For example, how one tailors the manufacturing process will be different whether it is done serially after the product has been developed or in parallel with the development of the product, as in IPPD. Processes, for example resource allocation, will also be tailored differently if the project is operating with integrated teams.

[PA153.IG101.SP103.AMP101]

The tailoring criteria and guidelines describe the following:

[PA153.IG101.SP103.N101]

- How the organization's set of standard processes and process assets are used to create the defined processes
- Mandatory requirements that must be satisfied by the defined processes (e.g., the subset of the organization's process assets that are essential for any defined process)
- Options that can be exercised and criteria for selecting among the options

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- Procedures that must be followed in performing process tailoring and documentation of tailoring performed

Examples of reasons for tailoring include the following:

[PA153.IG101.SP103.N102]

- Adapting the process for a new product line or host environment
- Customizing the process for a specific application or class of applications (e.g., initial development, maintenance, or creation of prototypes)
- Elaborating the process description so that the resulting defined process can be performed

Flexibility in tailoring and defining processes is balanced with ensuring appropriate consistency in the processes across the organization. Flexibility is needed to address contextual variables such as the domain; nature of the customer; cost, schedule, and quality tradeoffs; technical difficulty of the work; and experience of the people implementing the process. Consistency across the organization is needed so that organizational standards, objectives, and strategies are appropriately addressed, and process data and lessons learned can be shared. [PA153.IG101.SP103.N103]

For processes performed at the organizational level, the standard process may be the defined process, so tailoring may not be needed.

[PA153.IG101.SP103.N104]

Typical Work Products

1. Tailoring guidelines for the organization's set of standard processes [PA153.IG101.SP103.W101]

Subpractices

1. Specify the selection criteria and procedures for tailoring the organization's set of standard processes. [PA153.IG101.SP103.SubP101]

Examples of criteria and procedures include the following: [PA153.IG101.SP103.SubP101.N101]

- Criteria for selecting life-cycle models from those approved by the organization
- Criteria for selecting process elements from the organization's set of standard processes
- Procedures for tailoring the selected life-cycle models and process elements to accommodate the specific process characteristics and needs

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Examples of tailoring actions include: [PA153.IG101.SP103.SubP101.N102]

- Modifying a life-cycle model
- Combining elements of different life-cycle models
- Modifying process elements
- Replacing process elements
- Reordering process elements

2. Specify the standards for documenting the defined processes.

[PA153.IG101.SP103.SubP102]

3. Specify the procedures for submitting and obtaining approval of waivers from the requirements of the organization's set of standard processes. [PA153.IG101.SP103.SubP103]

4. Document the tailoring guidelines for the organization's set of standard processes. [PA153.IG101.SP103.SubP104]

5. Conduct peer reviews on the tailoring guidelines.

[PA153.IG101.SP103.SubP105]

Refer to the Verification process area for more information about conducting peer reviews. [PA153.IG101.SP103.SubP105.R101]

6. Revise the tailoring guidelines as necessary. [PA153.IG101.SP103.SubP106]

SG 2 Make Supporting Process Assets Available [PA153.IG102]

Process assets that support the use of the organization's set of standard processes are available.

SP 2.1-1 Establish an Organizational Measurement Repository

Establish and maintain an organizational measurement repository

[PA153.IG102.SP101]

The repository contains both product and process measures that are related to the organization's set of standard processes. It also contains or refers to the information needed to understand and interpret the measures and assess them for reasonableness and applicability. For example, the definitions of the measures are used to compare similar measures from different processes. [PA153.IG102.SP101.N101]

Typical Work Products

1. Definition of the common set of product and process measures for the organization's set of standard processes [PA153.IG102.SP101.W101]

4460 2. Organization's measurement repository (i.e., the repository
4461 structure and support environment) [PA153.IG102.SP101.W102]

4462 3. Organizational measurement data [PA153.IG102.SP101.W103]

4463 **Subpractices**

4464 1. Determine the organization's needs for storing, retrieving, and
4465 analyzing measurements. [PA153.IG102.SP101.SubP101]

4466 2. Define a common set of process and product measures for the
4467 organization's set of standard processes. [PA153.IG102.SP101.SubP102]

4468 The measures in the common set are selected based on the organization's set of
4469 standard processes. The common set of measures may vary for different standard
4470 processes. [PA153.IG102.SP101.SubP102.N101]

4471 Operational definitions for the measures specify the point in the process where
4472 the data will be collected and the procedures for collecting valid data.

4473 [PA153.IG102.SP101.SubP102.N102]

4474 Examples of classes of commonly used measures include the following:

4475 [PA153.IG102.SP101.SubP102.N103]

- 4476
- 4477 • Estimates of work product size (e.g., pages)
 - 4478 • Estimates of effort and cost (e.g., person hours)
 - 4479 • Actual measures of size, effort, and cost
 - 4480 • Quality measures (e.g., number of defects found, severity of defects)
 - 4481 • Peer review coverage
 - 4482 • Test or verification coverage
 - 4483 • Reliability measures (e.g., mean time to failure)

4484 *Refer to the Measurement and Analysis process area for more*
4485 *information about defining measures* [PA153.IG102.SP101.SubP102.N103.R101]

4486 3. Design and implement the measurement repository.
4487 [PA153.IG102.SP101.SubP103]

4488 4. Specify the procedures for storing, updating, and retrieving.
4489 [PA153.IG102.SP101.SubP104]

4490 5. Conduct peer reviews on the definitions of the common set of
4491 measures and the procedures for storing and retrieving measures.
4492 [PA153.IG102.SP101.SubP105]

4493 *Refer to the Verification process area for more information about*
4494 *conducting peer reviews.* [PA153.IG102.SP101.SubP105.R101]

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6. Enter the specified measures into the repository.

[PA153.IG102.SP101.SubP106]

Refer to the Measurement and Analysis process area for more information about collecting and analyzing data. [PA153.IG102.SP101.SubP106.R101]

7. Make the contents of the process measurement repository available for use by the organization and projects as appropriate.

[PA153.IG102.SP101.SubP107]

8. Revise the measurement repository, common set of measures, and procedures as the organizational needs change. [PA153.IG102.SP101.SubP108]

The following are examples of when the common set of measures may need to be revised. [PA153.IG102.SP101.SubP108.N101]

- New processes are added
- Processes are revised and new product or process measures are needed
- Finer granularity of data is required
- Greater visibility into the process is required
- Measures are retired

SP 2.2-1 Establish an Organizational Process Asset Library

Establish and maintain the organization's library of process-related assets. [PA153.IG102.SP102]

Examples of process-related documentation include the following:

[PA153.IG102.SP102.N101]

- Organizational policies
- Defined process descriptions
- Procedures (e.g., estimating procedure)
- Development plans
- Quality assurance plans
- Training materials
- Process aids (e.g., checklists)
- Lessons learned reports

Typical Work Products

1. Organization's library to store the process-related documentation (i.e., the library structure and support environment)

[PA153.IG102.SP102.W101]

- 4530 2. Best examples of process-related documentation items
4531 [PA153.IG102.SP102.W102]
- 4532 3. Catalog of process documentation items [PA153.IG102.SP102.W103]

4533 **Subpractices**

- 4534 1. Design and implement the library of process assets, including the
4535 library structure and support environment. [PA153.IG102.SP102.SubP101]
- 4536 2. Specify the criteria for including documentation items in the library.
4537 [PA153.IG102.SP102.SubP102]
- 4538 The documentation items are selected based primarily on their relationship to the
4539 organization's set of standard processes. [PA153.IG102.SP102.SubP102.N101]
- 4540 3. Specify the procedures for storing and retrieving documentation
4541 items. [PA153.IG102.SP102.SubP103]
- 4542 4. Enter the selected documentation items into the library and catalog
4543 them for easy reference and retrieval. [PA153.IG102.SP102.SubP104]
- 4544 5. Make the documentation items available for use by the projects.
4545 [PA153.IG102.SP102.SubP105]
- 4546 6. Periodically review the use of each documentation item and use
4547 the results to maintain the library contents. [PA153.IG102.SP102.SubP106]
- 4548 7. Revise the library of process-related assets as necessary.
4549 [PA153.IG102.SP102.SubP107]

4550 The following are examples of when the library may need to be revised:
4551 [PA153.IG102.SP102.SubP107.N101]

- 4552 • New process assets are added
4553 • Process assets are retired
4554 • Current versions of documentation items are changed
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4556 **Generic Practices by Goal**

4557 **GG 1 Achieve Specific Goals**

4558 ***The process supports and enables achievement of the specific goals of the***
4559 ***process area by transforming identifiable input work products to produce***
4560 ***identifiable output work products.***

4561 **GP 1.1 Identify Work Scope**

4562 *Identify the scope of the work to be performed and work products*
4563 *to be produced for organizational process definition, and*
4564 *communicate this information to those performing the work.* [GP101]

4565 **GP 1.2 Perform Base Practices**

4566 *Perform the base practices of the organizational process definition*
4567 *process to develop work products and provide services to achieve*
4568 *the specific goals of the process area.* [GP102]

4569 **GG 2 Institutionalize a Managed Process**

4570 *The process is institutionalized as a managed process.*

4571 **GP 2.1 Establish an Organizational Policy**

4572 *Establish and maintain an organizational policy for planning and*
4573 *performing the organizational process definition process.* [GP103]

4574 Elaboration:

4575 This policy establishes organizational expectations for establishing and
4576 maintaining a set of standard processes for use by the organization and
4577 making process assets available across the organization. [PA153.EL101]

4578 **GP 2.2 Plan the Process**

4579 *Establish and maintain the requirements and objectives, and plans*
4580 *for performing the organizational process definition process.* [GP104]

4581 Elaboration:

4582 These requirements, objectives, and plans are typically described in the
4583 organization's plan for process improvement. [PA153.EL102]

4584 **GP 2.3 Provide Resources**

4585 *Provide adequate resources for performing the organizational*
4586 *process definition process, developing the work products and*
4587 *providing the services of the process.* [GP105]

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Elaboration:

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A process group (e.g., an engineering process group or EPG) typically manages the organizational process definition activities. This group is typically staffed by a core of engineering professionals whose primary responsibility is coordinating organizational process improvement. This group is supported by process owners and people with expertise in various disciplines such as the following: [PA153.EL108]

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- Project management

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- The appropriate engineering disciplines

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- Configuration management

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- Quality assurance

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Examples of tools used in performing the activities of the Organizational Process Definition process area include the following: [PA153.EL106]

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- Database management systems

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- Process modeling tools

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- Web page builders and browsers

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GP 2.4 Assign Responsibility

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

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GP 2.5 Train People

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Train the people performing or supporting the organizational process definition process as needed. [GP107]

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Elaboration:

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Examples of training topics include the following: [PA153.EL107]

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- CMMI and other process and process improvement reference models

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- Planning, managing, and monitoring processes

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- Process modeling and definition

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- Developing a tailorable standard process

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GP 2.6 Manage Configurations

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

Elaboration:

Examples of work products placed under configuration management include the following: [PA153.EL103]

- Organization's set of standard processes
- Descriptions of the life-cycle models
- Tailoring guidelines for the organization's set of standard processes
- Definitions of the common set of product and process measures
- Organizational measurement data

GP 2.7 Identify and Involve Relevant Stakeholders

Identify and involve the relevant stakeholders of the organizational process definition process as planned. [GP124]

Elaboration:

Examples of activities for stakeholder involvement include: [PA153.EL111]

- Reviewing the organization's set of standard processes
- Reviewing the organization's life cycle models
- Resolving issues on the tailoring guidelines
- Assessing the definitions of the common set of process and product measures

GP 2.8 Monitor and Control the Process

Monitor and control the organizational process definition process against the plan and take appropriate corrective action. [GP110]

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Elaboration:

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Examples of measures used in monitoring and controlling the activities of the Organizational Process Development process area include the following: [PA153.EL104]

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- Percentage of projects using the process architectures and process elements of the organization's set of standard processes
- Defect density of each process element of the organization's set of standard processes

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GP 2.9 Objectively Evaluate Adherence

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Objectively evaluate adherence of the organizational process definition process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

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Elaboration:

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Examples of activities reviewed include the following: [PA153.EL105]

- Creating organizational process assets
- Making supporting process assets available

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Examples of work products reviewed include the following: [PA153.EL110]

- Organization's set of standard processes
- Descriptions of the life-cycle models
- Tailoring guidelines for the organization's set of standard processes
- Organizational Measurement data

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GP 2.10 Review Status with Higher-Level Management

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Review the activities, status, and results of the organizational process definition process with higher-level management and resolve issues. [GP112]

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GG 3 Institutionalize a Defined Process

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The process is institutionalized as a defined process.

4680 **GP 3.1 Establish a Defined Process**

4681 *Establish and maintain the description of a defined organizational*
4682 *process definition process. [GP114]*

4683 **GP 3.2 Collect Improvement Information**

4684 *Collect work products, measures, measurement results, and*
4685 *improvement information derived from planning and performing*
4686 *the organizational process definition process to support the future*
4687 *use and improvement of the organization's processes and process*
4688 *assets. [GP117]*

4689 **GG 4 Institutionalize a Quantitatively Managed Process**

4690 *The process is institutionalized as a quantitatively managed process.*

4691 **GP 4.1 Establish Quality Objectives**

4692 *Establish and maintain quantitative objectives for the*
4693 *organizational process definition process about quality and*
4694 *process performance based on customer needs and business*
4695 *objectives. [GP118]*

4696 **GP 4.2 Stabilize Subprocess Performance**

4697 *Stabilize the performance of one or more subprocesses of the*
4698 *organizational process definition process to determine its ability*
4699 *to achieve the established quantitative quality and process*
4700 *performance objectives. [GP119]*

4701 **GG 5 Institutionalize an Optimizing Process**

4702 *The process is institutionalized as an optimizing process.*

4703 **GP 5.1 Ensure Continuous Process Improvement**

4704 *Ensure continuous improvement of the organizational process*
4705 *definition process in fulfilling the relevant business goals of the*
4706 *organization. [GP125]*

4707 **GP 5.2 Correct Common Cause of Problems**

4708 *Identify and correct the root causes of defects and other problems*
4709 *in the organizational process definition process. [GP121]*

4710 ORGANIZATIONAL TRAINING

4711 Process Management

4712 Purpose

4713 The purpose of Organizational Training is to develop the skills and
4714 knowledge of people so they can perform their roles effectively and
4715 efficiently. [PA158]

4716 Introductory Notes

4717 Organizational Training includes training to support both the
4718 organization's strategic business objectives and the tactical training
4719 needs that are common across projects and support groups. Specific
4720 training needs identified by individual projects and support groups are
4721 handled at the project and support group level and are outside the
4722 scope of Organizational Training. Project and support groups are
4723 responsible for identifying and addressing their specific training needs.

4724 [PA158.N101]

4725 *Refer to the Project Planning process area for more information about*
4726 *the specific training needs identified by projects.* [PA158.N101.R101]

4727 An organizational training program involves the following: [PA158.N102]

- 4728
- 4729 • Identifying the training needed by the organization
 - 4730 • Obtaining and providing training to address those needs
 - 4731 • Establishing and maintaining training capability
 - 4732 • Establishing and maintaining training records
 - 4733 • Assessing training effectiveness

4734 Effective training requires assessment of needs, planning, instructional
4735 design, and appropriate training media (e.g., workbooks, computer
4736 software, etc.), as well as a repository of training process data. As an
4737 organizational process, the main components of training include a
4738 managed training development program, documented plans, personnel
4739 with appropriate mastery of specific disciplines and other areas of
4740 knowledge, and mechanisms for measuring the effectiveness of the
training program. [PA158.N103]

4741 The identification of process training needs is primarily based on the
4742 skills that are required to perform the organization's set of standard
4743 processes. [PA158.N104]

4744 *Refer to the Organizational Process Definition process area for more*
4745 *information about the organization's set of standard processes.*

4746 [PA158.N104.R101]

4747 Certain skills may be effectively and efficiently imparted through
4748 vehicles other than in-class training experiences, (e.g., informal
4749 mentoring). Other skills require more formalized training vehicles, such
4750 as in a classroom, by Web-based training, guided self-study, or a
4751 formalized on-the-job training program. The formal or informal training
4752 vehicles employed for each situation should be based on an
4753 assessment of the need for training and the performance gap to be
4754 addressed. The term "training" used throughout this process area is
4755 used broadly to include all of these learning options. [PA158.N105]

4756 Success in training can be measured in terms of the availability of
4757 opportunities to acquire knowledge and skill needed to perform new and
4758 ongoing enterprise activities. [PA158.N106]

4759 Skills and knowledge may be technical, organizational, or contextual.
4760 Technical skills pertain to the ability to use the equipment, tools,
4761 materials, data, and processes required by a project or process.
4762 Organizational skills pertain to behavior within and according to the
4763 employee's organization structure, role and responsibilities, and general
4764 operating principles and methods. Contextual skills are the self-
4765 management, communication, and interpersonal abilities needed to
4766 successfully perform in the organizational and social context of the
4767 project and support groups. [PA158.N107]

4768 The phrase "projects and support groups" is used frequently in the text
4769 of the process area description to indicate an organization-level
4770 perspective. [PA158.N108]

4771 Related Process Areas

4772 *Refer to the Organizational Process Definition process area for more*
4773 *information about the organization's process assets.* [PA158.R101]

4774 *Refer to the Project Planning process area for more information about*
4775 *the specific training needs identified by projects.* [PA158.R102]

4776 *Refer to the Decision Analysis and Resolution process area for how to*
4777 *apply decision-making criteria when determining training approaches.*

4778 [PA158.R103]

4779 Specific Goals

4780 **SG 1** Identify Training Needs and Make Training Available [PA158.IG101]

4781 *Training to support the organization's management and technical roles is*
4782 *identified and made available.*

4783 **SG 2** Provide Necessary Training [PA158.IG102]

4784 *Training necessary for individuals to perform their roles effectively is*
4785 *provided.*

4786 Generic Goals

4787 **GG 1** Achieve Specific Goals [CL102.GL101]

4788 *The process supports and enables achievement of the specific goals of the*
4789 *process area by transforming identifiable input work products to produce*
4790 *identifiable output work products.*

4791 **GG 2** Institutionalize a Managed Process [CL103.GL101]

4792 *The process is institutionalized as a managed process.*

4793 **GG 3** Institutionalize a Defined Process [CL104.GL101]

4794 *The process is institutionalized as a defined process.*

4795 **GG 4** Institutionalize a Quantitatively Managed Process [CL105.GL101]

4796 *The process is institutionalized as a quantitatively managed process.*

4797 **GG 5** Institutionalize an Optimizing Process [CL106.GL101]

4798 *The process is institutionalized as an optimizing process.*

4799 Practice to Goal Relationship Table

- 4800 SG 1 Identify Training Needs and Make Training Available [PA158.IG101]
- 4801 SP 1.1-1 Establish the Strategic Training needs
- 4802 SP 1.2-1 Determine Which Training Needs Are the Responsibility of the Organi-
- 4803 zation
- 4804 SP 1.3-1 Establish Organizational Training Tactical Plan
- 4805 SP 1.4-1 Establish Training Capability

- 4806 SG 2 Provide Necessary Training [PA158.IG102]
- 4807 SP 2.1-1 Deliver Training
- 4808 SP 2.2-1 Establish Training Records
- 4809 SP 2.3-1 Assess Training Effectiveness

- 4810 GG 1 Achieve Specific Goals [CL102.GL101]
- 4811 GP 1.1 Identify Work Scope
- 4812 GP 1.2 Perform Base Practices

- 4813 GG 2 Institutionalize a Managed Process [CL103.GL101]
- 4814 GP 2.1 Establish an Organizational Policy
- 4815 GP 2.2 Plan the Process
- 4816 GP 2.3 Provide Resources
- 4817 GP 2.4 Assign Responsibility
- 4818 GP 2.5 Train People
- 4819 GP 2.6 Manage Configurations
- 4820 GP 2.7 Identify and Involve Relevant Stakeholders
- 4821 GP 2.8 Monitor and Control the Process
- 4822 GP 2.9 Objectively Evaluate Adherence
- 4823 GP 2.10 Review Status with Higher-Level Management

- 4824 GG 3 Institutionalize a Defined Process [CL104.GL101]
- 4825 GP 3.1 Establish a Defined Process
- 4826 GP 3.2 Collect Improvement Information

- 4827 GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]
- 4828 GP 4.1 Establish Quality Objectives
- 4829 GP 4.2 Stabilize Subprocess Performance

- 4830 GG 5 Institutionalize an Optimizing Process [CL106.GL101]
- 4831 GP 5.1 Ensure Continuous Process Improvement
- 4832 GP 5.2 Correct Common Cause of Problems

4833 Specific Practices by Goal

4834 **SG 1 Identify Training Needs and Make Training Available** [PA158.IG101]

4835 ***Training to support the organization's management and technical roles is***
 4836 ***identified and made available.***

4837 The organization identifies the training required to develop the skills and
 4838 knowledge necessary to perform enterprise activities. Once the needs
 4839 are identified, a training program addressing those needs is developed.
 4840 [PA158.IG101.N101]

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For Integrated Product and Process Development
Cross-functional training, leadership training, interpersonal skills training, and training in the skills needed to integrate appropriate business and technical functions is needed by integrated team members. The potentially wider range of requirements and participant backgrounds may require stakeholders who were not involved in requirements development to take cross-training in the disciplines involved in product design in order to commit to requirements with a full understanding of the range of requirements and their interrelationships. [PA158.IG101.AMP101]

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SP 1.1-1 Establish the Strategic Training needs

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Establish and maintain the strategic training needs of the organization. [PA158.IG101.SP101]

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Examples of sources of strategic training needs include the following:

[PA158.IG101.SP101.N101]

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- Organization's standard processes
- Organization's strategic business plan
- Organization's process improvement plan
- Company-level initiatives and standards
- Skill appraisals
- Risk analyses

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Typical Work Products

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1. Training needs [PA158.IG101.SP101.W101]

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2. Assessment analysis [PA158.IG101.SP101.W102]

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Subpractices

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1. Analyze the organization's strategic business objectives and process improvement plan to identify potential future training needs. [PA158.IG101.SP101.SubP101]

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2. Document the strategic training needs of the organization.

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[PA158.IG101.SP101.SubP102]

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Examples of categories of training needs include (but are not limited to) the following: [PA158.IG101.SP101.SubP102.N101]

- Process analysis and documentation
- Engineering (e.g., requirements analysis, design, testing, configuration management, and quality assurance)
- Selection and management of suppliers
- Management (e.g., estimating, tracking, and risk management)

3. Determine the roles and skills needed to perform the organization's set of standard processes. [PA158.IG101.SP101.SubP103]
4. Document the required training needed to perform the roles in the organization's set of standard processes. [PA158.IG101.SP101.SubP104]
5. Revise the organization's strategic needs and required training as necessary. [PA158.IG101.SP101.SubP105]

SP 1.2-1 Determine Which Training Needs Are the Responsibility of the Organization

Determine which training needs are the responsibility of the organization and which will be left to the individual project or support group. [PA158.IG101.SP102]

Refer to the Project Planning process area for more information about project and support group-specific plans for training. [PA158.IG101.SP102.R101]

In addition to strategic training needs, organizational training addresses training requirements that are common across projects and support groups. Project and support groups have the primary responsibility for identifying and addressing their specific training needs. The organization's training staff is only responsible for addressing common cross-project and support group training needs. In some cases, however, the organization's training staff may address additional training needs of project and support groups, as negotiated with them, within the context of the training resources available and the organization's training priorities. [PA158.IG101.SP102.N101]

Typical Work Products

1. Common project and support groups training needs [PA158.IG101.SP102.W101]
2. Training commitments [PA158.IG101.SP102.W102]

Subpractices

1. Analyze the training needs identified by the various projects and support groups. [PA158.IG101.SP102.SubP101]

4911 Analysis of project and support group needs is intended to identify common
4912 training needs that can be most efficiently addressed organization-wide. These
4913 needs analysis activities are used to anticipate future training needs that are first
4914 visible at the project and support group level. [PA158.IG101.SP102.SubP101.N101]

4915 2. Negotiate with the various projects and support groups on how
4916 their specific training needs will be satisfied. [PA158.IG101.SP102.SubP102]

4917 The support provided by the organization's training staff depends on the training
4918 resources available and the organization's training priorities.

4919 [PA158.IG101.SP102.SubP102.N101]

4920 Examples of training appropriately performed by the project or support group
4921 include the following: [PA158.IG101.SP102.SubP102.N102]

- 4922 • Training in the application domain of the project
- 4923 • Training in the unique tools and methods used by the project or support group

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4925 3. Document the commitments for providing training support to the
4926 projects and support groups. [PA158.IG101.SP102.SubP103]

4927 SP 1.3-1 Establish Organizational Training Tactical Plan

4928 ***Establish and maintain an organizational training tactical plan.***

4929 [PA158.IG101.SP103]

4930 The Organizational Training Tactical Plan is a periodic, tactical plan for
4931 delivering training and assessing its effectiveness. [PA158.IG101.SP103.N101]

4932 Typical Work Products

4933 1. Organizational Training Tactical Plan [PA158.IG101.SP103.W101]

4934 Subpractices

4935 1. Establish plan content [PA158.IG101.SP103.SubP101]

4936 Organizational Training Tactical Plans typically contain the following:

4937 [PA158.IG101.SP103.SubP101.N101]

- 4938 • Training needs
- 4939 • Training topics
- 4940 • Schedules based on training activities and their dependencies
- 4941 • Methods used for training
- 4942 • Requirements and Quality standards for training materials
- 4943 • Training tasks, roles, and responsibilities
- 4944 • Required resources including tools, facilities, environments, staffing, skill and
4945 knowledge

- 4946 2. Establish commitments to the plan. [PA158.IG101.SP103.SubP102]
- 4947 Documented commitments by those responsible for implementing and supporting
- 4948 the plan are essential for the plan to be effective. [PA158.IG101.SP103.SubP102.N101]
- 4949 3. Revise plan and commitments as necessary. [PA158.IG101.SP103.SubP103]

SP 1.4-1 Establish Training Capability

Establish and maintain training capability to address organizational training needs. [PA158.IG101.SP104]

4953 *Refer to the Decision Analysis and Resolution process area for how to*

4954 *apply decision-making criteria when selecting training approaches and*

4955 *developing training materials.* [PA158.IG101.SP104.R101]

Typical Work Products

- 4956 1. Training materials and supporting artifacts [PA158.IG101.SP104.W101]

Subpractices

- 4958 1. Select the appropriate approaches to satisfy specific organizational
- 4959 training needs. [PA158.IG101.SP104.SubP101]
- 4960

4961 Many factors may affect the selection of training approaches, including audience-

4962 specific knowledge, costs and schedule, work environment and so on. Selection

4963 of an approach requires consideration of the means to providing skills and

4964 knowledge in the most effective way possible given the constraints.

4965 [PA158.IG101.SP104.SubP101.N101]

4966 Examples of training approaches include the following: [PA158.IG101.SP104.SubP101.N102]

- 4967 • Classroom training
- 4968 • Computer-aided instruction
- 4969 • Guided self-study
- 4970 • Formal apprenticeship and mentoring programs
- 4971 • Facilitated videos
- 4972 • Chalk talks
- 4973 • Brown-bag lunch seminars
- 4974 • Structured on-the-job training

- 4975
- 4976 2. Determine whether to develop training materials internally or
- 4977 acquire them externally. [PA158.IG101.SP104.SubP102]

4978 Determine the costs and benefits of internal training development or of obtaining

4979 training externally. [PA158.IG101.SP104.SubP102.N101]

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Example criteria that can be used to determine the most effective mode of acquiring knowledge or skill acquisition include the following:

[PA158.IG101.SP104.SubP102.N102]

- Performance objectives
- Time available to prepare for project execution
- Business objectives
- Availability of in-house expertise
- Availability of training from external sources

Examples of external sources of training include the following:

[PA158.IG101.SP104.SubP102.N103]

- Customer-provided training
- Commercially available training courses
- Academic programs
- Professional conferences
- Seminars

3. Develop or obtain training materials. [PA158.IG101.SP104.SubP103]

Training may be provided by the project, by support groups, by the organization, or by an external organization. The organization's training staff coordinates the acquisition and delivery of training regardless of its source.

[PA158.IG101.SP104.SubP103.N101]

Examples of training materials include the following: [PA158.IG101.SP104.SubP103.N102]

- Courses
- Computer-aided instruction
- Videos

4. Describe the training in the organization's training curriculum.

[PA158.IG101.SP104.SubP104]

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Examples of the information provided in the training descriptions for each course include the following: [PA158.IG101.SP104.SubP104.N101]

- Topics covered in the training
- Intended audience
- Prerequisites and preparation for participating
- Training objectives
- Length of the training
- Lesson plans
- Completion criteria for the course
- Criteria for granting training waivers

5. Revise the training materials and supporting artifacts as necessary.

[PA158.IG101.SP104.SubP105]

Examples of when the training materials and supporting artifacts may need to be revised include the following: [PA158.IG101.SP104.SubP105.N101]

- When training needs change (e.g., when new technology associated with the training topic is available)
- When an evaluation of the training identifies the need for change (e.g., evaluations of training effectiveness surveys, training program performance assessments, instructor evaluation forms, etc.)

SG 2 Provide Necessary Training [PA158.IG102]

Training necessary for individuals to perform their roles effectively is provided.

In selecting people to be trained, the following considerations need to be made: [PA158.IG102.N101]

- Background of the target population of training participants
- Prerequisite background to receive training
- Skills and abilities needed by people to perform their roles
- Need for cross-discipline technical management training to all disciplines, including project management
- Need for managers to have training in appropriate organizational processes
- Need for training in the basic principles of discipline-specific engineering to support personnel in quality management, configuration management, and other related support functions

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- Need to provide competency development for critical functional areas

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SP 2.1-1 Deliver Training

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Deliver the training following an organizational training plan.

[PA158.IG102.SP101]

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Typical Work Products

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1. Delivered training course [PA158.IG102.SP101.W101]

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Subpractices

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1. Select the people who will receive the training. [PA158.IG102.SP101.SubP101]

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Training is intended to impart knowledge and skills to people performing various roles within the organization. Some people already possess the knowledge and skills required to perform well in their designated roles. Training can be waived for these people, but care should be taken that training waivers are not abused.

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[PA158.IG102.SP101.SubP101.N101]

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2. Schedule the training, including any resources as necessary (e.g., facilities, instructors, etc.). [PA158.IG102.SP101.SubP102]

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5061

Training should be planned and scheduled. Training is provided that has a direct bearing on the expectations of work performance. Therefore, optimal training occurs in a timely manner with regards to imminent job-performance expectations. These expectations often include the following: [PA158.IG102.SP101.SubP102.N101]

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- Training in the use of specialized tools

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- Training in procedures that are new to the individual who will perform them

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3. Conduct the training. [PA158.IG102.SP101.SubP103]

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Experienced instructors should perform training. When possible, training is conducted in settings that closely resemble actual performance conditions and includes activities to simulate actual work situations. This approach includes integration of tools, methods, and procedures for competency development. Training is tied to work responsibilities so that on-the-job activities or other outside experiences will reinforce the training within a reasonable time after the training.

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[PA158.IG102.SP101.SubP103.N101]

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4. Track the delivery of training against the plan. [PA158.IG102.SP101.SubP104]

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SP 2.2-1 Establish Training Records

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Establish and maintain records of the organizational training.

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[PA158.IG102.SP102]

5079 Refer to the Project Monitoring and Control process area for information
5080 on how project or support group training records are maintained.

5081 [PA158.IG102.SP102.R101]

5082 The scope of this practice is for the training performed at the
5083 organizational level. Establishment and maintenance of training records
5084 for project or support group-sponsored training is the responsibility of
5085 each individual project or support group. [PA158.IG102.SP102.N101]

5086 **Typical Work Products**

- 5087 1. Training records [PA158.IG102.SP102.W101]
- 5088 2. Training updates to the organizational repository [PA158.IG102.SP102.W102]

5089 **Subpractices**

- 5090 1. Keep records of all students who successfully complete each
5091 training course or other approved training activity as well as those
5092 who are unsuccessful. [PA158.IG102.SP102.SubP101]
- 5093 2. Keep records of all staff who have been waived from specific
5094 training. [PA158.IG102.SP102.SubP102]

5095 The rationale for granting a waiver should be documented, and the manager
5096 responsible should approve the waiver for organizational training as well as by the
5097 manager of the excepted individual. [PA158.IG102.SP102.SubP102.N101]

- 5098 3. Keep records of all students who successfully complete their
5099 designated required training. [PA158.IG102.SP102.SubP103]
- 5100 4. Make training records available to the appropriate people for
5101 consideration in assignments. [PA158.IG102.SP102.SubP104]

5102 Training records may be part of a skills matrix developed by the training
5103 organization to provide a summary of the experience and education of people, as
5104 well as training sponsored by the organization. [PA158.IG102.SP102.SubP104.N101]

5105 **SP 2.3-1 Assess Training Effectiveness**

5106 **Assess the effectiveness of the organization's training program.**

5107 [PA158.IG102.SP103]

5108 A process should exist to determine the effectiveness of training, i.e.,
5109 how well the training is meeting the organization's needs.

5110 [PA158.IG102.SP103.N101]

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Examples of methods used to assess training effectiveness include the following: [PA158.IG102.SP103.N103]

- Testing in the training context
- Post-training surveys of training participants
- Surveys of managers' satisfaction with post-training effects
- Assessment mechanisms embedded in courseware

Measures may be taken to assess the added value of the training against work objectives of both the project and organization. Particular attention should be paid to the need for various training methods, such as training teams as integral work units. When used, performance objectives should be shared with course participants, and should be written unambiguously where the performance requirements are stated in a manner that makes them observable and verifiable. The results of the training effectiveness assessment should be used to revise training materials as described in "Establish Training Capability" above.

[PA158.IG102.SP103.N102]

Typical Work Products

1. Training effectiveness surveys [PA158.IG102.SP103.W101]
2. Training program performance assessments [PA158.IG102.SP103.W102]
3. Instructor evaluation forms [PA158.IG102.SP103.W103]
4. Training examinations [PA158.IG102.SP103.W104]

Subpractices

1. Assess in-progress or completed projects to determine whether staff knowledge was adequate for performing project tasks.
 [PA158.IG102.SP103.SubP101]
2. Provide a mechanism for assessing the effectiveness of each training course with respect to established organizational, project, or learning (or performance) objectives. [PA158.IG102.SP103.SubP102]
3. Obtain student evaluations of how well training activities met their needs. [PA158.IG102.SP103.SubP103]

5142 Generic Practices by Goal

5143 **GG 1 Achieve Specific Goals**

5144 *The process supports and enables achievement of the specific goals of the*
 5145 *process area by transforming identifiable input work products to produce*
 5146 *identifiable output work products.*

5147 **GP 1.1 Identify Work Scope**

5148 *Identify the scope of the work to be performed and work products*
5149 *to be produced for organizational training, and communicate this*
5150 *information to those performing the work.* [GP101]

5151 **GP 1.2 Perform Base Practices**

5152 *Perform the base practices of the organizational training process*
5153 *to develop work products and provide services to achieve the*
5154 *specific goals of the process area.* [GP102]

5155 **GG 2 Institutionalize a Managed Process**

5156 *The process is institutionalized as a managed process.*

5157 **GP 2.1 Establish an Organizational Policy**

5158 *Establish and maintain an organizational policy for planning and*
5159 *performing the organizational training process.* [GP103]

5160 Elaboration:

5161 This policy establishes organizational expectations for identifying the
5162 strategic training needs of the organization, and providing that training.

5163 [PA158.EL101]

5164 **GP 2.2 Plan the Process**

5165 *Establish and maintain the requirements and objectives, and plans*
5166 *for performing the organizational training process.* [GP104]

5167 Elaboration:

5168 These requirements, objectives, and plans are typically included in the
5169 plan for the organizational training process. This plan for organizational
5170 training differs from the organizational training plan described in the
5171 specific practice in this process area. The plan for organizational
5172 training addresses strategic high-level planning for all the
5173 organizational training activities. The organizational training plan
5174 addresses periodic, training needs. [PA158.EL102]

5175 **GP 2.3 Provide Resources**

5176 *Provide adequate resources for performing the organizational*
5177 *training process, developing the work products and providing the*
5178 *services of the process.* [GP105]

5179

Elaboration:

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Examples of people (full or part-time, internal or external), and skills needed include the following: [PA158.EL104]

- subject matter experts
- curriculum designers
- instructional designers
- instructors
- training administrators

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Special facilities may be required for training. When necessary, the facilities required for the activities in the Organizational Training process area are developed or purchased. [PA158.EL118]

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Examples of tools used in performing the activities of the Organizational Training process area include the following: [PA158.EL106]

- Instruments for analyzing training needs
- Workstations to be used for training
- Instructional design tools
- Packages for developing presentation materials

5198

GP 2.4 Assign Responsibility

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

5202

GP 2.5 Train People

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5204

Train the people performing or supporting the organizational training process as needed. [GP107]

5205 Elaboration:

5206 Examples of training topics include the following: [PA158.EL108]
5207

- Knowledge and skills needs analysis
- Instructional design
- Instructional techniques (e.g., train the trainer)
- Refresher training on subject matter

5211

5212 **GP 2.6 Manage Configurations**

5213 *Place designated work products of the organizational training*
5214 *process under appropriate levels of configuration management.*
5215 [GP109]

5216 Elaboration:

5217 Examples of work products placed under configuration management
5218 include the following: [PA158.EL109]
5219

- Organizational training tactical plan
- Training Records
- Training materials and supporting artifacts
- Instructor evaluation forms

5223

5224 **GP 2.7 Identify and Involve Relevant Stakeholders**

5225 *Identify and involve the relevant stakeholders of the organizational*
5226 *training process as planned.* [GP124]

5227 Elaboration:

5228 Examples of activities for stakeholder involvement include: [PA158.EL119]
5229

- Establishing a collaborative environment for discussion of training
5230 needs and training effectiveness to ensure that the organization's
5231 training needs are met.
- Identifying training needs
- Reviewing the organizational training tactical plan
- Assessing training effectiveness

5235

5236

GP 2.8 Monitor and Control the Process

5237

Monitor and control the organizational training process against the plan and take appropriate corrective action. [GP110]

5238

5239

Elaboration:

5240

Examples of measures used in monitoring and controlling the activities of the Organizational Training process area include the following:

5241

[PA158.EL112]

5242

5243

- Number of training courses delivered (e.g., planned versus actual)

5244

- Post-training evaluation ratings

5245

- Training program quality survey ratings

5246

5247

GP 2.9 Objectively Evaluate Adherence

5248

Objectively evaluate adherence of the organizational training process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

5249

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Elaboration:

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Examples of activities reviewed include the following: [PA158.EL114]

5254

- Identifying training needs and making training available

5255

- Providing necessary training

5256

5257

Examples of work products reviewed include the following: [PA158.EL116]

5258

- Organizational training tactical plan

5259

- Training materials and supporting artifacts

5260

- Instructor evaluation forms

5261

5262

GP 2.10 Review Status with Higher-Level Management

5263

Review the activities, status, and results of the organizational training process with higher-level management and resolve issues. [GP112]

5264

5265

5266

GG 3 Institutionalize a Defined Process

5267

The process is institutionalized as a defined process.

5268 **GP 3.1 Establish a Defined Process**

5269 *Establish and maintain the description of a defined organizational*
5270 *training process. [GP114]*

5271 **GP 3.2 Collect Improvement Information**

5272 *Collect work products, measures, measurement results, and*
5273 *improvement information derived from planning and performing*
5274 *the organizational training process to support the future use and*
5275 *improvement of the organization's processes and process assets.*

5276 [GP117]

5277 **GG 4 Institutionalize a Quantitatively Managed Process**

5278 *The process is institutionalized as a quantitatively managed process.*

5279 **GP 4.1 Establish Quality Objectives**

5280 *Establish and maintain quantitative objectives for the*
5281 *organizational training process about quality and process*
5282 *performance based on customer needs and business objectives.*

5283 [GP118]

5284 **GP 4.2 Stabilize Subprocess Performance**

5285 *Stabilize the performance of one or more subprocesses of the*
5286 *organizational training process to determine its ability to achieve*
5287 *the established quantitative quality and process performance*
5288 *objectives. [GP119]*

5289 **GG 5 Institutionalize an Optimizing Process**

5290 *The process is institutionalized as an optimizing process.*

5291 **GP 5.1 Ensure Continuous Process Improvement**

5292 *Ensure continuous improvement of the organizational training*
5293 *process in fulfilling the relevant business goals of the*
5294 *organization. [GP125]*

5295 **GP 5.2 Correct Common Cause of Problems**

5296 *Identify and correct the root causes of defects and other problems*
5297 *in the organizational training process. [GP121]*

5298 ORGANIZATIONAL PROCESS PERFORMANCE

5299 Process Management

5300 Purpose

5301 The purpose of Organizational Process Performance is to establish and
5302 maintain a quantitative understanding of the performance of the
5303 organization's set of standard processes, and to provide the process
5304 performance data, baselines, and models to quantitatively manage the
5305 organization's projects. [PA164]

5306 Introductory Notes

5307 Process performance is a measure of the actual results achieved by
5308 following a process. Process performance is characterized by both
5309 process measures (e.g., effort, cycle time, and defect removal
5310 efficiency) and product measures (e.g., reliability, and defect density).
5311 [PA164.N101]

5312 The common measures for the organization are composed of process
5313 and product measures that summarize the actual performance of
5314 processes in individual projects in the organization. The organizational
5315 data for these measures is analyzed to establish a distribution and
5316 range of results, which characterize the expected performance of the
5317 process when used on any individual project in the organization.
5318 [PA164.N102]

5319 In this process area, the phrase "quality and process performance
5320 objectives" covers objectives and requirements for product quality,
5321 service quality, and process performance. As indicated above, the term
5322 process performance includes product quality; however, to emphasize
5323 the importance of product quality, the phrase "quality and process
5324 performance objectives" is used rather than just "process performance
5325 objectives." [PA164.N106]

5326 The expected process performance can be used in establishing the
5327 project's quality and process performance objectives and can be used
5328 as a baseline against which actual project performance can be
5329 compared. This information is used to quantitatively manage the
5330 project. Each quantitatively managed project, in turn, provides actual
5331 performance results that become a part of the baseline data for the
5332 organization's process assets. [PA164.N103]

5333 The associated process capability models are used to represent past
5334 and current process performance and to predict future results of the
5335 process. [PA164.N104]

5336 For example, the latent defects in the delivered product can be
5337 predicted using measurements of defects identified during the product
5338 verification activities. [PA164.N107]

5339
5340 When the organization has measures, data, and analytic techniques for
5341 critical process and product characteristics, it is able to do the following:
5342 [PA164.N105]

- 5343 • Determine whether processes are behaving consistently or have
5344 stable trends (i.e., are predictable).
- 5345 • Identify processes that perform within consistent natural bounds
5346 across process implementation teams.
- 5347 • Establish criteria for identifying whether a process or process
5348 element should be statistically managed, and determine pertinent
5349 measures and analytic techniques to be used in such
5350 management.
- 5351 • Identify processes that show unusual (e.g., sporadic or
5352 unpredictable) behavior.
- 5353 • Identify any aspects of the processes that can be improved in the
5354 organization's set of standard processes.
- 5355 • Identify implementations of processes which may be best
5356 practices.

5357 Related Process Areas

5358 *Refer to the Quantitative Project Management process area for more*
5359 *information about the use of process performance baselines and*
5360 *models* [PA164.R101]

5361 *Refer to the Measurement and Analysis process area for more*
5362 *information about specifying measures, collecting and analyzing data.*
5363 [PA164.R102]

5364 Specific Goals

5365 **SG 1 Establish Performance Baselines and Models** [PA164.IG101]

5366 ***Baselines and models that characterize the expected process performance of***
5367 ***the organization's set of standard processes are established and maintained.***

5368 Generic Goals

5369 **GG 1** **Achieve Specific Goals** [CL102.GL101]

5370 *The process supports and enables achievement of the specific goals of the*
5371 *process area by transforming identifiable input work products to produce*
5372 *identifiable output work products.*

5373 **GG 2** **Institutionalize a Managed Process** [CL103.GL101]

5374 *The process is institutionalized as a managed process.*

5375 **GG 3** **Institutionalize a Defined Process** [CL104.GL101]

5376 *The process is institutionalized as a defined process.*

5377 **GG 4** **Institutionalize a Quantitatively Managed Process** [CL105.GL101]

5378 *The process is institutionalized as a quantitatively managed process.*

5379 **GG 5** **Institutionalize an Optimizing Process** [CL106.GL101]

5380 *The process is institutionalized as an optimizing process.*

5381 Practice to Goal Relationship Table

- 5382 SG 1 Establish Performance Baselines and Models [PA164.IG101]
- 5383 SP 1.1-1 Select Processes
- 5384 SP 1.2-1 Establish Process Performance Measures
- 5385 SP 1.3-1 Establish Quality and Process Performance Objectives
- 5386 SP 1.4-1 Establish Process Performance Baselines
- 5387 SP 1.5-1 Establish Process Performance Models

- 5388 GG 1 Achieve Specific Goals [CL102.GL101]
- 5389 GP 1.1 Identify Work Scope
- 5390 GP 1.2 Perform Base Practices

- 5391 GG 2 Institutionalize a Managed Process [CL103.GL101]
- 5392 GP 2.1 Establish an Organizational Policy
- 5393 GP 2.2 Plan the Process
- 5394 GP 2.3 Provide Resources
- 5395 GP 2.4 Assign Responsibility
- 5396 GP 2.5 Train People
- 5397 GP 2.6 Manage Configurations
- 5398 GP 2.7 Identify and Involve Relevant Stakeholders
- 5399 GP 2.8 Monitor and Control the Process
- 5400 GP 2.9 Objectively Evaluate Adherence
- 5401 GP 2.10 Review Status with Higher-Level Management

- 5402 GG 3 Institutionalize a Defined Process [CL104.GL101]
- 5403 GP 3.1 Establish a Defined Process
- 5404 GP 3.2 Collect Improvement Information

- 5405 GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]
- 5406 GP 4.1 Establish Quality Objectives
- 5407 GP 4.2 Stabilize Subprocess Performance

- 5408 GG 5 Institutionalize an Optimizing Process [CL106.GL101]
- 5409 GP 5.1 Ensure Continuous Process Improvement
- 5410 GP 5.2 Correct Common Cause of Problems

5411 Specific Practices by Goal

5412 **SG 1 Establish Performance Baselines and Models** [PA164.IG101]

5413 ***Baselines and models that characterize the expected process performance of***
 5414 ***the organization's set of standard processes are established and maintained.***

5415 **SP 1.1-1 Select Processes**

5416 ***Select the processes or process elements in the organization's set***
 5417 ***of standard processes that are to be included in the organization's***
 5418 ***process performance analyses.*** [PA164.IG101.SP101]

5419 *Refer to the Organizational Process Definition process area for more*
5420 *information about the structure of the organization's process assets.*

5421 [PA164.IG101.SP101.R101]

5422 The organization's set of standard processes consists of a set of
5423 standard processes that, in turn, are comprised of process elements.

5424 [PA164.IG101.SP101.N101]

5425 Typically, it will not be possible, useful, or economically justifiable to
5426 apply quantitative process performance techniques to all processes or
5427 process elements of the organization's set of standard processes.
5428 Selection of the processes and/or process elements is based upon the
5429 needs and objectives of both the organization and projects.

5430 [PA164.IG101.SP101.N102]

5431 **Typical Work Products**

- 5432 1. List of process or process elements identified for process
5433 performance analyses [PA164.IG101.SP101.W101]

5434 **SP 1.2-1 Establish Process Performance Measures**

5435 ***Establish and maintain definitions of the measures that are to be***
5436 ***included in the organization's process performance analyses.***

5437 [PA164.IG101.SP102]

5438 *Refer to the Measurement and Analysis process area for more*
5439 *information about selecting measures.* [PA164.IG101.SP102.R101]

5440 **Typical Work Products**

- 5441 1. Definitions for the selected measures of process performance
5442 [PA164.IG101.SP102.W101]

5443 **Subpractices**

- 5444 1. Determine which of the organization's business objectives for
5445 process performance need to be addressed by the measures.

5446 [PA164.IG101.SP102.SubP101]

- 5447 2. Select measures that provide appropriate insight into the
5448 organization's process performance. [PA164.IG101.SP102.SubP102]

5449 The Goal Question Metric paradigm is an approach that can be used to select
5450 measures that provide insight into the organization's business objectives.

5451 [PA164.IG101.SP102.SubP102.N101]

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Examples of criteria used to select measures include the following:
[PA164.IG101.SP102.SubP102.N102]

- Relationship of the measures to the organization's business objectives
- Coverage that the measures provide of the entire life cycle
- Visibility that the measures provide into the process performance
- Availability of the measures
- Extent to which the measures are objective
- Frequency at which the observations of the measure can be collected
- Extent to which the measures are controllable by changes to the process
- Extent to which the measures represent the users' view of effective process performance

3. Incorporate the selected measures into the organization's common set of measures. [PA164.IG101.SP102.SubP103]

Refer to the Organizational Process Definition process area for more information about establishing the organization's process assets.

[PA164.IG101.SP102.SubP103.R101]

4. Revise the set of measures as necessary. [PA164.IG101.SP102.SubP104]

SP 1.3-1 Establish Quality and Process Performance Objectives

Establish and maintain quantitative objectives for quality and process performance for the organization. [PA164.IG101.SP103]

The organization's process performance objectives have the following characteristics: [PA164.IG101.SP103.N101]

- Based on the organization's business objectives
- Based on the past performance of projects
- Defined to gauge process performance in areas such as product quality, productivity, and cycle time for product development

Typical Work Products

1. Organization's process performance objectives [PA164.IG101.SP103.W101]

Subpractices

1. Review the organization's business objectives related to process performance. [PA164.IG101.SP103.SubP101]

5484

Examples of business objectives include the following: [PA164.IG101.SP103.SubP101.N101]

5485

- Achieve a development cycle of a specified time for a specified release of a product.

5486

5487

- Decrease the cost of maintenance of the products currently in development by a specified percent.

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2. Define the organization's quantitative objectives for process performance. [PA164.IG101.SP103.SubP102]

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Objectives may be established for both process measurements (e.g., effort, cycle time, and defect removal efficiency) and product measurements (e.g., reliability and defect density). [PA164.IG101.SP103.SubP102.N101]

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Examples of process performance objectives include the following:

5496

[PA164.IG101.SP103.SubP102.N102]

5497

- Achieve a specified productivity.

5498

- Deliver work products with no more than a specified number of latent defects.

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3. Define the priorities of the organization's objectives for process performance. [PA164.IG101.SP103.SubP103]

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4. Review, negotiate, and obtain commitment for the organization's process performance objectives and their priorities from the relevant stakeholders. [PA164.IG101.SP103.SubP104]

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5. Revise the organization's quantitative objectives for process performance as necessary. [PA164.IG101.SP103.SubP105]

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Examples of when the organization's quantitative objectives for process performance may need to be revised include the following:

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[PA164.IG101.SP103.SubP105.N101]

5509

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- When the organization's business objectives change

5511

- When the organization's processes change

5512

- When actual process performance differs significantly from the objectives

5513

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SP 1.4-1 Establish Process Performance Baselines

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Establish and maintain the organization's process performance baselines. [PA164.IG101.SP104]

5516

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The organization's process performance baselines measure performance for the organization's set of standard processes at various levels of detail, as appropriate. The processes include the following:

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[PA164.IG101.SP104.N101]

- 5521 • Individual process elements (e.g., test case inspection element)
- 5522 • Sequence of connected processes
- 5523 • Processes for the complete life cycle
- 5524 • Processes for developing individual work products

5525 There may be several process performance baselines to characterize
5526 performance for subgroups of the organization. [PA164.IG101.SP104.N102]

5527 Examples of criteria used to categorize subgroups include the following:

5528 [PA164.IG101.SP104.N104]

- 5529 • Product line
- 5530 • Application domain
- 5531 • Complexity
- 5532 • Team size
- 5533 • Work product size
- 5534 • Process elements from the organization's set of standard
5535 processes

5536
5537 Allowable tailoring of the organization's set of standard processes may
5538 significantly affect the comparability of the data for inclusion in process
5539 performance baselines. The effects of tailoring should be considered in
5540 establishing baselines. [PA164.IG101.SP104.N103]

5541 *Refer to the Quantitative Project Management process area for more*
5542 *information about the use of process baselines* [PA164.IG101.SP104.N103.R101]

5543 **Typical Work Products**

- 5544 1. Baseline data on the organization's process performance

5545 [PA164.IG101.SP104.W101]

5546 **Subpractices**

- 5547 1. Collect measurements from the organization's projects.

5548 [PA164.IG101.SP104.SubP101]

5549 *Refer to the Measurement and Analysis process area for information*
5550 *about collecting and analyzing data* [PA164.IG101.SP104.SubP101.R101]

- 5551 2. Establish and maintain the organization's process performance
5552 baselines from the collected measurements and analyses.

5553 [PA164.IG101.SP104.SubP102]

5554 Process performance baselines are derived by analyzing the collected measures
5555 to establish a distribution and range of results that characterize the expected
5556 performance for selected processes when used on any individual project in the
5557 organization. [PA164.IG101.SP104.SubP102.N102]

5558 The measurements from stable processes from projects should be used; other
5559 data may not be reliable. [PA164.IG101.SP104.SubP102.N101]

5560 *Refer to the Measurement and Analysis process area for information*
5561 *about measuring process performance to establish performance*
5562 *baselines.* [PA164.IG101.SP104.SubP102.R101]

5563 3. Review and get agreement with relevant stakeholders about the
5564 organization's process performance baselines. [PA164.IG101.SP104.SubP103]

5565 4. Make the organization's process performance information available
5566 across the organization in the organization's measurement
5567 repository. [PA164.IG101.SP104.SubP104]

5568 The organization's process performance baselines are used by the projects to
5569 estimate the natural bounds for process performance. [PA164.IG101.SP104.SubP104.N101]

5570 *Refer to the Organizational Process Definition process area for more*
5571 *information about establishing the measurement repository*
5572 *[PA164.IG101.SP104.SubP104.N101.R101]*

5573 5. Compare the organization's process performance baselines to the
5574 associated objectives. [PA164.IG101.SP104.SubP105]

5575 6. Revise the organization's process performance baselines as
5576 necessary. [PA164.IG101.SP104.SubP106]

5577 Examples of when the organization's process performance baselines may need to
5578 be revised include the following: [PA164.IG101.SP104.SubP106.N101]

- 5579 • When the processes change
- 5580 • When the organization's results change
- 5581 • When the organization's needs change

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5583 **SP 1.5-1 Establish Process Performance Models**

5584 ***Establish and maintain the process performance models for the***
5585 ***organization's set of standard processes.*** [PA164.IG101.SP105]

5586 Process performance models are used to estimate or predict the value
5587 of a process performance measure from the values of other process
5588 and product measurements. These process performance models
5589 typically use process and product measurements collected throughout
5590 the life cycle to estimate progress toward achieving objectives which
5591 cannot be measured until later in the life cycle. [PA164.IG101.SP105.N101]

5592 The process performance models are used as follows:

5593 [PA164.IG101.SP105.N102]

- 5594 • The organization uses them for estimating, analyzing, and
5595 predicting the process performance associated with the processes
5596 in the organization's set of standard processes.
- 5597 • The organization uses them to assess the (potential) return on
5598 investment for process improvement activities.
- 5599 • Projects use them for estimating, analyzing, and predicting the
5600 process performance for their defined processes.
- 5601 • Projects use them for selecting processes for use.

5602 These measures and models are defined to provide insight into and to
5603 provide the ability to predict critical process and product characteristics
5604 that are relevant to business value. [PA164.IG101.SP105.N103]

5605 Examples of areas to use models include the following:

5606 [PA164.IG101.SP105.N104]

- 5607 • Schedule and cost
- 5608 • Reliability
- 5609 • Defect identification and removal rates
- 5610 • Defect removal efficiency
- 5611 • Latent defect estimation
- 5612 • Development progress
- 5613 • A combination of these areas

5614

5615 Examples of process performance models include the following:

5616 [PA164.IG101.SP105.N105]

- 5617 • System dynamics models
- 5618 • Reliability growth models
- 5619 • Complexity models

5620

5621 *Refer to the Quantitative Project Management process area for more*
5622 *information about the use of process models* [PA164.IG101.SP105.N105.R101]

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Typical Work Products

1. Process performance models [PA164.IG101.SP105.W101]

Subpractices

1. Establish the process performance models based on the organization's set of standard processes and the organization's process performance baselines. [PA164.IG101.SP105.SubP101]
2. Calibrate the process performance models based on the organization's past results and current needs. [PA164.IG101.SP105.SubP102]
3. Review the process performance models and get agreement with relevant stakeholders. [PA164.IG101.SP105.SubP103]
4. Support the projects' use of the process performance models. [PA164.IG101.SP105.SubP104]
5. Revise the process performance models as necessary. [PA164.IG101.SP105.SubP105]

Examples of when the process performance models may need to be revised include the following: [PA164.IG101.SP105.SubP105.N101]

- When the processes change
- When the organization's results change
- When the organization's needs change

5643 Generic Practices by Goal

5644 GG 1 Achieve Specific Goals

5645 ***The process supports and enables achievement of the specific goals of the***
5646 ***process area by transforming identifiable input work products to produce***
5647 ***identifiable output work products.***

5648 GP 1.1 Identify Work Scope

5649 ***Identify the scope of the work to be performed and work products***
5650 ***to be produced for organizational process performance, and***
5651 ***communicate this information to those performing the work.*** [GP101]

5652 GP 1.2 Perform Base Practices

5653 ***Perform the base practices of the organizational process***
5654 ***performance process to develop work products and provide***
5655 ***services to achieve the specific goals of the process area.*** [GP102]

5656 **GG 2 Institutionalize a Managed Process**

5657 ***The process is institutionalized as a managed process.***

5658 **GP 2.1 Establish an Organizational Policy**

5659 ***Establish and maintain an organizational policy for planning and***
5660 ***performing the organizational process performance process.* [GP103]**

5661 Elaboration:

5662 This policy establishes organizational expectations for establishing and
5663 maintaining process performance baselines for the organization's set of
5664 standard processes. [PA164.EL101]

5665 **GP 2.2 Plan the Process**

5666 ***Establish and maintain the requirements and objectives, and plans***
5667 ***for performing the organizational process performance process.***
5668 **[GP104]**

5669 **GP 2.3 Provide Resources**

5670 ***Provide adequate resources for performing the organizational***
5671 ***process performance process, developing the work products and***
5672 ***providing the services of the process.* [GP105]**

5673 Elaboration:

5674 Special expertise in statistics and statistical process control may be
5675 needed to establish the performance baseline of the organization's set
5676 of standard processes. [PA164.EL111]

5677 **Examples of tools used in performing the activities of the Organizational**
5678 **Process Performance process area include the following:** [PA164.EL102]

- 5679 • Database management systems
- 5680 • System dynamic models
- 5681 • Process modeling tools
- 5682 • Statistical analysis packages
- 5683 • Problem tracking packages

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GP 2.4 Assign Responsibility

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

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GP 2.5 Train People

Train the people performing or supporting the organizational process performance process as needed. [GP107]

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Elaboration:

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Examples of training topics include the following: [PA164.EL103]

- Process and process improvement modeling
- Quantitative and statistical methods (e.g., estimating models, Pareto analysis, and control charts)

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GP 2.6 Manage Configurations

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

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Elaboration:

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Examples of work products placed under configuration management include the following: [PA164.EL104]

- Organizational process performance objectives
- Definition for the selected measures of process performance
- Baseline data on the organization's process performance

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GP 2.7 Identify and Involve Relevant Stakeholders

Identify and involve the relevant stakeholders of the organizational process performance process as planned. [GP124]

5712 Elaboration:

5713 Examples of activities for stakeholder involvement include: [PA164.EL112]

- 5714 • Establishing the organization's process performance objectives
5715 and their priorities
- 5716 • Reviewing and resolving issues on the organization's process
5717 performance baselines
- 5718 • Reviewing and resolving issues on the organization's process
5719 performance models

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5721 **GP 2.8 Monitor and Control the Process**

5722 ***Monitor and control the organizational process performance***
5723 ***process against the plan and take appropriate corrective action.***

5724 [GP110]

5725 Elaboration:

5726 Examples of measures used in monitoring and controlling the activities
5727 of the Organizational Process Performance process area include the
5728 following: [PA164.EL105]

- 5729 • Trends in the organization's process performance with respect to
5730 changes in work products and task attributes (e.g., size growth,
5731 effort, schedule, and quality)

5732

5733 **GP 2.9 Objectively Evaluate Adherence**

5734 ***Objectively evaluate adherence of the organizational process***
5735 ***performance process and the work products and services of the***
5736 ***process to the applicable requirements, objectives, and standards,***
5737 ***and address noncompliance.*** [GP113]

5738 Elaboration:

5739 Examples of activities reviewed include the following: [PA164.EL106]

- 5740 • Establishing performance baselines and models

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Examples of work products reviewed include the following: [PA164.EL110]

- Process performance plans
- Organizational process performance objectives
- Definition for the selected measures of process performance

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GP 2.10 Review Status with Higher-Level Management

Review the activities, status, and results of the organizational process performance process with higher-level management and resolve issues. [GP112]

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GG 3 Institutionalize a Defined Process

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The process is institutionalized as a defined process.

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GP 3.1 Establish a Defined Process

Establish and maintain the description of a defined organizational process performance process. [GP114]

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GP 3.2 Collect Improvement Information

Collect work products, measures, measurement results, and improvement information derived from planning and performing the organizational process performance process to support the future use and improvement of the organization's processes and process assets. [GP117]

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GG 4 Institutionalize a Quantitatively Managed Process

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The process is institutionalized as a quantitatively managed process.

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GP 4.1 Establish Quality Objectives

Establish and maintain quantitative objectives for the organizational process performance process about quality and process performance based on customer needs and business objectives. [GP118]

5769 **GP 4.2 Stabilize Subprocess Performance**

5770 *Stabilize the performance of one or more subprocesses of the*
5771 *organizational process performance process to determine its*
5772 *ability to achieve the established quantitative quality and process*
5773 *performance objectives.* [GP119]

5774 **GG 5 Institutionalize an Optimizing Process**

5775 *The process is institutionalized as an optimizing process.*

5776 **GP 5.1 Ensure Continuous Process Improvement**

5777 *Ensure continuous improvement of the organizational process*
5778 *performance process in fulfilling the relevant business goals of*
5779 *the organization.* [GP125]

5780 **GP 5.2 Correct Common Cause of Problems**

5781 *Identify and correct the root causes of defects and other problems*
5782 *in the organizational process performance process.* [GP121]

5783 ORGANIZATIONAL INNOVATION AND DEPLOYMENT

5784 Process Management

5785 Purpose

5786 The purpose of Organizational Innovation and Deployment is to select
5787 and deploy incremental and innovative improvements that measurably
5788 improve the organization's processes and technologies. The
5789 improvements support the organization's quality and process
5790 performance objectives as derived from the organization's business
5791 objectives. [PA161]

5792 Introductory Notes

5793 The Organizational Innovation and Deployment process area selects
5794 and deploys improvements that can improve the organization's ability to
5795 meet its quality and process performance objectives. Quality and
5796 process performance objectives that this process area might address
5797 include the following: [PA161.N101]

- 5798 • Improved product quality (e.g., functionality, performance)
- 5799 • Increased productivity
- 5800 • Decreased development cycle time
- 5801 • Greater customer and end-user satisfaction
- 5802 • Shorter development and production time to change functionality,
5803 add features, or adapt to new technologies

5804 Achievement of these objectives depends on the successful
5805 establishment of an infrastructure that enables and encourages all
5806 people in the organization to propose potential improvements to the
5807 organization's processes and technologies. All members of the
5808 organization can participate in the organization's process and
5809 technology improvement activities. Their proposals are systematically
5810 gathered and addressed. [PA161.N102]

5811 Pilots are conducted to evaluate significant changes involving untried,
5812 high risk, or innovative improvements before they are incorporated into
5813 normal practice. [PA161.N103]

5814 Process and technology improvements that will be deployed across the
5815 organization are selected from process and technology improvement
5816 proposals based on the following criteria: [PA161.N104]

- 5817
- 5818
- 5819
- 5820
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- 5822
- 5823
- 5824
- A quantitative understanding of the organization's current quality and process performance
 - The organization's quality and process performance objectives
 - Estimates of the improvement in quality and process performance resulting from deploying the process and technology improvements
 - Estimated costs of deploying process and technology improvements, and the resources and funding available for such deployment

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The expected benefits added by the process and technology improvements are weighed against the cost and impact to the organization. Change and stability must be balanced carefully. Change that is too great or too rapid can overwhelm the organization, destroying its investment in organizational learning represented by the organization's process assets. Rigid stability can result in stagnation, allowing the changing business environment to erode the organization's business position. [PA161.N105]

5833

Improvements are deployed, as appropriate, to the following: [PA161.N106]

- 5834
- 5835
- 5836
- New projects
 - Ongoing development projects
 - Ongoing maintenance projects

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In this process area, the term 'process and technology improvements' refers to incremental and innovative improvements to processes and also to process or product technologies. [PA161.N107]

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The practices in this process area complement and extend those found in the Organizational Process Focus process area. The focus of this process area is process improvement that is based on a quantitative knowledge of the organization's set of standard processes and technologies and their expected quality and performance in predictable situations. In the Organizational Process Focus process area, no assumptions are made about the quantitative basis of improvement.

[PA161.N108]

5848 Related Process Areas

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Refer to the Organizational Process Definition process area for more information about incorporating the measures associated with the quantitative process improvement objectives into the organization's common set of measures and incorporating the deployed process improvements into the organization's process assets. [PA161.R101]

5854 Refer to the Organizational Process Focus process area for more
5855 information about soliciting, collecting, and handling of process
5856 improvement proposals and coordinating the deployment of the process
5857 improvement into the project's defined processes. [PA161.R102]

5858 Refer to the Organizational Training process area for more information
5859 about providing updated training to support deployment of process and
5860 technology improvements. [PA161.R103]

5861 Refer to the Organizational Process Performance process area for
5862 more information about quality and process performance objectives and
5863 process performance models. Quality and process performance
5864 objectives are used to analyze and select process and technology
5865 improvement proposals for deployment. Process performance models
5866 are used to quantify the impact and benefits of innovations. [PA161.R104]

5867 Refer to the Measurement and Analysis process area for more
5868 information about defining the process and technology improvement
5869 measures related to the organization's business objectives, establishing
5870 measures and objectives to determine the value of selected process
5871 and technology improvements with respect to business objectives, and
5872 revising process and technology improvement measures. [PA161.R105]

5873 Refer to the Integrated Project Management (IPPD) process area for
5874 more information about coordinating the deployment of process and
5875 technology improvements into the project's defined process. [PA161.R106]

5876 Specific Goals

5877 **SG 1** Select Improvements [PA161.IG101]

5878 **Process and technology improvements that contribute to meeting quality and**
5879 **process performance objectives are selected.**

5880 **SG 2** Deploy Improvements [PA161.IG102]

5881 **Measurable improvements to the organization's processes and technologies**
5882 **are continually and systematically deployed.**

5883 Generic Goals

5884 **GG 1** Achieve Specific Goals [CL102.GL101]

5885 **The process supports and enables achievement of the specific goals of the**
5886 **process area by transforming identifiable input work products to produce**
5887 **identifiable output work products.**

5888 **GG 2** Institutionalize a Managed Process [CL103.GL101]

5889 *The process is institutionalized as a managed process.*

5890 **GG 3** Institutionalize a Defined Process [CL104.GL101]

5891 *The process is institutionalized as a defined process.*

5892 **GG 4** Institutionalize a Quantitatively Managed Process [CL105.GL101]

5893 *The process is institutionalized as a quantitatively managed process.*

5894 **GG 5** Institutionalize an Optimizing Process [CL106.GL101]

5895 *The process is institutionalized as an optimizing process.*

5896 Practice to Goal Relationship Table

- 5897 **SG 1 Select Improvements** [PA161.IG101]
- 5898 SP 1.1-1 Collect and Analyze Improvement Proposals
- 5899 SP 1.2-1 Identify Innovations
- 5900 SP 1.3-1 Pilot Improvements
- 5901 SP 1.4-1 Select Improvements for Deployment
- 5902 **SG 2 Deploy Improvements** [PA161.IG102]
- 5903 SP 2.1-1 Plan the Deployment
- 5904 SP 2.2-1 Manage the Deployment
- 5905 SP 2.3-1 Measure Improvement Effects
- 5906 **GG 1 Achieve Specific Goals** [CL102.GL101]
- 5907 GP 1.1 Identify Work Scope
- 5908 GP 1.2 Perform Base Practices
- 5909 **GG 2 Institutionalize a Managed Process** [CL103.GL101]
- 5910 GP 2.1 Establish an Organizational Policy
- 5911 GP 2.2 Plan the Process
- 5912 GP 2.3 Provide Resources
- 5913 GP 2.4 Assign Responsibility
- 5914 GP 2.5 Train People
- 5915 GP 2.6 Manage Configurations
- 5916 GP 2.7 Identify and Involve Relevant Stakeholders
- 5917 GP 2.8 Monitor and Control the Process
- 5918 GP 2.9 Objectively Evaluate Adherence
- 5919 GP 2.10 Review Status with Higher-Level Management
- 5920 **GG 3 Institutionalize a Defined Process** [CL104.GL101]
- 5921 GP 3.1 Establish a Defined Process
- 5922 GP 3.2 Collect Improvement Information
- 5923 **GG 4 Institutionalize a Quantitatively Managed Process** [CL105.GL101]
- 5924 GP 4.1 Establish Quality Objectives
- 5925 GP 4.2 Stabilize Subprocess Performance
- 5926 **GG 5 Institutionalize an Optimizing Process** [CL106.GL101]
- 5927 GP 5.1 Ensure Continuous Process Improvement
- 5928 GP 5.2 Correct Common Cause of Problems

5929 Specific Practices by Goal

5930 **SG 1 Select Improvements** [PA161.IG101]

5931 ***Process and technology improvements that contribute to meeting quality and***
 5932 ***process performance objectives are selected.***

5933 **SP 1.1-1 Collect and Analyze Improvement Proposals**

5934 ***Collect and analyze process and technology improvement***
 5935 ***proposals.*** [PA161.IG101.SP101]

5936 Each process and technology improvement proposal must be analyzed.
5937 [PA161.IG101.SP101.N101]

5938 Simple process and technology improvements, with well-understood
5939 benefits and effects, will not usually undergo detailed evaluations.
5940 [PA161.IG101.SP101.N102]

5941 Examples of simple process and technology improvements include the
5942 following: [PA161.IG101.SP101.N104]

- 5943 • Add an item to a peer review checklist.
- 5944 • Combine the technical review and management review for
5945 suppliers into a single technical/management review.

5946

5947 **Typical Work Products**

- 5948 1. Analyzed process and technology improvement proposals
5949 [PA161.IG101.SP101.W101]

5950 **Subpractices**

- 5951 1. Collect process and technology improvement proposals.
5952 [PA161.IG101.SP101.SubP101]

5953 A process and technology improvement proposal documents proposed
5954 incremental and innovative improvements to specific processes and technologies.
5955 Managers and staff in the organization, as well as customers, end users, and
5956 suppliers can submit process and technology improvement proposals. Process
5957 and technology improvements may be implemented at the local level before being
5958 proposed for the organization. [PA161.IG101.SP101.SubP101.N101]

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Examples of sources for process and technology improvement proposals include the following: [PA161.IG101.SP101.SubP101.N102]

- Findings and recommendations of process assessments
- An organization's process and technology improvement objectives
- Analysis of data about customer problems and customer satisfaction
- Analysis of data about project performance compared to quality and productivity objectives
- Analysis of technical performance measures
- Results of process and product benchmarks
- Analysis of data on defect causes
- Measured effectiveness of process activities
- Examples of process and technology improvement proposals that were successfully adopted elsewhere
- Feedback on previously submitted process and technology improvement proposals
- Spontaneous ideas from managers and staff

Refer to the Organizational Process Focus process area for more information about process and technology improvement proposals.

[PA161.IG101.SP101.SubP101.N102.R101]

2. Analyze the costs and benefits of process and technology improvement proposals as appropriate. [PA161.IG101.SP101.SubP102]

Process and technology improvement proposals that have a large cost to benefit ratio are rejected. [PA161.IG101.SP101.SubP102.N101]

Criteria for evaluating costs and benefits include the following:

[PA161.IG101.SP101.SubP102.N102]

- Contribution toward meeting the organization's process and technology improvement objectives
- Effect on mitigating identified project and organizational risks
- Ability to respond quickly to changes in project requirements, market situations, and the business environment
- Effect on related processes and associated assets
- Cost of defining and collecting data that supports the measurement and analysis of the process and technology improvement proposal
- Expected life span of the proposal

Process and technology improvement proposals that would not improve the organization's processes are rejected. [PA161.IG101.SP101.SubP102.N103]

5996 Process performance models provide insight into the effect of process changes on
5997 process capability and performance. [PA161.IG101.SP101.SubP102.N104]

5998 *Refer to the Organizational Process Performance process area for*
5999 *practices that cover process performance models.*

6000 [PA161.IG101.SP101.SubP102.N104.R101]

6001 3. Identify the process and technology improvement proposals that
6002 are innovative. [PA161.IG101.SP101.SubP103]

6003 Innovative improvements are also identified and analyzed in the "Identify
6004 Innovations" specific practice. [PA161.IG101.SP101.SubP103.N101]

6005 Whereas this specific practice analyzes proposals that have been passively
6006 collected, the purpose of the "Identify Innovations" specific practice is to actively
6007 search for and locate innovative improvements. The search primarily involves
6008 looking outside the organization. [PA161.IG101.SP101.SubP103.N102]

6009 Innovative improvements are typically identified from reviewing process and
6010 technology improvement proposals or by actively investigating and monitoring
6011 innovations that are in use in other organizations or documented in research
6012 literature. Innovation may be inspired by internal improvement objectives or by the
6013 external business environment. [PA161.IG101.SP101.SubP103.N103]

6014 Innovative improvements are typically major changes to the process that
6015 represent a break from the old way of doing things (e.g., changing the life-cycle
6016 methodology). Innovative improvements may also include changes in the products
6017 that support, enhance, or automate the process (for example, using off-the-shelf
6018 products to support the process). [PA161.IG101.SP101.SubP103.N104]

6019 Examples of innovative improvements include the following:

6020 [PA161.IG101.SP101.SubP103.N105]

- 6021 • Advances in computer and related hardware products
- 6022 • New support tools
- 6023 • New techniques, methodologies, processes, or life cycles
- 6024 • New interface standards
- 6025 • New reusable components
- 6026 • New management techniques
- 6027 • New quality improvement techniques
- 6028 • New process development and deployment support tools

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6030 4. Identify potential barriers and risks to deploying each process and
6031 technology improvement proposal. [PA161.IG101.SP101.SubP104]

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Examples of barriers to deploying process and technology improvements include the following: [PA161.IG101.SP101.SubP104.N101]

- Turf guarding and parochial perspectives
- Unclear or weak business rationale
- Lack of short-term benefits and visible successes
- Unclear picture of what is expected from everyone
- Too many changes at the same time
- Lack of involvement and support of those affected

Examples of risk factors that affect the deployment of process and technology improvements include the following: [PA161.IG101.SP101.SubP104.N102]

- Compatibility of the improvement with existing processes, values, and skills of potential end users
- Complexity of the improvement
- Difficulty implementing the improvement
- Ability to demonstrate the value of the improvement before widespread deployment
- Justification for large, up-front investments in areas such as tools and training
- Inability to overcome "technology drag" where the current implementation is used successfully by a large and mature installed base of end users

5. Estimate the cost, effort, and schedule required for deploying each candidate process and technology improvement.

[PA161.IG101.SP101.SubP105]

6. Select the process and technology improvement proposals to be piloted before broad-scale deployment. [PA161.IG101.SP101.SubP106]

Since innovations, by definition, usually represent a major change, most innovative improvements will be piloted. [PA161.IG101.SP101.SubP106.N101]

7. Document the results of the evaluation of each process and technology improvement proposal. [PA161.IG101.SP101.SubP107]

8. Monitor the status of each process and technology improvement proposal. [PA161.IG101.SP101.SubP108]

SP 1.2-1 Identify Innovations

Identify innovative improvements that would increase the organization's quality and process performance. [PA161.IG101.SP102]

6067 The specific practice "Collect and analyze improvement proposals"
6068 analyzed proposals that were passively collected. The purpose of this
6069 specific practice is to actively search for and locate innovative
6070 improvements. This search primarily involves looking outside the
6071 organization. [PA161.IG101.SP102.N101]

6072 **Typical Work Products**

6073 1. Candidate innovation improvements [PA161.IG101.SP102.W101]

6074 **Subpractices**

6075 1. Analyze the organization's set of standard processes to determine
6076 areas where innovative improvements would be most helpful.

6077 [PA161.IG101.SP102.SubP101]

6078 These analyses are performed to determine which subprocesses are critical to
6079 achieving the organization's quality and process performance objectives and
6080 which ones are good candidates to be improved. [PA161.IG101.SP102.SubP101.N101]

6081 2. Investigate innovative improvements that may improve the
6082 organization's set of standard processes. [PA161.IG101.SP102.SubP102]

6083 Investigating innovative improvements involves the following:

6084 [PA161.IG101.SP102.SubP102.N101]

- 6085 • Systematically maintaining awareness of leading relevant technical work and
6086 technology trends
- 6087 • Periodically searching for commercially available innovative improvements
- 6088 • Collecting proposals for innovative improvements from the projects and the
6089 organization
- 6090 • Systematically reviewing processes and technologies used externally and
6091 comparing them to those used within the organization
- 6092 • Identifying areas where innovative improvements have been used successfully,
6093 and reviewing data and documentation of experience using these improvements

6094 3. Analyze potential innovative improvements to understand their
6095 effects on process elements and predict their influence on the
6096 process. [PA161.IG101.SP102.SubP103]

6097 Process performance models can provide a basis for analyzing possible effects of
6098 changes to process elements. [PA161.IG101.SP102.SubP103.N101]

6099 *Refer to the Organizational Process Performance process area for*
6100 *more information about process performance models.*

6101 [PA161.IG101.SP102.SubP103.N101.R101]

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Examples of such process performance models include: [PA161.IG101.SP102.SubP103.N102]

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- System dynamics models

6104

- Reliability growth models

6105

- Complexity models

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6107

4. Analyze the costs and benefits of potential innovative improvements. [PA161.IG101.SP102.SubP104]

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Innovative improvements that have a very large cost to benefit ratio are rejected.

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[PA161.IG101.SP102.SubP104.N101]

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6111

5. Create process and technology improvement proposals for those innovative improvements that would result in improving the organization's processes or technologies. [PA161.IG101.SP102.SubP105]

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6. Select the innovative improvements to be piloted before broad-scale deployment. [PA161.IG101.SP102.SubP106]

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Since innovations, by definition, usually represent a major change, most innovative improvements will be piloted. [PA161.IG101.SP102.SubP106.N101]

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7. Document the results of the evaluations of innovative improvements. [PA161.IG101.SP102.SubP107]

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SP 1.3-1 Pilot Improvements

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Pilot process and technology improvements to select which ones to implement. [PA161.IG101.SP103]

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Pilots are performed to assess new and unproven major changes before they are incorporated into normal practice, as appropriate.

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[PA161.IG101.SP103.N101]

6126

Typical Work Products

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1. Pilot evaluation reports [PA161.IG101.SP103.W101]

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2. Documented lessons learned from pilots [PA161.IG101.SP103.W102]

6129

Subpractices

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1. Plan the pilots. [PA161.IG101.SP103.SubP101]

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2. Review and get stakeholder agreement on the plans for the pilots.

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[PA161.IG101.SP103.SubP102]

6133

3. Consult with and assist the people performing the pilots.

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[PA161.IG101.SP103.SubP103]

- 6135 4. Perform each pilot in an environment that is characteristic of the
6136 environment present in a broad-scale deployment.
6137 [PA161.IG101.SP103.SubP104]
- 6138 5. Track the pilots against their plans. [PA161.IG101.SP103.SubP105]
- 6139 6. Review and document the results of pilots. [PA161.IG101.SP103.SubP106]
- 6140 Reviewing and documenting the results of pilots usually involves the following:
6141 [PA161.IG101.SP103.SubP106.N101]
- 6142 • Deciding whether to terminate the pilot, re-plan and continue the pilot, or proceed
6143 with deploying the process and technology improvement
 - 6144 • Updating the disposition of process and technology improvement proposals
6145 associated with the pilot
 - 6146 • Identifying and documenting new process and technology improvement proposals
6147 as appropriate
 - 6148 • Identifying and documenting lessons learned and problems encountered during
6149 the pilot.

6150 **SP 1.4-1 Select Improvements for Deployment**

6151 ***Select process and technology improvement proposals for***
6152 ***deployment across the organization.*** [PA161.IG101.SP104]

6153 **Typical Work Products**

- 6154 1. Process and technology improvement proposals selected for
6155 deployment [PA161.IG101.SP104.W101]

6156 **Subpractices**

- 6157 1. Prioritize the candidate process and technology improvements for
6158 deployment. [PA161.IG101.SP104.SubP101]

6159 Priority is based on an evaluation of the estimated cost-to-benefit ratio with regard
6160 to the quality and process performance objectives. [PA161.IG101.SP104.SubP101.N101]

6161 *Refer to the Organizational Process Performance process area for*
6162 *more information about quality and process performance objectives.*

6163 [PA161.IG101.SP104.SubP101.N101.R101]

- 6164 2. Select the process and technology improvements to be deployed.

6165 [PA161.IG101.SP104.SubP102]

6166 The selection of the process improvements is based on their priorities and the
6167 available resources. [PA161.IG101.SP104.SubP102.N101]

- 6168 3. Determine how each process and technology improvement will be
6169 deployed. [PA161.IG101.SP104.SubP103]

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Examples of how the process and technology improvements may be deployed include the following: [PA161.IG101.SP104.SubP103.N101]

- Organization's process assets
- All or a subset of the organization's product families
- All or a subset of the organization's projects
- All or a subset of the organizational groups

4. Document the results of the selection process. [PA161.IG101.SP104.SubP104]

The results of the selection process usually include the following:

[PA161.IG101.SP104.SubP104.N101]

- The selection criteria
- The disposition of each proposal
- The rationale for the disposition of each proposal
- The assets to be changed for each selected proposal

SG 2 Deploy Improvements [PA161.IG102]

Measurable improvements to the organization's processes and technologies are continually and systematically deployed.

SP 2.1-1 Plan the Deployment

Establish and maintain the plans for deploying the selected process and technology improvements. [PA161.IG102.SP101]

The plans for deploying each process and technology improvement may be included in the organization's process improvement deployment plan or they may be documented separately. [PA161.IG102.SP101.N101]

This specific practice plans the deployment of individual process and technology improvements. The "Plan the Process" generic practice plans the deployment of the Organizational Innovation and Deployment process itself. [PA161.IG102.SP101.N102]

Typical Work Products

1. Deployment plan for selected process and technology improvements [PA161.IG102.SP101.W101]

Subpractices

1. Determine how each process and technology improvement must be adjusted for organization-wide deployment. [PA161.IG102.SP101.SubP101]

6203 Process and technology improvements proposed within a limited context (e.g., for
6204 a single project) might have to be modified to work across the organization.

6205 [PA161.IG102.SP101.SubP101.N101]

6206 2. Determine the changes necessary to deploy each process and
6207 technology improvement. [PA161.IG102.SP101.SubP102]

6208 Examples of changes needed to deploy a process and technology improvement
6209 includes the following: [PA161.IG102.SP101.SubP102.N101]

- 6210 • Process descriptions, standards, and procedures
- 6211 • Development environments
- 6212 • Education and training
- 6213 • Skills
- 6214 • Existing commitments
- 6215 • Existing activities
- 6216 • Continuing support to end users
- 6217 • Organizational culture and characteristics

6218
6219 3. Identify strategies to address potential barriers to deploying each
6220 process and technology improvement. [PA161.IG102.SP101.SubP103]

6221 4. Establish measures and objectives for determining the value of
6222 each process and technology improvement with respect to the
6223 organization's business objectives. [PA161.IG102.SP101.SubP104]

6224 Examples of measures for determining the value of a process and technology
6225 improvement include the following: [PA161.IG102.SP101.SubP104.N101]

- 6226 • Return on investment
- 6227 • Time to recover the cost of the process or technology improvement
- 6228 • Measured improvement in the projects' or organization's process performance
- 6229 • Number and type of project and organizational risks mitigated by the process or
6230 technology improvement
- 6231 • Ability to respond quickly to changes in project requirements, market situations,
6232 and the business environment

6233
6234 *Refer to the Measurement and Analysis process area for more*
6235 *information about measurement selection.* [PA161.IG102.SP101.SubP104.N101.R101]

6236 5. Document the plan for deploying each process and technology
6237 improvement. [PA161.IG102.SP101.SubP105]

6238 6. Review and get agreement with stakeholders on the plan for
6239 deploying each process and technology improvement.

6240 [PA161.IG102.SP101.SubP106]

- 6241 7. Revise the plan for deploying each process and technology
6242 improvement as necessary. [PA161.IG102.SP101.SubP107]

6243 **SP 2.2-1 Manage the Deployment**

6244 ***Manage the deployment of the selected process and technology***
6245 ***improvements.*** [PA161.IG102.SP102]

6246 **Typical Work Products**

- 6247 1. Updated training materials (to reflect deployed process and
6248 technology improvements) [PA161.IG102.SP102.W101]
- 6249 2. Documented results of process and technology improvement
6250 deployment activities [PA161.IG102.SP102.W102]
- 6251 3. Revised process and technology improvement measures,
6252 objectives, priorities, and deployment plans [PA161.IG102.SP102.W103]

6253 **Subpractices**

- 6254 1. Monitor the deployment of the process and technology
6255 improvements using the deployment plan. [PA161.IG102.SP102.SubP101]
- 6256 2. Coordinate the deployment of process and technology
6257 improvements across the organization. [PA161.IG102.SP102.SubP102]

6258 Coordinating deployment includes the following activities: [PA161.IG102.SP102.SubP102.N101]

- 6259 • Coordinating the activities of projects, support groups, and organizational groups
6260 for each process and technology improvement.
- 6261 • Coordinating the activities for deploying related process and technology
6262 improvements.
- 6263 3. Quickly deploy process and technology improvements in a
6264 controlled and disciplined manner, as appropriate.
6265 [PA161.IG102.SP102.SubP103]

6266 Examples of methods for deploying process and technology improvements quickly
6267 include the following: [PA161.IG102.SP102.SubP103.N101]

- 6268 • Using red-lines, process change notices, or other controlled process
6269 documentation as interim process descriptions
- 6270 • Deploying process and technology improvements incrementally, rather than as a
6271 single deployment
- 6272 • Providing comprehensive consulting to early adopters of the process and
6273 technology improvement in lieu of revised formal training

- 6274
- 6275 4. Incorporate the process and technology improvements into the
6276 organization's process assets, as appropriate. [PA161.IG102.SP102.SubP104]

6277 *Refer to the Organizational Process Definition process area for more*
6278 *information about the organization's process assets.*

6279 [PA161.IG102.SP102.SubP104.R101]

6280 5. Coordinate the deployment of the process and technology
6281 improvements into the projects' defined processes as appropriate.

6282 [PA161.IG102.SP102.SubP105]

6283 *Refer to the Organizational Process Focus process area for more*
6284 *information about deploying the organization's process assets.*

6285 [PA161.IG102.SP102.SubP105.R101]

6286 6. Provide consulting, as appropriate, to support deployment of the
6287 process and technology improvements. [PA161.IG102.SP102.SubP106]

6288 7. Provide updated training materials to reflect the improvements to
6289 the organization's process and technology assets.

6290 [PA161.IG102.SP102.SubP107]

6291 *Refer to the Organizational Training process area for more information*
6292 *about training materials.* [PA161.IG102.SP102.SubP107.R101]

6293 8. Verify that the deployment of all process and technology
6294 improvements is completed. [PA161.IG102.SP102.SubP108]

6295 9. Determine whether the ability of the defined process to meet
6296 quality and process performance objectives is adversely affected
6297 by the process and technology improvement and take corrective
6298 action as necessary. [PA161.IG102.SP102.SubP109]

6299 *Refer to the Quantitative Project Management process area for more*
6300 *information about quantitatively managing the project's defined process*
6301 *to achieve the project's established quality and process performance*
6302 *objectives* [PA161.IG102.SP102.SubP109.R101]

6303 10. Document and review the results of process and technology
6304 improvement deployment. [PA161.IG102.SP102.SubP110]

6305 Documenting and reviewing the results includes the following:

6306 [PA161.IG102.SP102.SubP110.N101]

- 6307
- 6308 • Identifying and documenting lessons learned
 - 6309 • Identifying and documenting new process and technology improvement proposals
 - 6310 • Revising process and technology improvement measures, objectives, priorities,
and deployment plans

6311 *Refer to the Measurement and Analysis process area for more*
6312 *information about measurement selection.* [PA161.IG102.SP102.SubP110.N101.R101]

6313 **SP 2.3-1 Measure Improvement Effects**

6314 **Measure the effects of the deployed process and technology**
6315 **improvements.** [PA161.IG102.SP103]

6316 *Refer to the Measurement and Analysis process area for more*
6317 *information about measurement collection and analysis.*

6318 [PA161.IG102.SP103.R101]

6319 **Typical Work Products**

- 6320 1. Documented measures of the effects resulting from the deployed
6321 process and technology improvements [PA161.IG102.SP103.W101]

6322 **Subpractices**

- 6323 1. Measure the actual cost, effort, and schedule for deploying each
6324 process and technology improvement. [PA161.IG102.SP103.SubP101]
- 6325 2. Measure the value of each process and technology improvement.
6326 [PA161.IG102.SP103.SubP102]
- 6327 3. Measure the progress toward achieving the organization's
6328 quantitative objectives for process and technology improvement.
6329 [PA161.IG102.SP103.SubP103]
- 6330 4. Analyze the progress toward achieving the organization's
6331 quantitative objectives for process and technology improvement
6332 and take corrective action as needed. [PA161.IG102.SP103.SubP104]

6333 *Refer to the Organizational Process Performance process area for*
6334 *more information about process performance analyses.*

6335 [PA161.IG102.SP103.SubP104.R101]

- 6336 5. Store the measures in the organizational measurement repository.

6337 [PA161.IG102.SP103.SubP105]

6338 **Generic Practices by Goal**

6339 **GG 1 Achieve Specific Goals**

6340 **The process supports and enables achievement of the specific goals of the**
6341 **process area by transforming identifiable input work products to produce**
6342 **identifiable output work products.**

6343 **GP 1.1 Identify Work Scope**

6344 **Identify the scope of the work to be performed and work products**
6345 **to be produced for organizational innovation and deployment , and**
6346 **communicate this information to those performing the work.** [GP101]

6347 **GP 1.2 Perform Base Practices**

6348 *Perform the base practices of the organizational innovation and*
6349 *deployment process to develop work products and provide*
6350 *services to achieve the specific goals of the process area. [GP102]*

6351 **GG 2 Institutionalize a Managed Process**

6352 *The process is institutionalized as a managed process.*

6353 **GP 2.1 Establish an Organizational Policy**

6354 *Establish and maintain an organizational policy for planning and*
6355 *performing the organizational innovation and deployment*
6356 *process. [GP103]*

6357 Elaboration:

6358 This policy establishes organizational expectations for identifying and
6359 deploying process and technology improvements that contribute to
6360 meeting quality and process performance objectives. [PA161.EL101]

6361 **GP 2.2 Plan the Process**

6362 *Establish and maintain the requirements and objectives, and plans*
6363 *for performing the organizational innovation and deployment*
6364 *process. [GP104]*

6365 Elaboration:

6366 These requirements, objectives, and plans are described in the
6367 organization's plan for organizational innovation deployment. This plan
6368 differs from the deployment plan for selected process and technology
6369 improvements described in the specific practice in this process area.
6370 The plan for organizational innovation deployment addresses strategic,
6371 high-level planning for all the organizational innovation deployment
6372 activities. The deployment plan addresses the implementation of
6373 selected process and technology improvement proposals. [PA161.EL110]

6374 **GP 2.3 Provide Resources**

6375 *Provide adequate resources for performing the organizational*
6376 *innovation and deployment process, developing the work*
6377 *products and providing the services of the process. [GP105]*

6378

Elaboration:

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Examples of tools used in performing the activities of the Organizational Innovation and Deployment process area include the following:

[PA161.EL102]

- Simulation packages
- Prototyping tools
- Statistical packages
- Dynamic systems modeling
- Subscriptions to online technology databases
- Process modeling tools

6389

GP 2.4 Assign Responsibility

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Assign responsibility and authority for performing the process, developing the work products, and providing the services of the organizational innovation and deployment process. [GP106]

6393

GP 2.5 Train People

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Train the people performing or supporting the organizational innovation and deployment process as needed. [GP107]

6396

Elaboration:

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Examples of training topics include the following: [PA161.EL103]

- Planning, designing, and conducting pilots
- Cost/benefit analysis
- Technology transition
- Change management

6403

GP 2.6 Manage Configurations

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6406

Place designated work products of the organizational innovation and deployment process under appropriate levels of configuration management. [GP109]

6407 Elaboration:

6408 Examples of work products placed under configuration management
6409 include the following: [PA161.EL111]

- 6410
- 6411 • Documented lessons learned from pilots
 - 6412 • Revised process and technology improvement measures, objectives, priorities, and deployment plans
 - 6413 • Updated training material
- 6414

6415 **GP 2.7 Identify and Involve Relevant Stakeholders**

6416 ***Identify and involve the relevant stakeholders of the organizational***
6417 ***innovation and deployment process as planned.*** [GP124]

6418 Elaboration:

6419 Examples of activities for stakeholder involvement include: [PA161.EL114]

- 6420
- 6421 • Reviewing process and technology improvement proposals that may have major impacts on process performance or on customer and end-user satisfaction
 - 6422 • Providing feedback to the organization on the status and results of the process and technology improvement deployment activities
- 6423
- 6424

6425

6426 The feedback typically involves: [PA161.EL115]

- 6427
- 6428 • Informing the people who submit process and technology improvement proposals about the disposition of their proposals.
 - 6429 • Regularly informing stakeholders about the plans and status for selecting and deploying process and technology improvements.
 - 6430 • Preparing and distributing a summary of process and technology improvement selection and deployment activities.
- 6431
- 6432

6433 **GP 2.8 Monitor and Control the Process**

6434 ***Monitor and control the organizational innovation and deployment***
6435 ***process against the plan and take appropriate corrective action.***

6436 [GP110]

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Elaboration:

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Examples of measures used in monitoring and controlling the activities of the Organizational Innovation Deployment process area include the following: [PA161.EL106]

- Change in quality or process performance

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GP 2.9 Objectively Evaluate Adherence

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Objectively evaluate adherence of the organizational innovation and deployment process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

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Elaboration:

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Examples of activities reviewed include the following: [PA161.EL109]

- Selecting improvements
- Deploying improvements

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Examples of work products reviewed include the following: [PA161.EL113]

- Deployment plans
- Revised process and technology improvement measures, objectives, priorities, and deployment plans
- Updated training material

6459

GP 2.10 Review Status with Higher-Level Management

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Review the activities, status, and results of the organizational innovation and deployment process with higher-level management and resolve issues. [GP112]

6463

GG 3 Institutionalize a Defined Process

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The process is institutionalized as a defined process.

6465

GP 3.1 Establish a Defined Process

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6467

Establish and maintain the description of a defined organizational innovation and deployment process. [GP114]

6468 **GP 3.2 Collect Improvement Information**

6469 *Collect work products, measures, measurement results, and*
6470 *improvement information derived from planning and performing*
6471 *the organizational innovation and deployment process to support*
6472 *the future use and improvement of the organization's processes*
6473 *and process assets.* [GP117]

6474 **GG 4 Institutionalize a Quantitatively Managed Process**

6475 *The process is institutionalized as a quantitatively managed process.*

6476 **GP 4.1 Establish Quality Objectives**

6477 *Establish and maintain quantitative objectives for the*
6478 *organizational innovation and deployment process about quality*
6479 *and process performance based on customer needs and business*
6480 *objectives.* [GP118]

6481 **GP 4.2 Stabilize Subprocess Performance**

6482 *Stabilize the performance of one or more subprocesses of the*
6483 *organizational innovation and deployment process to determine*
6484 *its ability to achieve the established quantitative quality and*
6485 *process performance objectives.* [GP119]

6486 **GG 5 Institutionalize an Optimizing Process**

6487 *The process is institutionalized as an optimizing process.*

6488 **GP 5.1 Ensure Continuous Process Improvement**

6489 *Ensure continuous improvement of the organizational innovation*
6490 *and deployment process in fulfilling the relevant business goals*
6491 *of the organization.* [GP125]

6492 **GP 5.2 Correct Common Cause of Problems**

6493 *Identify and correct the root causes of defects and other problems*
6494 *in the organizational innovation and deployment process.* [GP121]

6495 PROJECT MANAGEMENT

6496 The following section contains all of the process areas that belong to
6497 the Project Management process area category. The Project
6498 Management process areas of CMMI are as follows: [FM105.T101]

- 6499 • Project Planning
- 6500 • Project Monitoring and Control
- 6501 • Supplier Agreement Management
- 6502 • Integrated Project Management (IPPD)
- 6503 • Risk Management
- 6504 • Integrated Teaming
- 6505 • Quantitative Project Management

6506 *Refer to the Understanding the Model chapter of the Overview section*
6507 *for more information about the Project Management process areas and*
6508 *how they interact.* [FM105.T101.R101]

6509 PROJECT PLANNING

6510 Project Management

6511 Purpose

6512 The purpose of Project Planning is to establish and maintain plans that
6513 define project activities. [PA163]

6514 Introductory Notes

6515 Project Planning includes developing the project plan, interacting with
6516 stakeholders appropriately and getting commitment to the plan, and
6517 maintaining the plan. [PA163.N101]

6518 Planning begins with requirements that define the product and project.
6519 [PA163.N102]

6520 Planning includes estimating the attributes of the work products and
6521 tasks, the resources needed, negotiating commitments, producing a
6522 schedule, and identifying and analyzing project risks. Iterating through
6523 these activities may be necessary to establish the project plan. The
6524 project plan provides the basis for performing and controlling the
6525 project's activities that address the commitments with the project's
6526 customer. [PA163.N103]

6527 The project plan will usually need to be revised as the project
6528 progresses to address changes in requirements and commitments,
6529 inaccurate estimates, corrective actions, and process changes.
6530 Activities describing both planning and re-planning are contained in this
6531 process area. [PA163.N104]

6532 The term "project plan" is used throughout these practices to refer to
6533 the overall plan for controlling the project. [PA163.N105]

6534 Related Process Areas

6535 *Refer to the Requirements Development process area for more*
6536 *information about developing requirements that define the product and*
6537 *product components. Product and product component requirements*
6538 *and changes to those requirements serve as a basis for planning and*
6539 *re-planning.* [PA163.R101]

6540 Refer to the Requirements Management process area for more
6541 information about managing requirements needed for planning and re-
6542 planning. [PA163.R102]

6543 Refer to the Risk Management process area for more information about
6544 identifying and managing risks. [PA163.R103]

6545 Refer to the Technical Solution process area for more information about
6546 transforming requirements into product and product component
6547 solutions. [PA163.R104]

6548 Refer to the Measurement and Analysis process area for more
6549 information about the planning required for project progress and
6550 performance measurement. [PA163.R105]

6551 Refer to the Supplier Selection and Monitoring for more information
6552 about the planning needs for managing an acquisition. [PA163.R106]

6553 Specific Goals

6554 **SG 1 Establish Estimates** [PA163.IG101]

6555 ***Estimates of project planning parameters are established and maintained.***

6556 **SG 2 Develop a Project Plan** [PA163.IG102]

6557 ***A project plan is established and maintained as the basis for managing the***
6558 ***project.***

6559 **SG 3 Obtain Commitment to the Plan** [PA163.IG103]

6560 ***Commitments to the project plan are established and maintained.***

6561 Generic Goals

6562 **GG 1 Achieve Specific Goals** [CL102.GL101]

6563 ***The process supports and enables achievement of the specific goals of the***
6564 ***process area by transforming identifiable input work products to produce***
6565 ***identifiable output work products.***

6566 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

6567 ***The process is institutionalized as a managed process.***

6568 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

6569 *The process is institutionalized as a defined process.*

6570 **GG 4 Institutionalize a Quantitatively Managed Process** [CL105.GL101]

6571 *The process is institutionalized as a quantitatively managed process.*

6572 **GG 5 Institutionalize an Optimizing Process** [CL106.GL101]

6573 *The process is institutionalized as an optimizing process.*

6574 Practice to Goal Relationship Table

- 6575 SG 1 Establish Estimates [PA163.IG101]
- 6576 SP 1.1-1 Estimate the Scope of the Project
- 6577 SP 1.2-1 Establish Estimates of Project Attributes
- 6578 SP 1.3-1 Define Project Life Cycle
- 6579 SP 1.4-1 Determine Estimates of Effort and Cost

- 6580 SG 2 Develop a Project Plan [PA163.IG102]
- 6581 SP 2.1-1 Establish the Budget and Schedule
- 6582 SP 2.2-1 Identify Project Risks
- 6583 SP 2.3-1 Plan for Data Management
- 6584 SP 2.4-1 Plan for Project Resources
- 6585 SP 2.5-1 Plan for Needed Knowledge and Skills
- 6586 SP 2.6-1 Plan Stakeholder Involvement
- 6587 SP 2.7-1 Establish the Project Plan

- 6588 SG 3 Obtain Commitment to the Plan [PA163.IG103]
- 6589 SP 3.1-1 Review Subordinate Plans
- 6590 SP 3.2-1 Reconcile Work and Resource Levels
- 6591 SP 3.3-1 Obtain Plan Commitment

- 6592 GG 1 Achieve Specific Goals [CL102.GL101]
- 6593 GP 1.1 Identify Work Scope
- 6594 GP 1.2 Perform Base Practices

- 6595 GG 2 Institutionalize a Managed Process [CL103.GL101]
- 6596 GP 2.1 Establish an Organizational Policy
- 6597 GP 2.2 Plan the Process
- 6598 GP 2.3 Provide Resources
- 6599 GP 2.4 Assign Responsibility
- 6600 GP 2.5 Train People
- 6601 GP 2.6 Manage Configurations
- 6602 GP 2.7 Identify and Involve Relevant Stakeholders
- 6603 GP 2.8 Monitor and Control the Process
- 6604 GP 2.9 Objectively Evaluate Adherence
- 6605 GP 2.10 Review Status with Higher-Level Management

- 6606 GG 3 Institutionalize a Defined Process [CL104.GL101]
- 6607 GP 3.1 Establish a Defined Process
- 6608 GP 3.2 Collect Improvement Information

- 6609 GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]
- 6610 GP 4.1 Establish Quality Objectives
- 6611 GP 4.2 Stabilize Subprocess Performance

- 6612 GG 5 Institutionalize an Optimizing Process [CL106.GL101]
- 6613 GP 5.1 Ensure Continuous Process Improvement
- 6614 GP 5.2 Correct Common Cause of Problems

6615 Specific Practices by Goal

- 6616 **SG 1 Establish Estimates** [PA163.IG101]

Estimates of project planning parameters are established and maintained.

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Project planning parameters include all information needed by the project to perform the necessary planning, organizing, staffing, directing, coordinating, reporting and budgeting. [PA163.IG101.N101]

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Estimates of planning parameters should have a sound basis to provide confidence that any plans, based on these estimates, are capable of supporting project objectives. [PA163.IG101.N102]

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Factors that are typically considered when estimating these parameters include the following: [PA163.IG101.N103]

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- Project requirements, including the product requirements, the requirements imposed by the organization, the requirements imposed by the customer, and other requirements that impact expectations from the project

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- Identified tasks and work products
- Technical approach
- Attributes of the work products and tasks (e.g., size or complexity)
- Models or historical data for converting the attributes of the work products and tasks into labor hours and cost
- Methodology (models, data, algorithms) used to determine needed material, skills, labor hours, and cost

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Documenting the estimating rationale and supporting data is needed for the review and commitment of stakeholders to the plan and for maintenance of the plan as the project progresses. [PA163.IG101.N104]

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SP 1.1-1 Estimate the Scope of the Project

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Establish and maintain a top-level work breakdown structure (WBS) to estimate of the scope of the project. [PA163.IG101.SP101]

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The WBS evolves with the project. Initially a top-level WBS can serve to structure the initial estimating. The development of a WBS divides the overall project into an interconnected set of manageable components. The WBS is typically a product-oriented structure that provides a scheme for identifying and organizing the logical units of work to be managed. The WBS provides a reference and organizational mechanism for assigning effort, schedule, and responsibility and is used as the underlying framework to plan, organize, and control the work done on the project. [PA163.IG101.SP101.N101]

6652

Typical Work Products

6653

1. Task descriptions [PA163.IG101.SP101.W101]

6654 2. Work product descriptions [PA163.IG101.SP101.W102]

6655 3. Work Breakdown Structure [PA163.IG101.SP101.W103]

6656 **Subpractices**

6657 1. Develop a WBS structure based on the product architecture.

6658 [PA163.IG101.SP101.SubP101]

6659 The WBS provides a scheme for organizing the project's work around the
6660 products that the work supports. The WBS should permit the identification of the
6661 following items: [PA163.IG101.SP101.SubP101.N101]

- 6662 • Identified risks and their mitigation tasks
- 6663 • Tasks for deliverables and supporting activities
- 6664 • Tasks for skill and knowledge acquisition
- 6665 • Tasks for development of needed support plans, such as configuration
6666 management, quality assurance, and verification plans
- 6667 • Tasks for integration and life-cycle management of non-developmental items

6668 2. Identify the work products in sufficient detail to specify estimates of
6669 the project tasks, responsibilities, and schedule.

6670 [PA163.IG101.SP101.SubP102]

6671 The top-level WBS is intended to help in gauging the project work effort in terms
6672 of tasks and organizational roles and responsibilities. The level of understanding
6673 of the WBS at this point in time will help in developing realistic schedules thereby
6674 minimizing the need for management reserve. [PA163.IG101.SP101.SubP102.N101]

6675 Ensure that estimates of effort required for creating and reviewing of work
6676 products (including re-reviews) are made. It is very common during planning to
6677 estimate only the effort involved in developing and testing components but not in
6678 reviewing them. This is also true for other work products such as documents.
6679 Failing to estimate the effort that is required in conducting reviews could force
6680 project teams to skip reviews or present unrealistic schedules (since moving a
6681 committed date may not be acceptable). [PA163.IG101.SP101.SubP102.N102]

6682 3. Identify work products (or components of work products) that will
6683 be externally acquired. [PA163.IG101.SP101.SubP103]

6684 *Refer to the Supplier Agreement Management process area for more*
6685 *information acquiring work products from sources external to the*
6686 *project.* [PA163.IG101.SP101.SubP103.R101]

6687 4. Identify work products that will be reused. [PA163.IG101.SP101.SubP104]

6688 **SP 1.2-1 Establish Estimates of Project Attributes**

6689 ***Establish and document estimates of the attributes of the work***
6690 ***products and tasks.*** [PA163.IG101.SP102]

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For Software Engineering

Software size is the primary input to many models used to estimate effort, cost, and schedule. The models may also be based on inputs such as connectivity, complexity, and structure. [PA163.IG101.SP102.AMP101]

For Software Engineering

Examples of types of work products for which size estimates are made include the following: [PA163.IG101.SP102.AMP102]

- *Operational software and support software*
- *Deliverable and non-deliverable work products*
- *Software and non-software work products (e.g., documents)*

For Software Engineering

*Examples of size measures include the following:
[PA163.IG101.SP102.AMP103]*

- *Function points*
- *Source lines of code*
- *Number of classes and objects*
- *Number of requirements*
- *Number of pages*

For Systems Engineering

*Examples of attributes to estimate include the following:
[PA163.IG101.SP102.AMP104]*

- *Number of functions*
- *Number of inputs and outputs*
- *Data volume*
- *Number and frequency of user interactions*
- *Number of interfaces*
- *Number of technical risk items*
- *Deliverable and non-deliverable work products*

These estimates should be consistent with project requirements to determine the project's effort hours, cost, and schedule. A relative level of difficulty or complexity should be assigned for each size attribute.

[PA163.IG101.SP102.N101]

6727

Typical Work Products

6728

1. Technical approach [PA163.IG101.SP102.W101]

6729

2. Size and complexity of tasks and work products [PA163.IG101.SP102.W102]

6730

3. Estimating models [PA163.IG101.SP102.W103]

6731

4. Attribute estimates [PA163.IG101.SP102.W104]

6732

Subpractices

6733

1. Determine the technical approach for the project.

6734

[PA163.IG101.SP102.SubP101]

6735

The technical approach defines a top-level strategy for development of the products. It includes decisions on architectural features, such as distributed or client server; state-of-the-art or established technologies to be applied, such as robotics, composite materials, or artificial intelligence; and breadth of the functionality expected in the final products, such as safety, security and ergonomics. [PA163.IG101.SP102.SubP101.N101]

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2. Use appropriate methods to determine the attributes of the work products and tasks that will be used to estimate the resource requirements. [PA163.IG101.SP102.SubP102]

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Methods for determining size and complexity should be based on validated models or historical data. [PA163.IG101.SP102.SubP102.N101]

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The methods for determining attributes evolve as our understanding of the relationship of product characteristics to the attributes increases.

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[PA163.IG101.SP102.SubP102.N102]

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For example, current methods include the following: number of logic gates for integrated circuit design, lines of code or function points for software, number/complexity of requirements for systems engineering, and number of square feet for standard-specified residential homes. [PA163.IG101.SP102.SubP102.N103]

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3. Estimate the attributes of the work products and tasks.

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[PA163.IG101.SP102.SubP103]

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4. Estimate, as appropriate, the labor, machinery, materials, and methods that will be required by the project. [PA163.IG101.SP102.SubP104]

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SP 1.3-1 Define Project Life Cycle

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Define the project life-cycle phases upon which to scope the planning effort. [PA163.IG101.SP103]

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6761 The determination of a project's life-cycle phases provides for planned
6762 periods of evaluation and decision making. These are normally defined
6763 to support logical decision points at which significant commitments are
6764 made from resource and technical approach perspectives. Such points
6765 provide planned events at which project course corrections and
6766 determinations of future scope and cost can be made.

6767 [PA163.IG101.SP103.N101]

6768 *For Software Engineering*

6769 *The determination of project phases for software typically*
6770 *includes selection and refinement of a software development*
6771 *model to address interdependencies and appropriate*
6772 *sequencing of software project activities.*

6773 [PA163.IG101.SP103.N101.AMP101]

6774 *For Software Engineering*

6775 *Examples of software development models include the*
6776 *following:* [PA163.IG101.SP103.N101.AMP103]

- 6777 • *Evolutionary*
- 6778 • *Incremental*
- 6779 • *Iterative*
- 6780 • *Spiral*
- 6781 • *Waterfall*

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6783 *For Systems Engineering*

6784 *Identify the major product phase (e.g., concept exploration,*
6785 *development, etc.) for the current state of the product,*
6786 *expected future phases, and the relationships and effects*
6787 *among phases. Adjust planning parameters to account for*
6788 *relationships and effects among phases.*

6789 [PA163.IG101.SP103.N101.AMP102]

6790 The project life cycle consists of phases that need to be defined
6791 depending on the scope of requirements, the estimates for project
6792 resources, and nature of the project. Larger projects may contain
6793 multiple phases, such as concept exploration, development, production,
6794 operations, and disposal. Within these phases, sub-phases may be
6795 needed. A development phase may include sub-phases such as
6796 requirements analysis, design, fabrication, integration, and verification.
6797 Depending on the strategy for development, there may be intermediate
6798 phases for the creation of prototypes, increments of capability, or spiral
6799 model cycles. [PA163.IG101.SP103.N102]

6800 Understanding the project life cycle is crucial in determining the scope
6801 of the planning effort, the timing of the initial planning, as well as the
6802 timing and criteria (critical milestones) for replanning. [PA163.IG101.SP103.N103]

6803 **Typical Work Products**

6804 1. Project life-cycle phases [PA163.IG101.SP103.W101]

6805 2. Product life-cycle phases [PA163.IG101.SP103.W102]

6806 **SP 1.4-1 Determine Estimates of Effort and Cost**

6807 ***Estimate the project effort and cost for the attributes of the work***
6808 ***products and tasks based on estimation rationale.*** [PA163.IG101.SP104]

6809 Estimates of effort and cost are generally based on the results of
6810 analysis using models or historical data applied to the size, activities,
6811 and other planning parameters. Confidence in these estimates is based
6812 on the rationale for selected model and the nature of the data. There
6813 may be occasions where the available historical data does not apply,
6814 e.g., where efforts are unprecedented and when the type of task does
6815 not fit available models. An effort is unprecedented (to some degree) if
6816 a similar product or component has never been built. An effort may also
6817 be unprecedented if the development group has never built such a
6818 product or component. [PA163.IG101.SP104.N101]

6819 Unprecedented efforts are more risky, require more research to develop
6820 reasonable bases of estimate, and require more management reserve.
6821 The uniqueness of the project must be documented when using these
6822 models to ensure a common understanding of any assumptions made
6823 in the initial planning stages. [PA163.IG101.SP104.N102]

6824 **Typical Work Products**

6825 1. Estimation rationale [PA163.IG101.SP104.W101]

6826 2. Project effort estimates [PA163.IG101.SP104.W102]

6827 3. Project schedule estimates [PA163.IG101.SP104.W103]

6828 4. Project cost estimates [PA163.IG101.SP104.W104]

6829 **Subpractices**

6830 1. Collect the models or historical data that will be used to transform
6831 the attributes of the work products and tasks into estimates of the
6832 labor hours, schedule, and cost. [PA163.IG101.SP104.SubP101]

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For Software Engineering

Within the software engineering area, many parametric models have been developed to aid in estimating cost and schedule. The use of these models as the sole source of estimation is not recommended as these models are based on historical project data that may or may not be pertinent to your project. Multiple models and/or methods may be used to ensure a high level of confidence in the estimate.

[PA163.IG101.SP104.SubP101.AMP101]

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Historical data include the cost, effort, and schedule data from previously executed projects, plus appropriate scaling data to account for differing sizes and complexity. *[PA163.IG101.SP104.SubP101.N101]*

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2. Include supporting infrastructure needs when estimating schedule and cost. *[PA163.IG101.SP104.SubP102]*

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The support infrastructure includes items needed from a life-cycle development and sustainment perspective for the product. *[PA163.IG101.SP104.SubP102.N101]*

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For Software Engineering

Consider critical computer resources in the host environment, in the test environment, in the target environment, or in any combination of these. Computer resource estimation typically includes the following: identifying the critical computer resources for the software project basing estimates of critical computer resources on allocated requirements *[PA163.IG101.SP104.SubP102.N101.AMP101]*

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For Software Engineering

Examples of critical computer resources include the following:

[PA163.IG101.SP104.SubP102.N101.AMP102]

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- *Memory, disk, and network capacity*
- *Processor power*
- *Communications channel capacity*
- *Workstation power*
- *Peripheral capacity*

For Software Engineering

Examples of software engineering facilities include the following: [PA163.IG101.SP104.SubP102.N101.AMP103]

- *Host computers, peripherals, and networks*
- *Software test computers and peripherals*
- *Target computer environment software*
- *Software engineering environment (i.e., software tools)*

3. Estimate the effort and cost using models and/or historical data.

[PA163.IG101.SP104.SubP103]

Effort and cost inputs used for estimating typically include the following:

[PA163.IG101.SP104.SubP103.N101]

- Judgmental estimates provided by an expert or group of experts (e.g. Delphi Method)
- Risks, including the extent to which the effort is unprecedented
- Critical competencies and roles needed to perform the work
- Product and product component requirements
- Technical approach
- Work breakdown structure
- Size estimates of work products and anticipated changes
- Cost of externally acquired work products
- Selected project life-cycle model and processes
- Life cycle cost estimates
- Capability of tools provided in engineering environment
- Skill levels of managers and staff needed to perform the work
- Knowledge, skill, and training needs
- Facilities needed (e.g., office and meeting space and workstations)
- Engineering facilities needed
- Capability of manufacturing process(es)
- Travel
- Level of security required for tasks, work products, hardware, software, personnel, and work environment
- Service level agreements for call centers and warranty work
- Direct labor and overhead

- 6900 4. Confirm that effort and cost estimates are based on credible
6901 prediction factors (rationale) that take into account: work product
6902 size and complexity, requirements, risk, technical feasibility,
6903 security issues, precedence, historical performance, and
6904 availability of personnel skill. [PA163.IG101.SP104.SubP104]

6905 Confirmation of resource estimates can be accomplished with structured reviews
6906 that check the adequacy and reasonableness of the estimating rationale.
6907 [PA163.IG101.SP104.SubP104.N101]

6908 **SG 2 Develop a Project Plan** [PA163.IG102]

6909 ***A project plan is established and maintained as the basis for managing the***
6910 ***project.***

6911 A project plan is a formal, approved document used to manage and
6912 control the execution of the project and is based on the project
6913 requirements and the established estimates. [PA163.IG102.N101]

6914 The project plan should consider all phases of the project life cycle and
6915 planning should ensure that subordinate plans are consistent with each
6916 other and with the overall project plan. [PA163.IG102.N102]

6917 **SP 2.1-1 Establish the Budget and Schedule**

6918 ***Establish and maintain the project's budget and schedule.***
6919 [PA163.IG102.SP101]

6920 The project's budget and schedule are based on the developed
6921 estimates ensuring that budget allocation, task complexity, and task
6922 dependencies are appropriately addressed. [PA163.IG102.SP101.N101]

6923 Event-driven schedules have proven to be effective in dealing with
6924 project risk. Identifying accomplishments to be demonstrated before
6925 initiation of the event provides some flexibility in the timing of the event,
6926 a common understanding of what is expected, a better vision of the
6927 state of the project, and a more accurate status of the project's tasks.
6928 [PA163.IG102.SP101.N102]

6929 **Typical Work Products**

- 6930 1. Project schedules [PA163.IG102.SP101.W101]
6931 2. Schedule dependencies [PA163.IG102.SP101.W102]
6932 3. Project Budget [PA163.IG102.SP101.W103]

6933 **Subpractices**

- 6934 1. Identify major milestones. [PA163.IG102.SP101.SubP101]

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Milestones are often imposed to ensure completion of certain deliverables by the milestone. Milestones can be event-based or calendar-based. If calendar-based, once these milestone dates have been agreed upon, it is often very difficult to change them. [PA163.IG102.SP101.SubP101.N101]

2. Identify schedule assumptions. [PA163.IG102.SP101.SubP102]

When schedules are initially developed, it is common to make assumptions about the duration of certain activities. These assumptions are frequently made on items for which little if any estimation data is available. Identifying these assumptions provides insight into the level of confidence (uncertainties) in the overall schedule. [PA163.IG102.SP101.SubP102.N101]

3. Identify constraints. [PA163.IG102.SP101.SubP103]

Factors that limit the flexibility of management options need to be identified as early as possible. The examination of the attributes of the work products and tasks will often surface these issues. Such attributes can include task duration, resources, inputs, and outputs. [PA163.IG102.SP101.SubP103.N101]

4. Identify task dependencies. [PA163.IG102.SP101.SubP104]

Typically, the tasks for a project can be accomplished in some ordered sequence that will minimize the duration of the project. This involves the identification of predecessor and successor tasks to determine the optimal ordering.

[PA163.IG102.SP101.SubP104.N101]

Examples of tools that can help determine an optimal ordering of task activities include the following: [PA163.IG102.SP101.SubP104.N102]

- Critical Path Method (CPM)
- Program Evaluation and Review Technique (PERT)
- Resource based scheduling

5. Define the budget and schedule. [PA163.IG102.SP101.SubP105]

Establishing and maintaining the project's budget and schedule typically includes the following: [PA163.IG102.SP101.SubP105.N101]

- Defining the committed or expected availability of resources and facilities
- Determining time phasing of activities
- Determining a breakout of subordinate schedules
- Defining the dependencies between the activities (predecessor or successor relationships)
- Defining the schedule activities and milestones to support accuracy in progress measurement
- Identifying milestones for delivery of products to the customer
- Defining activities of appropriate duration

- 6973 • Defining milestones of appropriate time separation
- 6974 • Defining a management reserve based on the confidence level in meeting the
- 6975 schedule
- 6976 • Using appropriate historical data to verify the schedule
- 6977 • Defining incremental funding requirements

6978 6. Establish corrective action criteria. [PA163.IG102.SP101.SubP106]

6979 Criteria are established for determining what constitutes a significant deviation
6980 from the project plan. A basis for gauging issues and problems is essential to
6981 formulate a rigorous and objective standard for determining when a corrective
6982 action should be taken. [PA163.IG102.SP101.SubP106.N101]

6983 **SP 2.2-1 Identify Project Risks**

6984 **Identify and analyze project risks.** [PA163.IG102.SP103]

6985 *Refer to the Risk Management process area for more information about*
6986 *risk management activities.* [PA163.IG102.SP103.R101]

6987 *Refer to the Monitor Project Risks specific practice in the Project*
6988 *Monitoring and Control process area for more information about risk*
6989 *monitoring activities.* [PA163.IG102.SP103.R102]

6990 Risks are identified or discovered and analyzed to support project
6991 planning. This practice should be extended down to all the subordinate
6992 plans to ensure that the appropriate interfacing is taking place between
6993 all relevant stakeholders on identified risks. Project planning risk
6994 identification and analysis typically includes the following:

6995 [PA163.IG102.SP103.N101]

- 6996 • Identifying risks
- 6997 • Analyzing the risks to determine the impact, probability of
- 6998 occurrence, and time-frame in which problems are likely to occur
- 6999 • Prioritizing risks

7000 **Typical Work Products**

- 7001 1. Identified risks [PA163.IG102.SP103.W101]
- 7002 2. Risk impacts and probability of occurrence [PA163.IG102.SP103.W102]
- 7003 3. Risk priorities [PA163.IG102.SP103.W103]

7004 **Subpractices**

- 7005 1. Identify risks. [PA163.IG102.SP103.SubP101]

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The identification of risks involves the identification of potential issues, hazards, threats, vulnerabilities, etc. that could negatively affect work efforts and plans. Risks must be identified and described in an understandable way before they can be analyzed. When identifying risks, it is good practice to use a standard method for defining risks. Risk identification and analysis tools may be used to help identify possible problems. [PA163.IG102.SP103.SubP101.N101]

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Examples of risk identification and analysis tools include the following:

[PA163.IG102.SP103.SubP101.N102]

- Risk taxonomies
- Risk assessments
- Checklists
- Structured interviews
- Brainstorming
- Performance models
- Cost models
- Network analysis
- Quality factor analysis

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2. Document the risks. [PA163.IG102.SP103.SubP102]
3. Review and obtain agreement with relevant stakeholders on the completeness and correctness of the documented risks.

[PA163.IG102.SP103.SubP103]

4. Revise the risks as appropriate. [PA163.IG102.SP103.SubP104]

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Examples of when identified risks may need to be revised include the following:

[PA163.IG102.SP103.SubP104.N101]

- When new risk is identified
- When risks are retired
- When project circumstances change significantly

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SP 2.3-1 Plan for Data Management

Plan for the management of project data. [PA163.IG102.SP102]

For Integrated Product and Process Development

When integrated teams are formed, project data includes data developed and used solely within a particular team as well as data applicable across integrated team boundaries if there are multiple integrated teams. [PA163.IG102.SP102.AMP101]

7042 Data are the various forms of documentation required to support a
7043 program in all of its areas (e.g., administration, engineering,
7044 configuration, financial, logistics, quality, safety, manufacturing, and
7045 procurement). The data may take any form (e.g., reports, manuals,
7046 notebooks, charts, drawings, specifications, files, or correspondence).
7047 The data may exist in any medium (e.g., printed or drawn on various
7048 materials, photographs, electronic, or multi-media). Data may be
7049 deliverable (e.g., items identified by a program's contract data
7050 requirements) or data may be non-deliverable (e.g., informal data, trade
7051 studies and analyses, internal meeting minutes, internal design review
7052 documentation, lessons learned and action items). Distribution may
7053 take many forms including electronic transmission. [PA163.IG102.SP102.N101]

7054 The data requirements for the project should be established for both the
7055 data items to be created and their content and form, based on a
7056 common or standard set of data requirements. Uniform content and
7057 format requirements for data items facilitate understanding of data
7058 content and help with consistent management of the data resources.
7059 [PA163.IG102.SP102.N102]

7060 The reason for collecting each document should be clear. This task
7061 includes the analysis and validation of project deliverables and non-
7062 deliverables, contract and non-contract data requirements and
7063 customer-supplied data. All too often, data is collected with no clear
7064 understanding of how it will be used. Data is costly and should be
7065 collected only when needed. [PA163.IG102.SP102.N103]

7066 **Typical Work Products**

- 7067 1. Data management plan [PA163.IG102.SP102.W101]
- 7068 2. Master list of managed data [PA163.IG102.SP102.W102]
- 7069 3. Data content and format description [PA163.IG102.SP102.W103]
- 7070 4. Data requirements lists for acquirers and for suppliers
7071 [PA163.IG102.SP102.W104]
- 7072 5. Privacy requirements [PA163.IG102.SP102.W105]
- 7073 6. Security requirements [PA163.IG102.SP102.W106]
- 7074 7. Security procedures [PA163.IG102.SP102.W107]
- 7075 8. Mechanism for data retrieval, reproduction, and distribution
7076 [PA163.IG102.SP102.W108]
- 7077 9. Schedule for collection of project data [PA163.IG102.SP102.W109]
- 7078 10. Listing of project data to be collected [PA163.IG102.SP102.W110]

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Subpractices

1. Establish requirements and procedures to ensure privacy and security of the data. [PA163.IG102.SP102.SubP101]

Not everyone will have the need or clearance necessary to access the project data. Procedures must be established to identify who has access to what data as well as when they have access to the data. [PA163.IG102.SP102.SubP101.N101]

2. Establish a mechanism to access archived data. [PA163.IG102.SP102.SubP102]

Accessed information should be in an understandable form (e.g., electronic or computer output from a database) or represented as originally generated.

[PA163.IG102.SP102.SubP102.N101]

3. Plan for the definition, collection, and analysis of project data.

[PA163.IG102.SP102.SubP103]

Progress and performance data (e.g., effort, cost, schedule, and technical performance) are essential for project tracking, re-planning, and estimating new tasks. [PA163.IG102.SP102.SubP103.N101]

Refer to the Define Measures specific practice of the Measurement and Analysis process area for examples of project management metrics.

[PA163.IG102.SP102.SubP103.N101.R101]

Refer to the Measurement and Analysis process area for planning for the definition, collection, and analysis of project progress and performance data. [PA163.IG102.SP102.SubP103.R101]

SP 2.4-1 Plan for Project Resources

Plan for necessary resources to perform the project. [PA163.IG102.SP104]

For Integrated Product and Process Development

When integrated teams are formed, planning for project resources has to consider staffing of the integrated teams.

[PA163.IG102.SP104.AMP101]

Defining project resources (labor, machinery/equipment, materials, and methods) and what quantities of each should be used to perform project activities builds on the estimates and provides additional information for the expansion of the WBS for the managing the project.

[PA163.IG102.SP104.N101]

7111 The top level WBS developed earlier as an estimation mechanism is
7112 typically expanded by decomposing these top-levels into work
7113 packages that represent singular work units that can be separately
7114 assigned, performed, and tracked. This subdivision is done to distribute
7115 management responsibility and provide better management control.
7116 This is the level at which organizational functions are assigned to
7117 perform the WBS tasks. This intersection of product and function is
7118 typically called a cost account. Each task or work product at this lower-
7119 level in the WBS should be assigned a unique identifier (e.g., number)
7120 to permit tracking. A WBS may be based on requirements, activities,
7121 work products, or a combination of these items. A task dictionary that
7122 describes the work for each task in the WBS should accompany the
7123 work breakdown structure. [PA163.IG102.SP104.N102]

7124 **Typical Work Products**

- 7125 1. WBS work packages [PA163.IG102.SP104.W101]
- 7126 2. WBS task dictionary [PA163.IG102.SP104.W102]
- 7127 3. Staffing requirements based on project size and scope
7128 [PA163.IG102.SP104.W103]
- 7129 4. Critical facilities/equipment list [PA163.IG102.SP104.W104]
- 7130 5. Process/workflow definitions and diagrams [PA163.IG102.SP104.W105]
- 7131 6. Program administration requirements list [PA163.IG102.SP104.W106]

7132 **Subpractices**

- 7133 1. Determine process requirements. [PA163.IG102.SP104.SubP101]

7134 The processes used to manage a project must be identified, defined, and
7135 coordinated with all the relevant stakeholders to ensure efficient operations during
7136 project execution. [PA163.IG102.SP104.SubP101.N101]

- 7137 2. Determine staffing requirements. [PA163.IG102.SP104.SubP102]

7138 The staffing of a project depends on the decomposition of the project
7139 requirements into tasks, roles, and responsibilities for accomplishing the project
7140 requirements as laid out within the work packages of the WBS.

7141 [PA163.IG102.SP104.SubP102.N101]

7142 Staffing requirements must consider the knowledge and skills required for each of
7143 the identified positions, as defined in the Plan for Needed Knowledge and Skills
7144 specific practice. [PA163.IG102.SP104.SubP102.N102]

- 7145 3. Determine facilities, equipment, and component requirements.

7146 [PA163.IG102.SP104.SubP103]

7147 Most projects are unique in some sense and require some set of unique assets to
7148 accomplish the objectives of the project. The determination and acquisition of
7149 these assets in a timely manner is crucial to project success.

7150 [PA163.IG102.SP104.SubP103.N101]

7151 Even when the required assets are not unique, comprising a list of all of the
7152 facilities, equipment and parts (e.g., number of computers for the personnel
7153 working on the project, software applications, office space, etc.) provides insight
7154 into one aspect of the scope of an effort that is often overlooked.

7155 [PA163.IG102.SP104.SubP103.N102]

7156 SP 2.5-1 Plan for Needed Knowledge and Skills

7157 ***Plan for knowledge and skills needed to perform the project.***

7158 [PA163.IG102.SP105]

7159 *Refer to the Organizational Training process area for more information*
7160 *about knowledge and skills information to be incorporated into the*
7161 *project plan.* [PA163.IG102.SP105.R101]

7162 Knowledge delivery to projects involves both training of project
7163 personnel and acquisition of knowledge from outside sources.

7164 [PA163.IG102.SP105.N101]

7165 Staffing requirements are dependent on the knowledge and skills
7166 available to support the execution of the project. [PA163.IG102.SP105.N102]

7167 Typical Work Products

7168 1. Inventory of skill needs [PA163.IG102.SP105.W101]

7169 2. Inventory of skill needs [PA163.IG102.SP105.W102]

7170 3. New hire plans [PA163.IG102.SP105.W103]

7171 4. Databases (e.g., skills and training) [PA163.IG102.SP105.W104]

7172 Subpractices

7173 1. Identify the knowledge and skills needed to perform the project.

7174 [PA163.IG102.SP105.SubP101]

7175 2. Assess the knowledge and skills available. [PA163.IG102.SP105.SubP102]

7176 3. Select mechanisms for providing needed knowledge and skills.

7177 [PA163.IG102.SP105.SubP103]

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Example mechanisms include the following: [PA163.IG102.SP105.SubP103.N101]

- In-house training (both organizational or project)
- External training
- New hires
- External skill acquisition

The choice of in-house training or external outsourcing for the needed knowledge and skills is determined by the availability of training expertise, the project's schedule, and business objectives. [PA163.IG102.SP105.SubP103.N102]

4. Incorporate selected mechanisms in the project plan. [PA163.IG102.SP105.SubP104]

SP 2.6-1 Plan Stakeholder Involvement

Plan the involvement with identified stakeholders. [PA163.IG102.SP106]

For Integrated Product and Process Development
When integrated teams are formed, stakeholder involvement needs to be planned down to the integrated team level.
[PA163.IG102.SP106.AMP101]

Stakeholders are identified from all phases of the product life cycle by identifying the type of people and functions needing representation in the project and describing their relevance and the degree of interaction for specific project activities. A two-dimensional matrix with stakeholders along one axis and project activities along the other axis is a convenient format for accomplishing this identification. Relevance of the stakeholder to the activity in a particular project phase and the amount of interaction expected would be shown at the intersection of the project phase activity axis and the stakeholder axis. [PA163.IG102.SP106.N101]

For the inputs of stakeholders to be useful, careful selection of those to be engaged is necessary. For each major activity, identify the stakeholders that are affected by the activity and those who have expertise that is needed to conduct the activity. This list of stakeholders will probably change as the project moves through the product life cycle. It is important however to assure that stakeholders in the later phases of the life cycle have early inputs to requirements and design decisions that affect them. [PA163.IG102.SP106.N102]

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Examples of the type of material that should be included in a plan for stakeholder interaction include the following: [PA163.IG102.SP106.N103]

- List of all relevant stakeholders
- Rationale for stakeholder involvement
- Roles and responsibilities of the stakeholders with respect to the project by project life-cycle phase
- Relationships between stakeholders
- Relative importance of the stakeholder to project success by project phase
- Resources (e.g., training, materials, time, funding) needed to ensure stakeholder interaction
- Schedule for phasing of stakeholder interaction

Conduct of this practice relies on shared, or exchanged, information with the previous Plan for Needed Knowledge and Skills specific practice. [PA163.IG102.SP106.N104]

SP 2.7-1 Establish the Project Plan

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Establish and maintain the overall project plan content.

[PA163.IG102.SP107]

For Systems Engineering

Systems engineering planning details the work activities and work products produced comprising the integrated technical effort across the project. [PA163.IG102.SP107.AMP101]

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For Systems Engineering

Examples of plans that have been used in the U.S. Department of Defense community include the following:

[PA163.IG102.SP107.AMP103]

- *Integrated Master Plan – an event-driven plan that documents the significant accomplishments with pass/fail criteria for both business and technical elements of the project necessary to complete the work and ties each accomplishment to a key program event.*
- *Integrated Master Schedule - an integrated and networked multi-layered schedule of program tasks required to complete the work effort captured in a related Integrated Master Plan.*
- *System Engineering Management Plan – a plan that details the integrated technical effort across the project.*
- *Systems Engineering Master Schedule – an event based schedule that contains a compilation of key technical accomplishments, each with measurable criteria, requiring successful completion to pass identified events.*
- *Systems Engineering Detailed Schedule – a detailed, time dependent, task-oriented schedule that associates specific dates and milestones with the Systems Engineering Master Schedule.*

For Software Engineering

For software, the planning document is often referred to as one of the following: [PA163.IG102.SP107.AMP102]

- *A software development plan*
- *A software project plan*
- *A software plan*

A documented plan that address all relevant planning items is necessary to achieve the mutual understanding, commitment, and performance of individuals, groups, and organizations that must execute or support the plans. The plan generated for the project defines all aspects of the effort, tying together in a logical manner: product life-cycle considerations; technical and management tasks; budgets and schedules; milestones; data management, risk identification, resource and skill requirements; and stakeholder identification and interaction. Infrastructure descriptions include responsibility and authority relationships for project staff, management, and support organizations.

[PA163.IG102.SP107.N101]

Typical Work Products

1. Overall project plan [PA163.IG102.SP107.W101]

7279 **SG 3 Obtain Commitment to the Plan** [PA163.IG103]

7280 ***Commitments to the project plan are established and maintained.***

7281 To be effective, plans require commitment by those responsible for
7282 implementing and supporting the plan. [PA163.IG103.N101]

7283 **SP 3.1-1 Review Subordinate Plans**

7284 ***Review subordinate plans to understand project commitments.***

7285 [PA163.IG103.SP103]

7286 *For Integrated Product and Process Development*

7287 *When integrated teams are formed, their integrated work*
7288 *plans are among the subordinate plans to review.*

7289 [PA163.IG103.SP103.AMP101]

7290 Subordinate plans and strategies developed within other process areas
7291 will typically contain the same type of information as called out for the
7292 overall project plan but tailored to the scope of that particular area. The
7293 subordinate plans should be compatible with and support the overall
7294 project plan to know who has the authority, responsibility, accountability
7295 and control. These subordinate plans should be reviewed to ensure a
7296 common understanding of the scope, goals, roles, and relationships
7297 that are required for the project to be successful. [PA163.IG103.SP103.N101]

7298 **Typical Work Products**

7299 1. Record of subordinate plan reviews [PA163.IG103.SP103.W101]

7300 **SP 3.2-1 Reconcile Work and Resource Levels**

7301 ***Reconcile the project plan to reflect available and projected***
7302 ***resources.*** [PA163.IG103.SP101]

7303 *For Integrated Product and Process Development*

7304 *When integrated teams are formed, special attention needs to*
7305 *be paid to resource commitments in circumstances of*
7306 *distributed integrated teams and when people are on multiple*
7307 *integrated teams in one or many projects.* [PA163.IG103.SP101.AMP101]

7308 To obtain commitment from relevant stakeholders, it is important to
7309 reconcile any differences between the estimates and the available
7310 resources. Reconciliation is typically accomplished by lowering or
7311 deferring technical performance requirements, negotiating more
7312 resources, finding ways to increase productivity, outsourcing, adjusting
7313 the staff skill mix, or revising subordinate plans or schedules.

7314 [PA163.IG103.SP101.N101]

- 7315 **Typical Work Products**
- 7316 1. Revised methods and corresponding estimating parameters (e.g.,
- 7317 better tools, use of off-the-shelf components) [PA163.IG103.SP101.W101]
- 7318 2. Re-negotiated budgets [PA163.IG103.SP101.W102]
- 7319 3. Revised schedules [PA163.IG103.SP101.W103]
- 7320 4. Revised requirements list [PA163.IG103.SP101.W104]
- 7321 5. Renegotiated stakeholder agreements [PA163.IG103.SP101.W105]

7322 **SP 3.3-1 Obtain Plan Commitment**

7323 ***Obtain commitment from relevant stakeholders responsible for***

7324 ***performing and supporting plan execution.*** [PA163.IG103.SP102]

7325 *For Integrated Product and Process Development*

7326 *When integrated teams are formed, the integrated team plans*

7327 *will need buy-in from the team members, the interfacing*

7328 *teams, the project, and the process owners of the standard*

7329 *processes that team has selected for tailored application.*

7330 [PA163.IG103.SP102.AMP101]

7331 Obtaining commitment involves interaction among all relevant

7332 stakeholders both internal and external to the project. The individual or

7333 group making a commitment should have confidence that the work can

7334 be performed within cost, schedule, and performance constraints. Often

7335 a provisional commitment is adequate to allow the effort to begin and to

7336 permit research to be performed to increase the confidence to the

7337 appropriate level needed to obtain a full commitment. [PA163.IG103.SP102.N101]

7338 **Typical Work Products**

- 7339 1. Documented requests for commitments [PA163.IG103.SP102.W101]
- 7340 2. Documented commitments [PA163.IG103.SP102.W102]

7341 **Subpractices**

- 7342 1. Identify needed support and negotiate commitments with relevant
- 7343 stakeholders. [PA163.IG103.SP102.SubP101]

7344 The WBS can be used as a checklist for assuring that commitments are obtained

7345 for all tasks. [PA163.IG103.SP102.SubP101.N101]

7346 The plan for stakeholder interaction should identify all parties from whom

7347 commitment should be obtained. [PA163.IG103.SP102.SubP101.N102]

- 7348 2. Document all organizational commitments, both full and
- 7349 provisional, ensuring appropriate level of signatories.

7350 [PA163.IG103.SP102.SubP102]

7351 Commitments must be documented to assure a consistent mutual understanding
7352 as well as for tracking and maintenance. Provisional commitments should be
7353 accompanied by a description of the risks associated with this relationship.

7354 [PA163.IG103.SP102.SubP102.N101]

7355 3. Review internal commitments with senior management as
7356 appropriate. [PA163.IG103.SP102.SubP103]

7357 4. Review external commitments with senior management as
7358 appropriate. [PA163.IG103.SP102.SubP104]

7359 Management may have the necessary insight and authority to reduce risks
7360 associated with external commitments. [PA163.IG103.SP102.SubP104.N101]

7361 5. Identify commitments on interfaces between elements in the
7362 project, and with other projects and organizational units, for
7363 monitoring. [PA163.IG103.SP102.SubP105]

7364 Well-defined interface specifications form the basis for commitments.

7365 [PA163.IG103.SP102.SubP105.N101]

7366 **Generic Practices by Goal**

7367 **GG 1 Achieve Specific Goals**

7368 *The process supports and enables achievement of the specific goals of the*
7369 *process area by transforming identifiable input work products to produce*
7370 *identifiable output work products.*

7371 **GP 1.1 Identify Work Scope**

7372 *Identify the scope of the work to be performed and work products*
7373 *to be produced for project planning, and communicate this*
7374 *information to those performing the work. [GP101]*

7375 **GP 1.2 Perform Base Practices**

7376 *Perform the base practices of the project planning process to*
7377 *develop work products and provide services to achieve the*
7378 *specific goals of the process area. [GP102]*

7379 **GG 2 Institutionalize a Managed Process**

7380 *The process is institutionalized as a managed process.*

7381 **GP 2.1 Establish an Organizational Policy**

7382 ***Establish and maintain an organizational policy for planning and***
7383 ***performing the project planning process.*** [GP103]

7384 Elaboration:

7385 This policy establishes organizational expectations for estimating the
7386 planning parameters, making internal and external commitments, and
7387 developing the plan for managing the project. [PA163.EL101]

7388 **GP 2.2 Plan the Process**

7389 ***Establish and maintain the requirements and objectives, and plans***
7390 ***for performing the project planning process.*** [GP104]

7391 Elaboration:

7392 These requirements, objectives, and plans are described in the plan for
7393 project planning. This plan for project planning differs from the project
7394 plan described in the specific practices in this process area. The
7395 project plan addresses the specific needs and objectives for the project;
7396 whereas the plan for project planning addresses the overall planning of
7397 this process area and how the specific practices will be performed.
7398 [PA163.EL103]

7399 **GP 2.3 Provide Resources**

7400 ***Provide adequate resources for performing the project planning***
7401 ***process, developing the work products and providing the services***
7402 ***of the process.*** [GP105]

7403 Elaboration:

7404 Special expertise, equipment, and facilities in project planning may be
7405 required. Special expertise in project planning may include the
7406 following: [PA163.EL104]

- 7407
- 7408 • Experienced estimators
 - 7409 • Schedulers
 - 7410 • Technical experts in applicable areas (e.g., product domain and technology)

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Examples of tools used in performing the activities of the Project Planning process area include the following: [PA163.EL106]

- Spreadsheet programs
- Estimating models
- Project planning and scheduling packages

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GP 2.4 Assign Responsibility

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

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GP 2.5 Train People

Train the people performing or supporting the project planning process as needed. [GP107]

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Elaboration:

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Examples of training topics include the following: [PA163.EL108]

- Estimating
- Budgeting
- Negotiating
- Risk identification and analysis
- Data management
- Planning
- Scheduling

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GP 2.6 Manage Configurations

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

7437 Elaboration:

7438 Examples of work products placed under configuration management
7439 include the following: [PA163.EL110]

- 7440
- 7441 • Work breakdown structure
 - 7442 • Project plan
 - 7443 • Data management plan
 - 7444 • Stakeholder involvement plan

7445 **GP 2.7 Identify and Involve Relevant Stakeholders**

7446 ***Identify and involve the relevant stakeholders of the project***
7447 ***planning process as planned.*** [GP124]

7448 Elaboration:

7449 This generic practice is different from developing the plan for
7450 stakeholder involvement for the project itself, which is covered in a
7451 specific practice of this process area. [PA163.EL111]

7452 At the project level, consider stakeholders from among senior
7453 managers, project managers, project functional managers (e.g.,
7454 systems engineering, software engineering, other disciplines), software
7455 engineers, systems engineers, manufacturing engineers, logisticians,
7456 suppliers, customers, and others who may be affected by, or may
7457 affect, the project. [PA163.EL118]

7458 Examples of activities for stakeholder involvement include: [PA163.EL119]

- 7459
- 7460 • Establishing estimates
 - 7461 • Reviewing and resolving issues on the completeness and
7462 correctness of the project risks
 - 7463 • Reviewing data management plans
 - 7464 • Establishing project plans
 - 7465 • Reviewing project plans and resolving issues on work and resource
7466 issues

7467 **GP 2.8 Monitor and Control the Process**

7468 ***Monitor and control the project planning process against the plan***
7469 ***and take appropriate corrective action.*** [GP110]

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Elaboration:

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Examples of measures used in monitoring and controlling the activities of the Project Planning process area include the following: [PA163.EL113]

- Number of revisions to the plan
- Cost, schedule, and effort variance per plan revision

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GP 2.9 Objectively Evaluate Adherence

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Objectively evaluate adherence of the project planning process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

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Elaboration:

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Examples of activities reviewed include the following: [PA163.EL115]

- Establishing estimates
- Developing a project plan
- Obtaining commitments to the project plan

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Examples of work products reviewed include the following: [PA163.EL117]

- Work breakdown structure
- Project plan
- Data management plan
- Stakeholder involvement plan

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GP 2.10 Review Status with Higher-Level Management

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Review the activities, status, and results of the project planning process with higher-level management and resolve issues. [GP112]

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GG 3 Institutionalize a Defined Process

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The process is institutionalized as a defined process.

7498 **GP 3.1 Establish a Defined Process**
7499 *Establish and maintain the description of a defined project*
7500 *planning process.* [GP114]

7501 **GP 3.2 Collect Improvement Information**
7502 *Collect work products, measures, measurement results, and*
7503 *improvement information derived from planning and performing*
7504 *the project planning process to support the future use and*
7505 *improvement of the organization's processes and process assets.*
7506 [GP117]

7507 **GG 4 Institutionalize a Quantitatively Managed Process**
7508 *The process is institutionalized as a quantitatively managed process.*

7509 **GP 4.1 Establish Quality Objectives**
7510 *Establish and maintain quantitative objectives for the project*
7511 *planning process about quality and process performance based*
7512 *on customer needs and business objectives.* [GP118]

7513 **GP 4.2 Stabilize Subprocess Performance**
7514 *Stabilize the performance of one or more subprocesses of the*
7515 *project planning process to determine its ability to achieve the*
7516 *established quantitative quality and process performance*
7517 *objectives.* [GP119]

7518 **GG 5 Institutionalize an Optimizing Process**
7519 *The process is institutionalized as an optimizing process.*

7520 **GP 5.1 Ensure Continuous Process Improvement**
7521 *Ensure continuous improvement of the project planning process*
7522 *in fulfilling the relevant business goals of the organization.* [GP125]

7523 **GP 5.2 Correct Common Cause of Problems**
7524 *Identify and correct the root causes of defects and other problems*
7525 *in the project planning process.* [GP121]

7526 PROJECT MONITORING AND CONTROL

7527 Project Management

7528 Purpose

7529 The purpose of Project Monitoring and Control is to provide
7530 understanding into the project's progress so that appropriate corrective
7531 actions can be taken when the project's performance deviates
7532 significantly from the plan. [PA162]

7533 Introductory Notes

7534 A project's documented plan is the basis for monitoring activities,
7535 communicating status, and taking corrective action. Progress is
7536 primarily determined by comparing actual work product and task
7537 attributes, effort, cost, and schedule to the plan at prescribed
7538 milestones or control levels within the project schedule or work
7539 breakdown structure. Appropriate visibility enables timely corrective
7540 action to be taken when performance deviates significantly from the
7541 plan. A deviation is significant if it precludes meeting project objectives
7542 if left unresolved. [PA162.N101]

7543 The term "project plan" is used throughout these practices to refer to
7544 the overall plan for controlling the project. [PA162.N102]

7545 When actual status deviates significantly from the expected values,
7546 corrective actions are taken as appropriate. These actions may require
7547 re-planning, which may include revising the original plan, establishing
7548 new agreements, or including additional mitigation activities within the
7549 current plan. [PA162.N103]

7550 Related Process Areas

7551 *Refer to the Project Planning process area for more information about*
7552 *the project plan, including how it specifies the appropriate level of*
7553 *project monitoring, the measures used to monitor progress, and known*
7554 *risks. [PA162.R101]*

7555 *Refer to the Measurement and Analysis process area for information*
7556 *about measures, including measuring, analyzing, and recording.*
7557 *[PA162.R102]*

7558 Specific Goals

7559 **SG 1** Monitor Project Against Plan [PA162.IG101]

7560 *Actual performance and progress of the project is monitored against the*
7561 *project plan.*

7562 **SG 2** Manage Corrective Action to Closure [PA162.IG102]

7563 *Corrective actions are managed to closure when the project's performance or*
7564 *results deviate significantly from the plan.*

7565 Generic Goals

7566 **GG 1** Achieve Specific Goals [CL102.GL101]

7567 *The process supports and enables achievement of the specific goals of the*
7568 *process area by transforming identifiable input work products to produce*
7569 *identifiable output work products.*

7570 **GG 2** Institutionalize a Managed Process [CL103.GL101]

7571 *The process is institutionalized as a managed process.*

7572 **GG 3** Institutionalize a Defined Process [CL104.GL101]

7573 *The process is institutionalized as a defined process.*

7574 **GG 4** Institutionalize a Quantitatively Managed Process [CL105.GL101]

7575 *The process is institutionalized as a quantitatively managed process.*

7576 **GG 5** Institutionalize an Optimizing Process [CL106.GL101]

7577 *The process is institutionalized as an optimizing process.*

7578 Practice to Goal Relationship Table

- 7579 SG 1 Monitor Project Against Plan [PA162.IG101]
- 7580 SP 1.1-1 Monitor Project Planning Parameters
- 7581 SP 1.2-1 Monitor Commitments
- 7582 SP 1.3-1 Monitor Project Risks
- 7583 SP 1.4-1 Monitor Data Management
- 7584 SP 1.5-1 Monitor Stakeholder Involvement
- 7585 SP 1.6-1 Conduct Progress Reviews
- 7586 SP 1.7-1 Conduct Milestone Reviews

- 7587 SG 2 Manage Corrective Action to Closure [PA162.IG102]
- 7588 SP 2.1-1 Analyze Issues
- 7589 SP 2.2-1 Take Correction Action
- 7590 SP 2.3-1 Manage Corrective Action

- 7591 GG 1 Achieve Specific Goals [CL102.GL101]
- 7592 GP 1.1 Identify Work Scope
- 7593 GP 1.2 Perform Base Practices

- 7594 GG 2 Institutionalize a Managed Process [CL103.GL101]
- 7595 GP 2.1 Establish an Organizational Policy
- 7596 GP 2.2 Plan the Process
- 7597 GP 2.3 Provide Resources
- 7598 GP 2.4 Assign Responsibility
- 7599 GP 2.5 Train People
- 7600 GP 2.6 Manage Configurations
- 7601 GP 2.7 Identify and Involve Relevant Stakeholders
- 7602 GP 2.8 Monitor and Control the Process
- 7603 GP 2.9 Objectively Evaluate Adherence
- 7604 GP 2.10 Review Status with Higher-Level Management

- 7605 GG 3 Institutionalize a Defined Process [CL104.GL101]
- 7606 GP 3.1 Establish a Defined Process
- 7607 GP 3.2 Collect Improvement Information

- 7608 GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]
- 7609 GP 4.1 Establish Quality Objectives
- 7610 GP 4.2 Stabilize Subprocess Performance

- 7611 GG 5 Institutionalize an Optimizing Process [CL106.GL101]
- 7612 GP 5.1 Ensure Continuous Process Improvement
- 7613 GP 5.2 Correct Common Cause of Problems

7614 Specific Practices by Goal

7615 **SG 1 Monitor Project Against Plan** [PA162.IG101]

7616 7617	<i>Actual performance and progress of the project is monitored against the project plan.</i>
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7618 **SP 1.1-1 Monitor Project Planning Parameters**

7619 **Monitor the actual values of the project planning parameters**
7620 **against the project plan.** [PA162.IG101.SP101]

7621 Project planning parameters constitute typical indicators of project
7622 progress and performance and include attributes of work products and
7623 tasks, cost, effort, and schedule. Attributes of the work products and
7624 tasks include such items as size, complexity, weight, form, fit, or
7625 function. [PA162.IG101.SP101.N101]

7626 *Refer to the Measurement and Analysis process area for periodically*
7627 *measuring, analyzing, and recording the actual attributes of the work*
7628 *products and tasks and other planning parameters and comparing them*
7629 *to their associated estimates.* [PA162.IG101.SP101.N101.R101]

7630 Monitoring typically involves measuring the actual values of project
7631 planning parameters, comparing actual values to the estimates in the
7632 plan, and identifying significant deviations. Recording actual values of
7633 the project planning parameters includes recording associated
7634 contextual information to help understand the measures. Analysis of the
7635 impact of significant deviations to determine what corrective action to
7636 take is handled in the second specific goal and its specific practices in
7637 this process area. [PA162.IG101.SP101.N102]

7638 **Typical Work Products**

- 7639 1. Records of project performance [PA162.IG101.SP101.W101]
7640 2. Records of significant deviations [PA162.IG101.SP101.W102]

7641 **Subpractices**

- 7642 1. Monitor progress against the schedule. [PA162.IG101.SP101.SubP101]

7643 Progress monitoring typically includes the following: [PA162.IG101.SP101.SubP101.N101]

- 7644 • Periodically measuring the actual completion of activities and milestones
7645 • Comparing actual completion of activities and milestones against the schedule
7646 documented in the project plan
7647 • Identifying significant deviations from the schedule estimates in the project plan

- 7648 2. Monitor the project's cost and expended effort. [PA162.IG101.SP101.SubP102]

7649 Effort and cost monitoring typically includes the following: [PA162.IG101.SP101.SubP102.N101]

- 7650 • Periodically measuring the actual effort and cost expended and staff assigned
7651 • Comparing actual effort, costs, staffing, and training to the estimates documented
7652 in the project plan
7653 • Identifying significant deviations from the estimates in the project plan

- 7654 3. Monitor the attributes of the work products and tasks.

7655 [PA162.IG101.SP101.SubP103]

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Monitoring of the attributes of the work products and tasks typically includes the following: [PA162.IG101.SP101.SubP103.N101]

- Periodically measuring the actual attributes of the work products and tasks, e.g. size or complexity (and the changes to the attributes).
- Comparing the actual attributes of the work products and tasks (and the changes to the attributes) to the estimates documented in the project plan
- Identifying significant deviations from the estimates in the project plan

Refer to the Project Planning process area for information about the attributes of work products and tasks. [PA162.IG101.SP101.SubP103.R101]

4. Monitor resources provided and used. [PA162.IG101.SP101.SubP104]

For Software Engineering

Examples of software engineering resources include the following: [PA162.IG101.SP101.SubP104.AMP101]

- *Host computers and peripherals*
- *Networks*
- *Software test computers and peripherals*
- *Target computer environment software*
- *Software engineering environment (e.g., software tools)*

Examples of resources include: [PA162.IG101.SP101.SubP104.N101]

- Physical facilities
- Computers, peripherals, and software used in design, manufacturing, test and operation
- Networks
- Security environment
- Manpower
- Processes

Refer to the Project Planning process area for information about planned resources. [PA162.IG101.SP101.SubP104.R101]

5. Monitor the knowledge and skills of project personnel.

[PA162.IG101.SP101.SubP105]

Monitoring of the knowledge and skills of the project personnel typically includes the following: [PA162.IG101.SP101.SubP105.N101]

- Periodically measuring the acquisition of knowledge and skills by project personnel

- 7692 • Comparing the actual training obtained to that documented in the project plan
- 7693 • Identifying significant deviations from the estimates in the project plan

7694 *Refer to Project Planning process area for information about planning*
7695 *for knowledge and skills needed to perform the project.*

7696 [PA162.IG101.SP101.SubP105.R101]

- 7697 6. Document the significant deviations in the project planning
7698 parameters. [PA162.IG101.SP101.SubP106]

7699 **SP 1.2-1 Monitor Commitments**

7700 ***Monitor commitments against those identified in the project plan.***

7701 [PA162.IG101.SP102]

7702 **Typical Work Products**

- 7703 1. Records of commitment reviews [PA162.IG101.SP102.W101]

7704 **Subpractices**

- 7705 1. Regularly review commitments (both external and internal).
7706 [PA162.IG101.SP102.SubP101]
- 7707 2. Identify commitments that have not been satisfied or which are at
7708 significant risk of not being satisfied. [PA162.IG101.SP102.SubP102]
- 7709 3. Document the results of the commitment reviews.
7710 [PA162.IG101.SP102.SubP103]

7711 **SP 1.3-1 Monitor Project Risks**

7712 ***Monitor risks against those identified in the project plan.***

7713 [PA162.IG101.SP103]

7714 *Refer to the Project Planning process area for more information about*
7715 *identifying project risks. [PA162.IG101.SP103.R101]*

7716 *Refer to the Risk Management process area for more information about*
7717 *risk management activities. [PA162.IG101.SP103.R102]*

7718 **Typical Work Products**

- 7719 1. Records of project risk monitoring [PA162.IG101.SP103.W101]

7720 **Subpractices**

- 7721 1. Periodically review the documentation of the risks in the context of
7722 the project's current status and circumstances. [PA162.IG101.SP103.SubP101]
- 7723 2. Revise the documentation of the risks, as additional information
7724 becomes available, to incorporate changes. [PA162.IG101.SP103.SubP102]

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3. Communicate risk status to those affected. [PA162.IG101.SP103.SubP103]

Examples of risk status include the following: [PA162.IG101.SP103.SubP103.N101]

- A change in the probability that the risk occurs
- A change in risk priority

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SP 1.4-1 Monitor Data Management

Monitor the management of project data. [PA162.IG101.SP106]

Refer to the Plan for Data Management specific practice in the Project Planning process area for more information about identifying the types of data that should be managed and how to plan for their management.

[PA162.IG101.SP106.R101]

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Once the plans for the management of project data are made, the management of that data must be monitored to ensure that those plans are accomplished. [PA162.IG101.SP106.N101]

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Typical Work Products

1. Records of data management [PA162.IG101.SP106.W101]

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Subpractices

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1. Periodically review data management activities against their description in the project plan. [PA162.IG101.SP106.SubP101]

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2. Identify and document significant issues and their impacts. [PA162.IG101.SP106.SubP102]

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3. Document the results of data management activity reviews. [PA162.IG101.SP106.SubP103]

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SP 1.5-1 Monitor Stakeholder Involvement

Monitor stakeholder involvement against the project plan.

[PA162.IG101.SP107]

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Refer to the Plan Stakeholder Involvement specific practice in the Project Planning process area for more information on identifying relevant stakeholders and planning the appropriate involvement with them. [PA162.IG101.SP107.R101]

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Once the stakeholders are identified and the extent of their involvement within the project are specified in project planning, that involvement must be monitored to ensure that the appropriate interactions are occurring with the appropriate stakeholders. [PA162.IG101.SP107.N101]

7759 **Typical Work Products**

- 7760 1. Records of stakeholder involvement [PA162.IG101.SP107.W101]

7761 **Subpractices**

- 7762 1. Periodically review the status of stakeholder involvement.

7763 [PA162.IG101.SP107.SubP101]

- 7764 2. Identify and document significant issues and their impacts.

7765 [PA162.IG101.SP107.SubP102]

- 7766 3. Document the results of the stakeholder involvement status
7767 reviews. [PA162.IG101.SP107.SubP103]

7768 **SP 1.6-1 Conduct Progress Reviews**

7769 ***Periodically review the project's progress, performance, and***
7770 ***issues.*** [PA162.IG101.SP104]

7771 Progress reviews are reviews on the project to keep stakeholders
7772 informed. These project reviews can be informal reviews and may not
7773 be specified explicitly in the project plans. [PA162.IG101.SP104.N101]

7774 Examples of these reviews include the following: [PA162.IG101.SP104.N102]

- 7775 • Reviews with staff
- 7776 • Reviews with project engineers and support
- 7777 • Reviews with management

7778 **Typical Work Products**

- 7779 1. Documented project review results. [PA162.IG101.SP104.W101]

7780 **Subpractices**

- 7781 1. Regularly communicate status on assigned activities and work
7782 products to relevant stakeholders. [PA162.IG101.SP104.SubP101]

7783 Managers, staff members, customers, end users, suppliers, and other
7784 stakeholders affected within the organization are included in the reviews as
7785 appropriate. [PA162.IG101.SP104.SubP101.N101]

- 7786 2. Review the results of collecting and analyzing measures for
7787 controlling the project. [PA162.IG101.SP104.SubP102]

- 7788 3. Identify and document significant issues and deviations from the
7789 plan. [PA162.IG101.SP104.SubP103]

- 7790 4. Document change requests and problems identified in any of the
7791 work products and processes. [PA162.IG101.SP104.SubP104]

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- 7793 5. Document the results of the reviews. [PA162.IG101.SP104.SubP105]
7794 6. Track change requests and problem reports to closure.
7795 [PA162.IG101.SP104.SubP106]

7796 **SP 1.7-1 Conduct Milestone Reviews**

7797 ***Review the accomplishments and results of the project at selected***
7798 ***project milestones.*** [PA162.IG101.SP105]

7799 *Refer to the Project Planning process area for more information about*
7800 *milestone planning.* [PA162.IG101.SP105.R101]

7801 Milestone reviews are planned during project planning and are typically
7802 formal reviews. [PA162.IG101.SP105.N101]

7803 **Typical Work Products**

- 7804 1. Documented milestone review results [PA162.IG101.SP105.W101]

7805 **Subpractices**

- 7806 1. Conduct the reviews at meaningful points in the project's schedule,
7807 such as the completion of selected stages, with relevant
7808 stakeholders. [PA162.IG101.SP105.SubP101]

7809 Managers, staff members, customers, end users, suppliers, and other
7810 stakeholders affected within the organization are included in the milestone
7811 reviews as appropriate. [PA162.IG101.SP105.SubP101.N101]

- 7812 2. Review the commitments, plan, status, and risks of the project.

7813 [PA162.IG101.SP105.SubP102]

- 7814 3. Identify and document significant issues and their impacts.

7815 [PA162.IG101.SP105.SubP103]

- 7816 4. Document the results of the review, action items, and decisions.

7817 [PA162.IG101.SP105.SubP104]

- 7818 5. Track action items to closure. [PA162.IG101.SP105.SubP105]

7819 **SG 2 Manage Corrective Action to Closure** [PA162.IG102]

7820 ***Corrective actions are managed to closure when the project's performance or***
7821 ***results deviate significantly from the plan.***

7822 **SP 2.1-1 Analyze Issues**

7823 ***Collect and analyze the issues and determine the corrective***
7824 ***actions necessary to address the issues.*** [PA162.IG102.SP101]

7825 **Typical Work Products**

- 7826 1. List of issues needing corrective actions [PA162.IG102.SP101.W101]

7827 **Subpractices**

- 7828 1. Gather issues for analysis. [PA162.IG102.SP101.SubP101]

7829 Issues are collected from reviews and the execution of other processes.

7830 [PA162.IG102.SP101.SubP101.N101]

7831 Examples of issues to be gathered include: [PA162.IG102.SP101.SubP101.N102]

- 7832 • Issues discovered through performing verification and validation activities
- 7833 • Significant deviations in the project planning parameters from the estimates in the
- 7834 project plan
- 7835 • Commitments (either internal or external) that have not been satisfied
- 7836 • Significant changes in risk status
- 7837 • Data access, collection, privacy, or security issues
- 7838 • Stakeholder representation or involvement issues

7839

7840 *Refer to the Verification and Validation process areas for more*

7841 *information about how discovered issues are handled*

7842 [PA162.IG102.SP101.SubP101.R101]

- 7843 2. Analyze issues to determine need for corrective action.

7844 [PA162.IG102.SP101.SubP102]

7845 Corrective action is required when the issue may prevent the project from meeting

7846 its objectives if left unresolved. [PA162.IG102.SP101.SubP102.N101]

7847 *Refer to Project Planning process area for information about corrective*

7848 *action criteria.* [PA162.IG102.SP101.SubP102.R101]

7849 **SP 2.2-1 Take Correction Action**

7850 ***Take corrective action on identified issues.*** [PA162.IG102.SP102]

7851 **Typical Work Products**

- 7852 1. Corrective action plan [PA162.IG102.SP102.W101]

7853 **Subpractices**

- 7854 1. Determine and document the appropriate actions needed to
- 7855 address the identified issues. [PA162.IG102.SP102.SubP101]

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Examples of potential actions include the following: [PA162.IG102.SP102.SubP101.N101]

- Modifying the statement of work
- Modifying requirements
- Revising estimates and plans
- Renegotiating commitments
- Adding resources
- Changing appropriate processes
- Revising project risks

Refer to the Project Planning process area for more information about the project plan when re-planning is needed [PA162.IG102.SP102.SubP101.R101]

2. Review and get agreement with relevant stakeholders on the actions to be taken. [PA162.IG102.SP102.SubP102]
3. Negotiate changes to internal and external commitments. [PA162.IG102.SP102.SubP103]

SP 2.3-1 Manage Corrective Action

Manage corrective actions to closure. [PA162.IG102.SP103]

Typical Work Products

1. Corrective action results [PA162.IG102.SP103.W101]

Subpractices

1. Monitor corrective actions for completion. [PA162.IG102.SP103.SubP101]
2. Analyze results of corrective actions to determine the effectiveness of the correction action. [PA162.IG102.SP103.SubP102]
3. Determine and document appropriate actions to correct deviations from planned results for corrective actions. [PA162.IG102.SP103.SubP103]

Generic Practices by Goal

GG 1 Achieve Specific Goals

The process supports and enables achievement of the specific goals of the process area by transforming identifiable input work products to produce identifiable output work products.

7886 **GP 1.1 Identify Work Scope**

7887 *Identify the scope of the work to be performed and work products*
7888 *to be produced for project monitoring and control , and*
7889 *communicate this information to those performing the work. [GP101]*

7890 **GP 1.2 Perform Base Practices**

7891 *Perform the base practices of the project monitoring and control*
7892 *process to develop work products and provide services to achieve*
7893 *the specific goals of the process area. [GP102]*

7894 **GG 2 Institutionalize a Managed Process**

7895 *The process is institutionalized as a managed process.*

7896 **GP 2.1 Establish an Organizational Policy**

7897 *Establish and maintain an organizational policy for planning and*
7898 *performing the project monitoring and control process. [GP103]*

7899 Elaboration:

7900 This policy establishes organizational expectations for monitoring
7901 performance against the project plan and managing corrective action to
7902 closure when actual performance or results deviate significantly from
7903 the plan. [PA162.EL101]

7904 **GP 2.2 Plan the Process**

7905 *Establish and maintain the requirements and objectives, and plans*
7906 *for performing the project monitoring and control process. [GP104]*

7907 Elaboration:

7908 These requirements, objectives, and plans are typically described in the
7909 project plan as described in the Project Planning process area.
7910 [PA162.EL102]

7911 **GP 2.3 Provide Resources**

7912 *Provide adequate resources for performing the project monitoring*
7913 *and control process, developing the work products and providing*
7914 *the services of the process. [GP105]*

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Elaboration:

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Examples of tools used in performing the activities of the Project Monitoring and Control process area include the following: [PA162.EL103]

- Cost tracking systems
- Effort reporting systems
- Action item tracking systems
- Project management and scheduling programs

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GP 2.4 Assign Responsibility

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Assign responsibility and authority for performing the process, developing the work products, and providing the services of the project monitoring and control process. [GP106]

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GP 2.5 Train People

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Train the people performing or supporting the project monitoring and control process as needed. [GP107]

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Elaboration:

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Examples of training topics include the following: [PA162.EL104]

- Monitoring and control of projects
- Risk management
- Data management

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GP 2.6 Manage Configurations

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Place designated work products of the project monitoring and control process under appropriate levels of configuration management. [GP109]

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GP 2.7 Identify and Involve Relevant Stakeholders

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Identify and involve the relevant stakeholders of the project monitoring and control process as planned. [GP124]

7943 Elaboration:

7944 This generic practice is different from monitoring stakeholder interaction
7945 for the project, which is covered by a specific practice in this process
7946 area. [PA162.EL107]

7947 Examples of activities for stakeholder involvement include: [PA162.EL108]

- 7948 • Assessing the project against the plan
- 7949 • Reviewing commitments and resolving issues
- 7950 • Reviewing project risks
- 7951 • Reviewing data management activities
- 7952 • Reviewing project progress
- 7953 • Managing corrective actions to closure

7954

7955 **GP 2.8 Monitor and Control the Process**

7956 ***Monitor and control the project monitoring and control process***
7957 ***against the plan and take appropriate corrective action.*** [GP110]

7958 Elaboration:

7959 Examples of measures used in monitoring and controlling the activities
7960 of the Project Monitoring and Control include the following: [PA162.EL105]

- 7961 • Number of open and closed corrective actions
- 7962 • Project milestone dates (e.g., planned versus actual and slipped
7963 milestones)

7964

7965 **GP 2.9 Objectively Evaluate Adherence**

7966 ***Objectively evaluate adherence of the project monitoring and***
7967 ***control process and the work products and services of the***
7968 ***process to the applicable requirements, objectives, and standards,***
7969 ***and address noncompliance.*** [GP113]

7970 Elaboration:

7971 Examples of activities reviewed include the following: [PA162.EL106]

- 7972 • Monitoring the project against the project plan
- 7973 • Managing corrective actions to closure

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Examples of work products reviewed include the following: [PA162.EL109]

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- Records of project performance

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- Project review results

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GP 2.10 Review Status with Higher-Level Management

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Review the activities, status, and results of the project monitoring and control process with higher-level management and resolve issues. [GP112]

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GG 3 Institutionalize a Defined Process

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The process is institutionalized as a defined process.

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GP 3.1 Establish a Defined Process

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Establish and maintain the description of a defined project monitoring and control process. [GP114]

7987

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GP 3.2 Collect Improvement Information

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Collect work products, measures, measurement results, and improvement information derived from planning and performing the project monitoring and control process to support the future use and improvement of the organization's processes and process assets. [GP117]

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GG 4 Institutionalize a Quantitatively Managed Process

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The process is institutionalized as a quantitatively managed process.

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GP 4.1 Establish Quality Objectives

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Establish and maintain quantitative objectives for the project monitoring and control process about quality and process performance based on customer needs and business objectives.

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[GP118]

8001 **GP 4.2 Stabilize Subprocess Performance**

8002 *Stabilize the performance of one or more subprocesses of the*
8003 *project monitoring and control process to determine its ability to*
8004 *achieve the established quantitative quality and process*
8005 *performance objectives.* [GP119]

8006 **GG 5 Institutionalize an Optimizing Process**

8007 *The process is institutionalized as an optimizing process.*

8008 **GP 5.1 Ensure Continuous Process Improvement**

8009 *Ensure continuous improvement of the project monitoring and*
8010 *control process in fulfilling the relevant business goals of the*
8011 *organization.* [GP125]

8012 **GP 5.2 Correct Common Cause of Problems**

8013 *Identify and correct the root causes of defects and other problems*
8014 *in the project monitoring and control process.* [GP121]

8015 SUPPLIER AGREEMENT MANAGEMENT

8016 Project Management

8017 Purpose

8018 The purpose of Supplier Agreement Management is to manage the
8019 acquisition of products and services from suppliers external to the
8020 project for which there exists a formal agreement. [PA166]

8021 Introductory Notes

8022 A formal agreement is any legal agreement between the organization
8023 (representing the project) and the supplier. This agreement may be a
8024 contract, a license, or a memorandum of agreement. The acquired
8025 product is delivered to the project from the supplier and becomes part of
8026 the products delivered to the customer. [PA166.N101]

8027 The acquired product may be a product component in the overall
8028 product under development. In this process area, "product" will be used
8029 to refer to both products and product components acquired from a
8030 supplier. [PA166.N102]

8031 The Supplier Agreement Management process area addresses the
8032 need of the project to effectively select and manage those portions of
8033 work that are produced by suppliers. The term "supplier" is used to
8034 identify an internal or external organization that develops,
8035 manufactures, or supports products being developed or maintained that
8036 will be delivered to the customer. Suppliers may take many forms
8037 depending on business needs including in-house vendors (i.e.,
8038 organizations within a company but which are external to the project),
8039 fabrication capabilities and laboratories, and commercial vendors.
8040 [PA166.N103]

8041 The Supplier Agreement Management process area involves the
8042 following activities: [PA166.N104]

- 8043 • Identifying the products to be acquired
- 8044 • Selecting suppliers
- 8045 • Establishing and maintaining agreements with suppliers
- 8046 • Overseeing supplier performance
- 8047 • Accepting delivery of products
- 8048 • Arranging for maintenance and support of the products

8049 This process area does not directly cover the acquisition of products
8050 that are not delivered to the project's customer (for example,
8051 development tools). When development tools are not delivered to the
8052 customer, a project may choose to use the practices in this process
8053 area to minimize the risk to the project. However, if the project
8054 establishes an environment that includes development tools and this
8055 environment is part of the products that are delivered to the customer,
8056 this process area is applicable. [PA166.N105]

8057 This process area also does not directly cover arrangements where the
8058 supplier is integrated into the project team (for example, integrated
8059 product teams, virtual organizations, or employees from a supplier
8060 supplementing the project's staff). Although these situations typically
8061 require formal agreements, they are often handled by other functions
8062 outside of the project. Again, the practices of this process area may be
8063 useful to the project in these situations. [PA166.N106]

8064 Related Process Areas

8065 *Refer to the Project Monitoring and Control process area for more*
8066 *information about monitoring projects and taking corrective action.*
8067 [PA166.R101]

8068 *Refer to the Requirements Development process area for more*
8069 *information about defining requirements.* [PA166.R102]

8070 *Refer to the Requirements Management process area for more*
8071 *information about managing requirements, including the traceability of*
8072 *requirements for products acquired from suppliers.* [PA166.R103]

8073 *Refer to the Technical Solution process area for more information about*
8074 *determining the products and product components that may be*
8075 *acquired from suppliers.* [PA166.R104]

8076 Specific Goals

8077 **SG 1 Establish Supplier Agreements** [PA166.IG101]

8078 ***Agreements with the suppliers are established and maintained.***

8079 **SG 2 Satisfy Supplier Agreements** [PA166.IG102]

8080 ***Agreements with the suppliers are satisfied by both the project and the***
8081 ***supplier.***

8082 Generic Goals

8083 **GG 1** **Achieve Specific Goals** [CL102.GL101]

8084 *The process supports and enables achievement of the specific goals of the*
8085 *process area by transforming identifiable input work products to produce*
8086 *identifiable output work products.*

8087 **GG 2** **Institutionalize a Managed Process** [CL103.GL101]

8088 *The process is institutionalized as a managed process.*

8089 **GG 3** **Institutionalize a Defined Process** [CL104.GL101]

8090 *The process is institutionalized as a defined process.*

8091 **GG 4** **Institutionalize a Quantitatively Managed Process** [CL105.GL101]

8092 *The process is institutionalized as a quantitatively managed process.*

8093 **GG 5** **Institutionalize an Optimizing Process** [CL106.GL101]

8094 *The process is institutionalized as an optimizing process.*

8095 Practice to Goal Relationship Table

- 8096 SG 1 Establish Supplier Agreements [PA166.IG101]
- 8097 SP 1.1-1 Analyze Needs and Requirements Determined by the Project
- 8098 SP 1.2-1 Select Suppliers
- 8099 SP 1.3-1 Establish Supplier Agreements

- 8100 SG 2 Satisfy Supplier Agreements [PA166.IG102]
- 8101 SP 2.1-1 Acquire COTS Products
- 8102 SP 2.2-1 Execute the Supplier Agreement
- 8103 SP 2.3-1 Conduct Acceptance Testing
- 8104 SP 2.4-1 Transition Products

- 8105 GG 1 Achieve Specific Goals [CL102.GL101]
- 8106 GP 1.1 Identify Work Scope
- 8107 GP 1.2 Perform Base Practices

- 8108 GG 2 Institutionalize a Managed Process [CL103.GL101]
- 8109 GP 2.1 Establish an Organizational Policy
- 8110 GP 2.2 Plan the Process
- 8111 GP 2.3 Provide Resources
- 8112 GP 2.4 Assign Responsibility
- 8113 GP 2.5 Train People
- 8114 GP 2.6 Manage Configurations
- 8115 GP 2.7 Identify and Involve Relevant Stakeholders
- 8116 GP 2.8 Monitor and Control the Process
- 8117 GP 2.9 Objectively Evaluate Adherence
- 8118 GP 2.10 Review Status with Higher-Level Management

- 8119 GG 3 Institutionalize a Defined Process [CL104.GL101]
- 8120 GP 3.1 Establish a Defined Process
- 8121 GP 3.2 Collect Improvement Information

- 8122 GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]
- 8123 GP 4.1 Establish Quality Objectives
- 8124 GP 4.2 Stabilize Subprocess Performance

- 8125 GG 5 Institutionalize an Optimizing Process [CL106.GL101]
- 8126 GP 5.1 Ensure Continuous Process Improvement
- 8127 GP 5.2 Correct Common Cause of Problems

8128 Specific Practices by Goal

8129 **SG 1 Establish Supplier Agreements** [PA166.IG101]

8130 ***Agreements with the suppliers are established and maintained.***

8131 **SP 1.1-1 Analyze Needs and Requirements Determined by the Project**

8132 ***Analyze the project's needs and requirements that will be fulfilled***
 8133 ***by sources outside the project to determine how the needs and***
 8134 ***requirements will be satisfied.*** [PA166.IG101.SP101]

For Integrated Product and Process Development

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When integrated teams are formed, the risk to the acquirer may be unacceptable if the suppliers for one, or more, of the products needed are not employing IPPD approaches. In analyzing needs, the project should consider whether or not to use a non-IPPD supplier. [PA166.IG101.SP101.AMP101]

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The determination of what products or product components will be acquired is frequently referred to as a "make-or-buy analysis." It is based on an analysis of the needs of the project. This make-or-buy analysis begins early in the project when the requirements are being developed, continues during the design process, and is completed with the decision to acquire the product. [PA166.IG101.SP101.N101]

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Refer to the Requirements Development process area for more information about determining the product and product component requirements. [PA166.IG101.SP101.N101.R101]

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Refer to the Requirements Management process area for more information about managing requirements. [PA166.IG101.SP101.N101.R102]

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Refer to the Technical Solution process area for more information about design decisions for the make-or-buy analysis. [PA166.IG101.SP101.N101.R103]

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Factors affecting the make-or-buy decision include the following:
[PA166.IG101.SP101.N102]

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- Functions the products or services will provide and how these functions will fit into the project
 - Available project resources and skills
 - Costs of acquiring versus developing internally
 - Critical delivery and integration dates
 - Strategic business alliances including high level business requirements
 - Market research of available products, including commercial-off-the-shelf (COTS) products
 - Functionality and quality of available products
 - Skills and capabilities of potential suppliers
 - Impact on core competencies
 - Licenses, warranties, responsibilities, and limitations associated with products being acquired
 - Product availability
 - Proprietary issues
 - Risk reduction

8173 Many of these factors are addressed by the project and are covered by
8174 the practices described in the Requirements Development, Technical
8175 Solution, and Project Planning process areas. [PA166.IG101.SP101.N105]

8176 The make-or-buy decision can be conducted using a structured
8177 decision-making approach [PA166.IG101.SP101.N103]

8178 *Refer to the Decision Analysis and Resolution process area for more*
8179 *information about structured decision-making.* [PA166.IG101.SP101.N103.R101]

8180 **Typical Work Products**

8181 1. List of products to be acquired [PA166.IG101.SP101.W101]

8182 2. Outsourcing needs and requirements [PA166.IG101.SP101.W102]

8183 **Subpractices**

8184 1. Select acquisition options for the candidate products to be acquired
8185 to satisfy the project's needs and requirements.

8186 [PA166.IG101.SP101.SubP101]

8187 These options include the following: [PA166.IG101.SP101.SubP101.N101]

- 8188 • Purchasing COTS products or services
- 8189 • Obtaining products or services through a contractual agreement
- 8190 • Obtaining products or services from another part of the business enterprise (i.e.,
8191 another part of the corporation, government agency, etc.)
- 8192 • Obtaining products from the customer
- 8193 • Combining some of the above (e.g., contracting for a modification to a COTS
8194 product or having another part of the business enterprise co-develop products
8195 with an external supplier)

8196 **SP 1.2-1 Select Suppliers**

8197 ***Select suppliers based on an evaluation of their ability to meet the***
8198 ***specified requirements and established criteria.*** [PA166.IG101.SP102]

8199 *Refer to the Decision Analysis and Resolution process area for more*
8200 *information about decision-making approaches that can be used to*
8201 *select suppliers.* [PA166.IG101.SP102.R101]

8202 *Refer to the Requirements Management process area for more*
8203 *information about specified requirements.* [PA166.IG101.SP102.R102]

8204 Criteria should be established to address factors that are important to
8205 the project. [PA166.IG101.SP102.N101]

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Examples of factors include: [PA166.IG101.SP102.N103]

- Geographical location of the supplier
- Supplier's performance records on similar work
- Engineering capabilities
- Staff available to perform the work
- Prior experience in similar applications

Typical Work Products

1. List of candidate suppliers [PA166.IG101.SP102.W101]
2. Preferred supplier list [PA166.IG101.SP102.W102]
3. Rationale for selection of suppliers [PA166.IG101.SP102.W103]
4. Advantages and disadvantages of candidate suppliers
[PA166.IG101.SP102.W104]
5. Evaluation criteria [PA166.IG101.SP102.W105]

Subpractices

1. Establish and document criteria for evaluating potential suppliers.
[PA166.IG101.SP102.SubP101]
2. Identify potential suppliers and distribute solicitation material and requirements to them. [PA166.IG101.SP102.SubP102]
3. Evaluate proposals according to evaluation criteria.
[PA166.IG101.SP102.SubP103]
4. Evaluate risks associated with each proposed supplier.
[PA166.IG101.SP102.SubP104]

Refer to the Risk Management process area for more information about evaluating project risks. [PA166.IG101.SP102.SubP104.R101]

5. Evaluate proposed suppliers' ability to perform the work.
[PA166.IG101.SP102.SubP105]

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Examples of methods to evaluate the proposed supplier's ability to perform the work include the following: [PA166.IG101.SP102.SubP105.N101]

- Evaluation of prior experience in similar applications
- Evaluation of prior performance on similar work
- Evaluation of management capabilities
- Capability evaluations
- Evaluation of staff available to perform the work
- Evaluation of available facilities and resources
- Evaluation of the project's ability to work with the proposed supplier

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SP 1.3-1 Establish Supplier Agreements

Establish and maintain formal agreements with the supplier.

[PA166.IG101.SP103]

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For Integrated Product and Process Development

When integrated teams are formed, team membership needs to be negotiated with suppliers and incorporated into the agreement. The agreement needs to identify any integrated decision-making, reporting requirements (business and technical), and trade studies requiring supplier involvement. The supplier efforts should be orchestrated to support the IPPD efforts undertaken by the acquirer. [PA166.IG101.SP103.AMP101]

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A formal agreement is any legal agreement between the organization (representing the project) and the supplier. This agreement may be a contract, a license, or a memorandum of agreement. [PA166.IG101.SP103.N101]

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Typical Work Products

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1. Statements of work [PA166.IG101.SP103.W101]
2. Contracts [PA166.IG101.SP103.W102]
3. Memoranda of agreement [PA166.IG101.SP103.W103]

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Subpractices

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1. Revise the requirements to be fulfilled by the supplier to reflect negotiations with the supplier when necessary. [PA166.IG101.SP103.SubP101]

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Refer to the Requirements Development process area for more information about revising requirements. [PA166.IG101.SP103.SubP101.R101]

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Refer to the Requirements Management process area for more information about managing changes to requirements. [PA166.IG101.SP103.SubP101.R102]

- 8269 2. Document what the project will provide to the supplier.
8270 [PA166.IG101.SP103.SubP102]
- 8271 Include the following: [PA166.IG101.SP103.SubP102.N101]
- 8272 • Project-furnished facilities
 - 8273 • Documentation
 - 8274 • Services
- 8275 3. Document the supplier agreement. [PA166.IG101.SP103.SubP103]
- 8276 The supplier agreement should include a statement of work, specification, terms
8277 and conditions, a list of deliverables, a schedule, budget, and a defined
8278 acceptance process. [PA166.IG101.SP103.SubP103.N101]
- 8279 This subpractice typically includes the following: [PA166.IG101.SP103.SubP103.N102]
- 8280 • Establishing the statement of work, specification, terms and conditions, list of
8281 deliverables, schedule, budget, and acceptance process
 - 8282 • Identifying who from the project and supplier are responsible and authorized to
8283 make changes to the supplier agreement
 - 8284 • Identifying how requirements changes and changes to the supplier agreement are
8285 determined, communicated, and addressed
 - 8286 • Identifying standards and procedures that will be followed
 - 8287 • Identifying critical dependencies between the project and the supplier
 - 8288 • Identifying the type and depth of project oversight of the supplier, procedures, and
8289 evaluation criteria to be used in monitoring supplier performance
 - 8290 • Identifying the supplier's responsibilities for ongoing maintenance and support of
8291 the acquired products
 - 8292 • Identifying warranty, ownership, and usage rights for the acquired products
 - 8293 • Identifying acceptance criteria
- 8294 4. Ensure all parties to the agreement understand and agree to all
8295 requirements before implementing the agreement.
8296 [PA166.IG101.SP103.SubP104]
- 8297 5. Revise the supplier agreement as necessary. [PA166.IG101.SP103.SubP105]
- 8298 6. Revise the project's plans and commitments as necessary to
8299 reflect the supplier agreement. [PA166.IG101.SP103.SubP106]
- 8300 *Refer to the Project Monitoring and Control process area for more*
8301 *information about revising the project plan.* [PA166.IG101.SP103.SubP106.R101]

8302 **SG 2 Satisfy Supplier Agreements** [PA166.IG102]

8303 **Agreements with the suppliers are satisfied by both the project and the**
8304 **supplier.**

8305 **SP 2.1-1 Acquire COTS Products**

8306 ***Acquire COTS products to satisfy the specified requirements that***
8307 ***are covered under a supplier agreement.*** [PA166.IG102.SP101]

8308 In the event that COTS products are desired, care in evaluating and
8309 selecting these products and the vendor may be critical to the project.

8310 [PA166.IG102.SP101.N101]

8311 The identification of product components that will be satisfied by COTS
8312 is done in the Technical Solution process area. [PA166.IG102.SP101.N102]

8313 *Refer to the Technical Solution process area for more information about*
8314 *the identification of product components that will be satisfied with COTS*
8315 *products.* [PA166.IG102.SP101.N102.R101]

8316 **Typical Work Products**

- 8317 1. Trade studies [PA166.IG102.SP101.W101]
- 8318 2. Price lists [PA166.IG102.SP101.W102]
- 8319 3. Evaluation criteria [PA166.IG102.SP101.W103]
- 8320 4. Supplier performance reports [PA166.IG102.SP101.W104]

8321 **Subpractices**

- 8322 1. Develop criteria for evaluating COTS products. [PA166.IG102.SP101.SubP101]
- 8323 2. Evaluate candidate products against the associated requirements
8324 and criteria. [PA166.IG102.SP101.SubP102]

8325 These requirements include the following: [PA166.IG102.SP101.SubP102.N101]

- 8326 • Functionality, performance, quality, and reliability
- 8327 • Terms and conditions of warranties for the products
- 8328 • Risk
- 8329 • Suppliers' responsibilities for ongoing maintenance and support of the products

8330 *Refer to the Requirements Management and the Requirements*
8331 *Development process areas for more information about the*
8332 *requirements that will be used to evaluate candidate products.*

8333 [PA166.IG102.SP101.SubP102.R101]

- 8334 3. Evaluate the impact of candidate products on the project's plans
8335 and commitments. [PA166.IG102.SP101.SubP103]

8336 Evaluate according to the following: [PA166.IG102.SP101.SubP103.N101]

- 8337 • Cost of the products
- 8338 • Cost and effort to incorporate the products into the project

- 8339
- Security requirements
- 8340
- Benefits and impacts that may result from future product releases
- 8341
- 8342
- 8343
- 8344
- 8345
- 8346
- 8347
- 8348
4. Assess the suppliers' performance and ability to deliver.

[PA166.IG102.SP101.SubP103.N102]

[PA166.IG102.SP101.SubP104]

[PA166.IG102.SP101.SubP105]

8349

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8351

Refer to the Project Planning and the Risk Management process areas for more information about identifying project risks.

[PA166.IG102.SP101.SubP105.R101]

- 8352
6. Select the COTS product to be acquired. [PA166.IG102.SP101.SubP106]

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In some cases, selection of COTS products may require a supplier agreement in addition to the agreements in the product's standard license.

[PA166.IG102.SP101.SubP106.N101]

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Examples of agreements with COTS suppliers include the following:

[PA166.IG102.SP101.SubP106.N102]

- Discounts for large quantity purchases
- Covering relevant stakeholders under the licensing agreement, including project suppliers, team members, and the project's customer
- Plans for future enhancements
- On-site support such as responses to queries and problem reports
- Additional capabilities that are not in the product
- Maintenance support, including support after the product is withdrawn from general availability

- 8367
7. Plan for the maintenance of the COTS product. [PA166.IG102.SP101.SubP107]

8368

SP 2.2-1 Execute the Supplier Agreement

8369

8370

Perform activities with the supplier as specified in the supplier agreement. [PA166.IG102.SP102]

8371

8372

8373

Refer to the Project Monitoring and Control process area for more information about monitoring projects and taking corrective action.

[PA166.IG102.SP102.R101]

8374 **Typical Work Products**

- 8375 1. Supplier progress reports [PA166.IG102.SP102.W101]
- 8376 2. Results of audit reviews [PA166.IG102.SP102.W102]
- 8377 3. Review reports [PA166.IG102.SP102.W103]
- 8378 4. Action items [PA166.IG102.SP102.W104]
- 8379 5. Documentation of work product and document deliveries
- 8380 [PA166.IG102.SP102.W105]

8381 **Subpractices**

- 8382 1. Monitor supplier progress and performance (schedule, effort, cost
- 8383 and technical performance) as defined in the supplier agreement.
- 8384 [PA166.IG102.SP102.SubP101]
- 8385 2. Monitor selected supplier process activities and take corrective
- 8386 action when necessary. [PA166.IG102.SP102.SubP102]

8387 Examples of processes to be monitored are quality assurance and configuration

8388 management. [PA166.IG102.SP102.SubP102.N101]

- 8389
- 8390 3. Conduct reviews with the supplier as specified in the supplier
- 8391 agreement. [PA166.IG102.SP102.SubP103]

8392 Reviews cover both formal and informal reviews and include the following steps:

8393 [PA166.IG102.SP102.SubP103.N101]

- 8394 • Preparing for the review
- 8395 • Ensuring that relevant stakeholders participate
- 8396 • Conducting the review
- 8397 • Identifying, documenting, and tracking to closure all action items
- 8398 • Preparing and distributing to the affected people a summary report of the review

8399 *Refer to the Project Monitoring and Control process area for more*

8400 *information about conducting reviews.* [PA166.IG102.SP102.SubP103.R101]

- 8401 4. Conduct technical reviews with the supplier as defined in the
- 8402 supplier agreement. [PA166.IG102.SP102.SubP104]

8403 Technical reviews typically include the following: [PA166.IG102.SP102.SubP104.N101]

- 8404 • Providing the supplier with visibility into the needs and desires of the project's
- 8405 customers and end users, as appropriate
- 8406 • Reviewing the suppliers technical activities and verifying that the supplier's
- 8407 interpretation and implementation of the requirements are consistent with the
- 8408 project's interpretation, technical commitments are being met, and technical
- 8409 issues are communicated and resolved in a timely manner

- 8410
- Obtaining technical information about the supplier's work products
- 8411
- Providing appropriate technical information and support to the supplier
- 8412
- 8413
5. Conduct management reviews with the supplier as defined in the supplier agreement. [PA166.IG102.SP102.SubP105]
- 8414
- Management reviews typically include the following: [PA166.IG102.SP102.SubP105.N101]
- 8415
- Reviewing critical dependencies
- 8416
- Reviewing project risks involving the supplier
- 8417
- Reviewing schedule and budget
- 8418
- Technical and management reviews may be coordinated and held jointly.
- 8419
- [PA166.IG102.SP102.SubP105.N102]
- 8420
6. Use results to improve the supplier's performance and for establishing and nurturing long-term relationships with preferred suppliers. [PA166.IG102.SP102.SubP106]
- 8421
- 8422
- 8423
7. Monitor risks involving the supplier and take corrective action as necessary. [PA166.IG102.SP102.SubP107]
- 8424
- 8425
- Refer to the Project Monitoring and Control process area for more information about monitoring project risks. [PA166.IG102.SP102.SubP107.R101]*
- 8426
- 8427
8. Revise the supplier agreement and project plans and schedules as necessary. [PA166.IG102.SP102.SubP108]
- 8428

SP 2.3-1 Conduct Acceptance Testing

Ensure that the supplier agreement is satisfied before accepting the acquired product. [PA166.IG102.SP103]

8432

8433

8434

Acceptance reviews and tests and configuration audits should be completed before the acceptance of the product as defined in the supplier agreement. [PA166.IG102.SP103.N101]

Typical Work Products

- 8435
1. Acceptance test procedures [PA166.IG102.SP103.W101]
- 8436
2. Acceptance test reports [PA166.IG102.SP103.W102]
- 8437

Subpractices

- 8438
1. Define the acceptance procedures. [PA166.IG102.SP103.SubP101]
- 8439
2. Review and obtain agreement with relevant stakeholders on the acceptance procedures before the acceptance review or test.
- 8440
- 8441
- 8442
- [PA166.IG102.SP103.SubP102]

- 8443 3. Verify that the acquired products satisfy their requirements.
8444 [PA166.IG102.SP103.SubP103]
- 8445 *Refer to the Verification process area for more information about*
8446 *verifying products.* [PA166.IG102.SP103.SubP103.R101]
- 8447 4. Verify that the non-technical commitments associated with the
8448 acquired work product are satisfied. [PA166.IG102.SP103.SubP104]
- 8449 This may include verifying that the appropriate license, warranty, ownership,
8450 usage, and support or maintenance agreements are in place and that all
8451 supporting materials are received. [PA166.IG102.SP103.SubP104.N101]
- 8452 5. Document the results of the acceptance review or test.
8453 [PA166.IG102.SP103.SubP105]
- 8454 6. Establish and obtain supplier agreement on an action plan for any
8455 acquired work products that do not pass their acceptance review or
8456 test. [PA166.IG102.SP103.SubP106]
- 8457 7. Identify, document, and track action items to closure.
8458 [PA166.IG102.SP103.SubP107]
- 8459 *Refer to the Project Monitoring and Control process area for more*
8460 *information about tracking action items.* [PA166.IG102.SP103.SubP107.R101]

8461 SP 2.4-1 Transition Products

8462 ***Transition the acquired products from the supplier to the project.***

8463 [PA166.IG102.SP104]

8464 **Typical Work Products**

- 8465 1. Transition plans [PA166.IG102.SP104.W101]
- 8466 2. Training plans [PA166.IG102.SP104.W102]
- 8467 3. Support and maintenance plans [PA166.IG102.SP104.W103]

8468 **Subpractices**

- 8469 1. Ensure there are appropriate facilities to receive, store, use, and
8470 maintain the acquired products. [PA166.IG102.SP104.SubP101]
- 8471 2. Ensure that appropriate training is provided for the people involved
8472 in receiving, storing, using, and maintaining the acquired products.
8473 [PA166.IG102.SP104.SubP102]
- 8474 3. Ensure that storing, distributing, and using the acquired products is
8475 performed according to the terms and conditions specified in the
8476 supplier agreement or license. [PA166.IG102.SP104.SubP103]

8477 Generic Practices by Goal

8478 **GG 1 Achieve Specific Goals**

8479 *The process supports and enables achievement of the specific goals of the*
8480 *process area by transforming identifiable input work products to produce*
8481 *identifiable output work products.*

8482 **GP 1.1 Identify Work Scope**

8483 *Identify the scope of the work to be performed and work products*
8484 *to be produced for supplier agreement management , and*
8485 *communicate this information to those performing the work. [GP101]*

8486 **GP 1.2 Perform Base Practices**

8487 *Perform the base practices of the supplier agreement management*
8488 *process to develop work products and provide services to achieve*
8489 *the specific goals of the process area. [GP102]*

8490 **GG 2 Institutionalize a Managed Process**

8491 *The process is institutionalized as a managed process.*

8492 **GP 2.1 Establish an Organizational Policy**

8493 *Establish and maintain an organizational policy for planning and*
8494 *performing the supplier agreement management process. [GP103]*

8495 Elaboration:

8496 This policy establishes organizational expectations for establishing,
8497 maintaining, and satisfying supplier agreements. [PA166.EL101]

8498 **GP 2.2 Plan the Process**

8499 *Establish and maintain the requirements and objectives, and plans*
8500 *for performing the supplier agreement management process. [GP104]*

8501 **GP 2.3 Provide Resources**

8502 *Provide adequate resources for performing the supplier agreement*
8503 *management process, developing the work products and*
8504 *providing the services of the process. [GP105]*

8505 Elaboration:

8506 Examples of tools used in performing the activities of the Supplier
8507 Agreement Management process area include the following: [PA166.EL102]

- 8508
- 8509 • Preferred supplier lists
 - 8510 • Requirements tracking programs
 - 8511 • Project management and scheduling programs

8512 **GP 2.4 Assign Responsibility**

8513 *Assign responsibility and authority for performing the process,*
8514 *developing the work products, and providing the services of the*
8515 *supplier agreement management process.* [GP106]

8516 **GP 2.5 Train People**

8517 *Train the people performing or supporting the supplier agreement*
8518 *management process as needed.* [GP107]

8519 Elaboration:

8520 Examples of training topics include the following: [PA166.EL103]

- 8521
- 8522 • Regulations and business practices related to negotiating and
working with suppliers
 - 8523 • Acquisition planning and preparation
 - 8524 • COTS products acquisition
 - 8525 • Supplier evaluation and selection
 - 8526 • Negotiation and conflict resolution
 - 8527 • Supplier management
 - 8528 • Testing and transitioning of acquired products
 - 8529 • Receiving, storing, using, and maintaining the acquired products
- 8530

8531 **GP 2.6 Manage Configurations**

8532 *Place designated work products of the supplier agreement*
8533 *management process under appropriate levels of configuration*
8534 *management.* [GP109]

8535

Elaboration:

8536

Examples of work products placed under configuration management include the following: [PA166.EL104]

8537

8538

- Statements of work

8539

- Supplier agreements

8540

- Memoranda of agreement

8541

- Subcontracts

8542

- Preferred supplier list

8543

8544

GP 2.7 Identify and Involve Relevant Stakeholders

8545

Identify and involve the relevant stakeholders of the supplier agreement management process as planned. [GP124]

8546

8547

Elaboration:

8548

Examples of activities for stakeholder involvement include: [PA166.EL109]

8549

- Establishing criteria for evaluation of potential suppliers

8550

- Reviewing potential suppliers

8551

- Establishing supplier agreements

8552

- Resolving issues with suppliers

8553

- Reviewing supplier performance

8554

8555

GP 2.8 Monitor and Control the Process

8556

Monitor and control the supplier agreement management process against the plan and take appropriate corrective action. [GP110]

8557

8558

Elaboration:

8559

Examples of measures used in monitoring and controlling the activities of the Supplier Agreement Management process area include the following: [PA166.EL105]

8560

8561

8562

- Number of changes made to the requirements for the supplier

8563

- Cost and schedule variance per supplier agreement

8564

8565 **GP 2.9 Objectively Evaluate Adherence**

8566 ***Objectively evaluate adherence of the supplier agreement***
8567 ***management process and the work products and services of the***
8568 ***process to the applicable requirements, objectives, and standards,***
8569 ***and address noncompliance.*** [GP113]

8570 Elaboration:

8571 Examples of activities reviewed include the following: [PA166.EL106]
8572 • Establishing and maintaining supplier agreements
8573 • Satisfying supplier agreements

8574
8575 Examples of work products reviewed include the following: [PA166.EL108]
8576 • Plan for Supplier Agreement Management
8577 • Supplier agreements
8578

8579 **GP 2.10 Review Status with Higher-Level Management**

8580 ***Review the activities, status, and results of the supplier agreement***
8581 ***management process with higher-level management and resolve***
8582 ***issues.*** [GP112]

8583 **GG 3 Institutionalize a Defined Process**

8584 ***The process is institutionalized as a defined process.***

8585 **GP 3.1 Establish a Defined Process**

8586 ***Establish and maintain the description of a defined supplier***
8587 ***agreement management process.*** [GP114]

8588 **GP 3.2 Collect Improvement Information**

8589 ***Collect work products, measures, measurement results, and***
8590 ***improvement information derived from planning and performing***
8591 ***the supplier agreement management process to support the***
8592 ***future use and improvement of the organization's processes and***
8593 ***process assets.*** [GP117]

8594 **GG 4 Institutionalize a Quantitatively Managed Process**

8595 *The process is institutionalized as a quantitatively managed process.*

8596 **GP 4.1 Establish Quality Objectives**

8597 *Establish and maintain quantitative objectives for the supplier*
8598 *agreement management process about quality and process*
8599 *performance based on customer needs and business objectives.*

8600 [GP118]

8601 **GP 4.2 Stabilize Subprocess Performance**

8602 *Stabilize the performance of one or more subprocesses of the*
8603 *supplier agreement management process to determine its ability*
8604 *to achieve the established quantitative quality and process*
8605 *performance objectives.* [GP119]

8606 **GG 5 Institutionalize an Optimizing Process**

8607 *The process is institutionalized as an optimizing process.*

8608 **GP 5.1 Ensure Continuous Process Improvement**

8609 *Ensure continuous improvement of the supplier agreement*
8610 *management process in fulfilling the relevant business goals of*
8611 *the organization.* [GP125]

8612 **GP 5.2 Correct Common Cause of Problems**

8613 *Identify and correct the root causes of defects and other problems*
8614 *in the supplier agreement management process.* [GP121]

8615 INTEGRATED PROJECT MANAGEMENT (IPPD)

8616 Project Management

8617 Purpose

8618 The purpose of Integrated Project Management (IPPD) is to establish
8619 and manage the project and the involvement of the relevant
8620 stakeholders according to an integrated and defined process that is
8621 tailored from the organization's set of standard processes. It also covers
8622 the establishment of a shared vision for the project and a team structure
8623 for integrated teams that will carry out the objectives of the project .

8624 [PA167]

8625 Introductory Notes

8626 The integrated and defined process that is tailored from the
8627 organization's set of standard is called the project's defined process.

8628 [PA167.N101]

8629 Integrated Project Management (IPPD) involves the following: [PA167.N102]

- 8630 • Tailoring the project's defined process from the organization's set
8631 of standard processes.
- 8632 • Establishing a shared vision by and for the project.
- 8633 • Establishing a structure of integrated teams that are tasked to
8634 accomplish the objectives of the project.
- 8635 • Managing the project using the project's defined process.
- 8636 • Using and contributing to the organization's process assets.
- 8637 • Enabling each relevant stakeholder's unique expertise and
8638 concerns to be identified, considered, and implemented during the
8639 development of the product.
- 8640 • Ensuring that the relevant stakeholders associated with the project
8641 coordinate their efforts in a timely manner: (1) to address product
8642 and product component requirements, plans, objectives, issues,
8643 and risks; (2) to make their commitments; and (3) to identify, track,
8644 and resolve issues.

8645 Managing the project's effort, cost, schedule, staffing, risks, and other
8646 factors is tied to the tasks of the project's defined process. The
8647 implementation and management of the project's defined process is
8648 typically described in the project plan. Certain activities may be covered
8649 in other subordinate plans, such as the quality assurance plan,
8650 verification strategy, risk management strategy, and the configuration
8651 management plan. [PA167.N103]

8652 Since the defined process for each project is tailored from the
8653 organization's set of standard processes, variability among projects is
8654 typically reduced and projects can more easily share process assets,
8655 data, and lessons learned. [PA167.N104]

8656 This process area also addresses the coordination of all activities
8657 associated with the project including the following: [PA167.N105]

- 8658 • Technical activities such as requirements development, design,
8659 and verification
- 8660 • Support activities such as configuration management,
8661 documentation, marketing, and training

8662 The term relevant stakeholder in this process area refers to a group or
8663 individual that is affected by or is in some way accountable for the
8664 outcome of the project. A relevant stakeholder could be an individual
8665 from another project or team, individuals representing technical or
8666 support activities, suppliers, customers, or end users. [PA167.N106]

8667 The working interfaces and interactions among relevant stakeholders
8668 internal and external to the project are planned and managed to ensure
8669 the quality and integrity of the entire product. Relevant stakeholders
8670 participate, as appropriate, in defining the project's defined process and
8671 the project plan. Reviews and exchanges are regularly conducted with
8672 these relevant stakeholders to ensure that everyone involved in the
8673 project is appropriately aware of the status and plans of all activities,
8674 and that project coordination issues receive appropriate attention. In
8675 defining the project's defined process, formal interfaces are created as
8676 necessary to ensure that appropriate coordination and collaboration
8677 occurs. [PA167.N107]

8678 This process area applies in any organizational structure, including
8679 projects that are structured as line organizations, matrix organizations,
8680 integrated teams (also known as Integrated Product Teams [IPTs]). The
8681 terminology should be appropriately interpreted for the organizational
8682 structure in place. [PA167.N108]

8683 If you are using the continuous representation, the first goal in this
8684 process area may be redundant when applying the capability level three
8685 generic practices to project-related process areas. However, the
8686 practices, subpractices, and notes will provide many details that will
8687 assist you with this application. [PA167.N109]

8688 Related Process Areas

- 8689 *Refer to the Project Planning process area for more information about*
8690 *practices that cover the planning of the project. [PA167.R101]*
- 8691 *Refer to the Project Monitoring and Control process area for more*
8692 *information about the practices that cover monitoring and controlling the*
8693 *project. [PA167.R102]*
- 8694 *Refer to the Project Planning process area for more information about*
8695 *identifying relevant stakeholders and their appropriate involvement in*
8696 *the project. [PA167.R103]*
- 8697 *Refer to the Verification process area for more information about peer*
8698 *reviews. [PA167.R104]*
- 8699 *Refer to the Organizational Process Definition process area for more*
8700 *information about the organization's set of standard processes, process*
8701 *assets, and tailoring guidelines. [PA167.R105]*
- 8702 *Refer to the Measurement and Analysis process area for more*
8703 *information about measuring and analyzing processes. [PA167.R106]*
- 8704 *Refer to the Integrated Teaming process area for more information*
8705 *about how teams are established and maintained. [PA167.R107]*
- 8706 *Refer to the Organizational Environment for Integration process area for*
8707 *more information about the work environment and the creation of the*
8708 *organization's shared vision, and managing people for integration.*
8709 *[PA167.R108]*

8710 Specific Goals

8711 **SG 1 Use the Project's Defined Process** [PA167.IG101]

8712 ***The project is conducted using a defined process that is tailored from the***
8713 ***organization's set of standard processes.***

8714 **SG 2 Coordinate and Collaborate with Relevant Stakeholders** [PA167.IG102]

8715 ***Coordination and collaboration of the project with relevant stakeholders is***
8716 ***conducted.***

8717 **SG 3 Use the Project's Shared Vision** [PA167.IG103]

8718 ***The project is conducted using the project's shared vision.***

8719 **SG 4 Organize Integrated Teams** [PA167.IG104]

8720 *The integrated teams needed to execute the project are identified, defined,*
8721 *structured, and tasked.*

8722 Generic Goals

8723 **GG 1 Achieve Specific Goals** [CL102.GL101]

8724 *The process supports and enables achievement of the specific goals of the*
8725 *process area by transforming identifiable input work products to produce*
8726 *identifiable output work products.*

8727 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

8728 *The process is institutionalized as a managed process.*

8729 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

8730 *The process is institutionalized as a defined process.*

8731 **GG 4 Institutionalize a Quantitatively Managed Process** [CL105.GL101]

8732 *The process is institutionalized as a quantitatively managed process.*

8733 **GG 5 Institutionalize an Optimizing Process** [CL106.GL101]

8734 *The process is institutionalized as an optimizing process.*

8735 Practice to Goal Relationship Table

- 8736 SG 1 Use the Project's Defined Process [PA167.IG101]
- 8737 SP 1.1-1 Establish the Project's Defined Process
- 8738 SP 1.2-1 Use Organizational Process Assets for Planning Project Activities
- 8739 SP 1.3-1 Integrate Plans
- 8740 SP 1.4-1 Manage the Project Using the Integrated Plans
- 8741 SP 1.5-1 Contribute to the Organization's Process Assets

- 8742 SG 2 Coordinate and Collaborate with Relevant Stakeholders [PA167.IG102]
- 8743 SP 2.1-1 Manage Stakeholder Involvement
- 8744 SP 2.2-1 Manage Dependencies
- 8745 SP 2.3-1 Resolve Coordination Issues

- 8746 SG 3 Use the Project's Shared Vision [PA167.IG103]
- 8747 SP 3.1-1 Define Project's Shared Vision Context
- 8748 SP 3.2-1 Establish the Project's Shared Vision

- 8749 SG 4 Organize Integrated Teams [PA167.IG104]
- 8750 SP 4.1-1 Determine Integrated Team Structure for the Project
- 8751 SP 4.2-1 Develop a Preliminary Distribution of Requirements to Integrated
- 8752 Teams
- 8753 SP 4.3-1 Establish Integrated Teams

- 8754 GG 1 Achieve Specific Goals [CL102.GL101]
- 8755 GP 1.1 Identify Work Scope
- 8756 GP 1.2 Perform Base Practices

- 8757 GG 2 Institutionalize a Managed Process [CL103.GL101]
- 8758 GP 2.1 Establish an Organizational Policy
- 8759 GP 2.2 Plan the Process
- 8760 GP 2.3 Provide Resources
- 8761 GP 2.4 Assign Responsibility
- 8762 GP 2.5 Train People
- 8763 GP 2.6 Manage Configurations
- 8764 GP 2.7 Identify and Involve Relevant Stakeholders
- 8765 GP 2.8 Monitor and Control the Process
- 8766 GP 2.9 Objectively Evaluate Adherence
- 8767 GP 2.10 Review Status with Higher-Level Management

- 8768 GG 3 Institutionalize a Defined Process [CL104.GL101]
- 8769 GP 3.1 Establish a Defined Process
- 8770 GP 3.2 Collect Improvement Information

- 8771 GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]
- 8772 GP 4.1 Establish Quality Objectives
- 8773 GP 4.2 Stabilize Subprocess Performance

- 8774 GG 5 Institutionalize an Optimizing Process [CL106.GL101]
- 8775 GP 5.1 Ensure Continuous Process Improvement
- 8776 GP 5.2 Correct Common Cause of Problems

8777 Specific Practices by Goal

8778 **SG 1 Use the Project's Defined Process** [PA167.IG101]

8779 ***The project is conducted using a defined process that is tailored from the***
8780 ***organization's set of standard processes.***

8781 The project's defined process must include those standard processes
8782 elements from the organization's set of standard processes and
8783 guidelines that are unique to IPPD. For example the defined processes
8784 are not only integrated but reflect a parallel, rather than a serial,
8785 development process. The product-related processes, such as the
8786 manufacturing and support processes, are developed concurrently with
8787 the product. [PA167.IG101.N101]

8788 **SP 1.1-1 Establish the Project's Defined Process**

8789 ***Establish and maintain the project's defined process.*** [PA167.IG101.SP101]

8790 *Refer to the Organizational Process Definition process area for more*
8791 *information about the organization's set of standard processes, the*
8792 *library of process assets, life-cycle models, and tailoring guidelines.*
8793 [PA167.IG101.SP101.R101]

8794 *Refer to the Organizational Process Focus process area for more*
8795 *information about organizational process needs and objectives.*
8796 [PA167.IG101.SP101.R102]

8797 The project's defined process is a set of defined processes and
8798 subprocesses that form an integrated, coherent life cycle for the project.
8799 [PA167.IG101.SP101.N101]

8800 The project's defined process includes the IPPD processes that will be
8801 applied by the project (tailored from the organization's IPPD processes).
8802 Processes to select the team structure, allocate limited personnel
8803 resources, implement cross-integrated team communication, and
8804 conduct issue resolution processes are part of the project's defined
8805 process. The project's defined process should satisfy the project's
8806 contractual and operational needs, opportunities, and constraints. It is
8807 designed to provide a best fit for the project's needs. A project's defined
8808 process is based on the following: [PA167.IG101.SP101.N102]

- 8809 • Customer requirements
- 8810 • Product and product component requirements
- 8811 • Commitments
- 8812 • Organizational process needs and objectives
- 8813 • Operational environment
- 8814 • Business environment

8815 **Typical Work Products**

- 8816 1. The project's defined process [PA167.IG101.SP101.W101]

8817 **Subpractices**

- 8818 1. Select a life-cycle model from those available from the
8819 organization's process assets. [PA167.IG101.SP101.SubP101]
- 8820 2. Select the standard processes from the organization's set of
8821 standard processes that best fit the needs of the project.
8822 [PA167.IG101.SP101.SubP102]
- 8823 3. Tailor the organization's set of standard processes and other
8824 process assets according to the tailoring guidelines to produce the
8825 project's defined process. [PA167.IG101.SP101.SubP103]

8826 Sometimes the available life-cycle models and standard processes are
8827 inadequate to meet a specific project's needs. Sometimes the project will be
8828 unable to produce required work products or measures. In such circumstances,
8829 the project will need to seek approval to deviate from what is required by the
8830 organization. Waivers are provided for this purpose. [PA167.IG101.SP101.SubP103.N101]

- 8831 4. Use other artifacts from the organization's library of process assets
8832 as appropriate. [PA167.IG101.SP101.SubP104]

8833 Other artifacts may include the following: [PA167.IG101.SP101.SubP104.N101]

- 8834 • Lessons learned documents
- 8835 • Templates
- 8836 • Example documents
- 8837 • Estimating models

- 8838 5. Document the project's defined process. [PA167.IG101.SP101.SubP105]

8839 The project's defined process covers all the engineering, management, and
8840 support activities for the project and its interfaces to relevant stakeholders.

8841 [PA167.IG101.SP101.SubP105.N101]

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Examples of project activities include the following: [PA167.IG101.SP101.SubP105.N102]

- Project planning
- Project monitoring and controlling
- Requirements development
- Requirements management
- Design and implementation
- Verification and validation
- Product integration
- Acquisition management
- Configuration management
- Quality assurance

6. Conduct peer reviews of the project's defined process.

[PA167.IG101.SP101.SubP106]

Refer to the Verification process area for more information about conducting peer reviews. [PA167.IG101.SP101.SubP106.R101]

7. Revise the project's defined process as necessary.

[PA167.IG101.SP101.SubP107]

SP 1.2-1 Use Organizational Process Assets for Planning Project Activities

Use the organization's process assets and measurement repository for estimating and planning the project's activities.

[PA167.IG101.SP102]

Refer to the Organizational Process Definition process area for more information about organizational process assets and the organization's measurement repository. [PA167.IG101.SP102.R101]

Typical Work Products

1. Project estimates [PA167.IG101.SP102.W101]
2. Project plans [PA167.IG101.SP102.W102]

Subpractices

1. Base the activities for estimating and planning on the tasks and work products of the project's defined process. [PA167.IG101.SP102.SubP101]

An understanding of the relationships among the various tasks and work products of the project's defined process, and of the roles to be performed by the relevant stakeholders, is a basis for developing a realistic plan. [PA167.IG101.SP102.SubP101.N101]

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2. Use the organization's measurement repository in estimating the project's planning parameters. [PA167.IG101.SP102.SubP102]

This estimate typically includes the following: [PA167.IG101.SP102.SubP102.N101]

- Using appropriate historical data from this project or similar projects
- Accounting for and recording similarities and differences between the current project and those projects whose historical data will be used
- Independently validating the historical data
- Recording the reasoning, assumptions, and rationale used to select the historical data

Examples of parameters that are considered for similarities and differences include the following: [PA167.IG101.SP102.SubP102.N102]

- Work product and task attributes
- Application domain
- Design approach
- Operational environment
- Experience of the people

Examples of data contained in the organization's measurement repository include the following: [PA167.IG101.SP102.SubP102.N103]

- Size of work products or other work product attributes
- Effort
- Cost
- Schedule
- Staffing
- Defects

SP 1.3-1 Integrate Plans

Integrate the project plan and the subordinate plans to describe the project's defined process. [PA167.IG101.SP103]

Refer to the Project Planning process area for more information about establishing and maintaining a project plan. [PA167.IG101.SP103.R101]

Refer to the Organizational Process Definition process area for more information about organizational process assets and, in particular, the organization's measurement repository. [PA167.IG101.SP103.R102]

8910 *Refer to the Measurement and Analysis process area for more*
8911 *information about defining measures and measurement activities and*
8912 *using analytic techniques. [PA167.IG101.SP103.R103]*

8913 *Refer to the Risk Management process area for more information about*
8914 *identifying and analyzing risks. [PA167.IG101.SP103.R104]*

8915 *Refer to the Organizational Process Focus process area for more*
8916 *information about organizational process needs and objectives.*
8917 *[PA167.IG101.SP103.R105]*

8918 This specific practice extends the practices involved in establishing and
8919 maintaining a project plan to address additional planning activities such
8920 as incorporating the project's defined process, coordinating with
8921 relevant stakeholders, using organizational process assets,
8922 incorporating plans for peer reviews, and establishing objective entry
8923 and exit criteria for tasks. [PA167.IG101.SP103.N101]

8924 The development of the project plan should account for current and
8925 projected needs, objectives, and requirements of the organization,
8926 customer, and end users, as appropriate. This plan development also
8927 includes accounting for organizational process needs and objectives.
8928 [PA167.IG101.SP103.N102]

8929 The plans of the integrated teams are included in this integration.
8930 Developing a complete project plan and project's defined process may
8931 require an iterative effort if a complex, multi-layered integrated team
8932 structure is being deployed. [PA167.IG101.SP103.N103]

8933 **Typical Work Products**

- 8934 1. Project plan [PA167.IG101.SP103.W101]
- 8935 2. Subordinate plans [PA167.IG101.SP103.W102]

8936 **Subpractices**

- 8937 1. Integrate the subordinate plans with the project plan.
8938 [PA167.IG101.SP103.SubP101]

8939 The subordinate plans may include the following: [PA167.IG101.SP103.SubP101.N101]

- 8940 • Quality assurance plans
- 8941 • Configuration management plans
- 8942 • Risk management strategy
- 8943 • Verification strategy
- 8944 • Validation strategy
- 8945 • Product integration plans
- 8946 • Documentation plans

- 8947 2. Incorporate into the project plan the definitions of measures and
8948 measurement activities for managing the project.

8949 [PA167.IG101.SP103.SubP102]

8950 Examples of measures that would be incorporated include the following:

8951 [PA167.IG101.SP103.SubP102.N101]

- 8952 • Organization's common set of measures
8953 • Additional project-specific measures

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8955 3. Identify and analyze product and project interface risks.

8956 [PA167.IG101.SP103.SubP103]

- 8957 4. Schedule the tasks in a sequence that accounts for critical
8958 development factors and project risks. [PA167.IG101.SP103.SubP104]

8959 Examples of factors considered in scheduling include the following:

8960 [PA167.IG101.SP103.SubP104.N101]

- 8961 • Size and complexity of the tasks
8962 • Integration and test issues
8963 • Needs of the customer and end users
8964 • Availability of critical resources
8965 • Availability of key personnel

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8967 5. Incorporate the plans for performing peer reviews on the work
8968 products of the project's defined process. [PA167.IG101.SP103.SubP105]

8969 *Refer to the Verification process area for more information about peer*
8970 *reviews* [PA167.IG101.SP103.SubP105.R101]

- 8971 6. Incorporate the training needed to perform the project's defined
8972 process in the project's training plans. [PA167.IG101.SP103.SubP106]

8973 This task typically involves negotiating with the organizational training group the
8974 support they will provide. [PA167.IG101.SP103.SubP106.N101]

- 8975 7. Establish objective entry and exit criteria to authorize the initiation
8976 and completion of the tasks described in the work breakdown
8977 structure. [PA167.IG101.SP103.SubP107]

- 8978 8. Ensure that the project plan is appropriately compatible with the
8979 plans of relevant stakeholders. [PA167.IG101.SP103.SubP108]

8980 Typically the plan and changes to the plan will be reviewed for compatibility.

8981 [PA167.IG101.SP103.SubP108.N101]

- 8982 9. Identify how conflicts will be resolved that arise between
8983 stakeholders involved in the project. [PA167.IG101.SP103.SubP109]

8984 **SP 1.4-1 Manage the Project Using the Integrated Plans**

8985 ***Manage the project using the project plan, the subordinate plans,***
8986 ***and the project's defined process.*** [PA167.IG101.SP104]

8987 *Refer to the Organizational Process Definition process area for more*
8988 *information about the library of process assets.* [PA167.IG101.SP104.R101]

8989 *Refer to the Organizational Process Focus process area for more*
8990 *information about organizational process needs and objectives and*
8991 *coordinating process improvement activities with the rest of the*
8992 *organization.* [PA167.IG101.SP104.R102]

8993 *Refer to the Risk Management process area for more information about*
8994 *managing risks.* [PA167.IG101.SP104.R103]

8995 *Refer to the Project Monitoring and Control process area for more*
8996 *information about monitoring and controlling the project.*

8997 [PA167.IG101.SP104.R104]

8998 **Typical Work Products**

- 8999 1. Work products created by performing the project's defined process

9000 [PA167.IG101.SP104.W101]

- 9001 2. Collected measures ("actuals") and progress records or reports

9002 [PA167.IG101.SP104.W102]

- 9003 3. Revised requirements, plans, and commitments [PA167.IG101.SP104.W103]

- 9004 4. Integrated plans [PA167.IG101.SP104.W104]

9005 **Subpractices**

- 9006 1. Implement the project's defined process using the organization's
9007 library of process assets. [PA167.IG101.SP104.SubP101]

9008 This task typically includes the following: [PA167.IG101.SP104.SubP101.N101]

- 9009 • Incorporating artifacts from the library into the project as appropriate
9010 • Using lessons learned from the library to manage the project

- 9011 2. Monitor and control the project's activities and work products using
9012 the project's defined process, project plan, and subordinate plans.

9013 [PA167.IG101.SP104.SubP102]

9014 This task typically includes the following: [PA167.IG101.SP104.SubP102.N101]

- 9015 • Using the defined entry and exit criteria to authorize the initiation and determine
9016 the completion of the tasks
9017 • Monitoring the activities that could significantly affect the actual values of the
9018 project's planning parameters

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- Tracking the project's planning parameters using measurable thresholds that will trigger investigation and appropriate actions
 - Monitoring product and project interface risks
 - Managing external and internal commitments based on the plans for the tasks and work products of implementing the project's defined process

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An understanding of the relationships among the various tasks and work products of the project's defined process, roles to be performed by the relevant stakeholders, along with well-defined control mechanisms (e.g., peer reviews), are used to achieve better visibility into the project's performance and better control of the project. [PA167.IG101.SP104.SubP102.N102]

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3. Obtain and analyze the selected measures to manage the project and support the organization's needs. [PA167.IG101.SP104.SubP103]

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Refer to the Measurement and Analysis process area for more information about obtaining and analyzing measures.

[PA167.IG101.SP104.SubP103.R101]

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4. Periodically review the adequacy of the environment to meet the project's needs and support coordination. [PA167.IG101.SP104.SubP104]

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Examples of actions that might be taken include the following:

[PA167.IG101.SP104.SubP104.N101]

- 9038
- 9039
- Adding new tools
 - Acquiring additional networks, equipment, training, and support

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5. Periodically review and align the project's performance with the current and projected needs, objectives, and requirements of the organization, customer, and end users, as appropriate.

[PA167.IG101.SP104.SubP105]

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This review includes alignment with the organizational process needs and objectives. [PA167.IG101.SP104.SubP105.N101]

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Examples of actions that achieve alignment include the following:

[PA167.IG101.SP104.SubP105.N102]

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- Accelerating the schedule, with appropriate adjustments to other planning parameters and the project risks
 - Changing the requirements in response to a change in market opportunities or customer and end-user needs
 - Terminating the project

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SP 1.5-1 Contribute to the Organization's Process Assets

Contribute work products, measures, and documented experiences to the organization's process assets. [PA167.IG101.SP105]

Refer to the Organizational Process Focus process area for more information about process improvement proposals. [PA167.IG101.SP105.R101]

Refer to the Organizational Process Definition process area for more information about the organization's process assets, the organization's measurement repository, and the library of process assets.
[PA167.IG101.SP105.R102]

Typical Work Products

1. Proposed improvements to the organization's process assets
[PA167.IG101.SP105.W101]
2. Actual process and product measures collected from the project
[PA167.IG101.SP105.W102]
3. Documentation (e.g., exemplary process descriptions, plans, training modules, checklists, and lessons learned) [PA167.IG101.SP105.W103]

Subpractices

1. Propose improvements to the organization's process assets.
[PA167.IG101.SP105.SubP101]
2. Store process and product measures in the organization's measurement repository. [PA167.IG101.SP105.SubP102]

This typically includes the following: [PA167.IG101.SP105.SubP102.N101]

- Planning data
- Re-planning data
- Measures

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Examples of data recorded by the project include the following:
[PA167.IG101.SP105.SubP102.N102]

- Task description
- Assumptions
- Estimates
- Revised estimates
- Definitions of recorded data and measures
- Measures
- Context information that relates the measures to the activities performed and work products produced
- Associated information needed to reconstruct the estimates, assess their reasonableness, and derive estimates for new work

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Refer to the Project Planning process area for more information about recording planning and re-planning data. [PA167.IG101.SP105.SubP102.R101]

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Refer to the Project Monitoring and Control process area for more information about recording measures. [PA167.IG101.SP105.SubP102.R102]

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3. Submit documentation for possible inclusion in the organization's library of process assets. [PA167.IG101.SP105.SubP103]

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Examples of documentation include the following: [PA167.IG101.SP105.SubP103.N101]

- Exemplary process descriptions
- Training modules
- Exemplary plans
- Checklists

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4. Document lessons learned from the project for inclusion in the organization's library of process assets. [PA167.IG101.SP105.SubP104]

9107 **SG 2**

Coordinate and Collaborate with Relevant Stakeholders [PA167.IG102]

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Coordination and collaboration of the project with relevant stakeholders is conducted.

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SP 2.1-1 Manage Stakeholder Involvement

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Manage the involvement of the relevant stakeholders in the project. [PA167.IG102.SP101]

9113 *Refer to the Project Planning process area for more information about*
9114 *identifying stakeholders and their appropriate involvement and on*
9115 *establishing and maintaining commitments.* [PA167.IG102.SP101.R101]

9116 **Typical Work Products**

- 9117 1. Agendas and schedules for collaborative activities [PA167.IG102.SP101.W101]
- 9118 2. Documented issues (e.g. issues with the customer requirements,
9119 product and product component requirements, product
9120 architecture, and product design) [PA167.IG102.SP101.W102]
- 9121 3. Recommendations on issues [PA167.IG102.SP101.W103]
- 9122 4. Documented defects, issues, and action items arising from reviews
9123 [PA167.IG102.SP101.W104]
- 9124 5. Documented product and project interface risks [PA167.IG102.SP101.W105]

9125 **Subpractices**

- 9126 1. Coordinate with the relevant stakeholders that should participate in
9127 the project's activities. [PA167.IG102.SP101.SubP101]

9128 The relevant stakeholders should already be identified in the project plan.

9129 [PA167.IG102.SP101.SubP101.N101]

- 9130 2. Participate in reviews of the activities and work products of other
9131 projects as appropriate. [PA167.IG102.SP101.SubP102]
- 9132 3. Ensure that work products produced to satisfy commitments meet
9133 the requirements of the receiving projects. [PA167.IG102.SP101.SubP103]

9134 This task typically includes the following: [PA167.IG102.SP101.SubP103.N101]

- 9135 • Reviewing, demonstrating, or testing, as appropriate, each work product produced
9136 by relevant stakeholders
- 9137 • Reviewing, demonstrating, or testing, as appropriate, each work product produced
9138 by the project for other projects with representatives of the projects receiving the
9139 work product
- 9140 • Resolving issues related to the acceptance of the work products

9141 *Refer to the Verification process area for more information about*
9142 *determining acceptability of work products.* [PA167.IG102.SP101.SubP103.R101]

- 9143 4. Develop recommendations and coordinate the actions to resolve
9144 misunderstandings and problems with the product and product
9145 component requirements, product and product component
9146 architecture, and product and product component design.
9147 [PA167.IG102.SP101.SubP104]

SP 2.2-1 Manage Dependencies

Participate with relevant stakeholders to identify, negotiate, and track critical dependencies. [PA167.IG102.SP102]

Refer to the Project Planning process area for more information about identifying stakeholders and their appropriate involvement and on establishing and maintaining commitments. [PA167.IG102.SP102.R101]

Typical Work Products

1. Agendas and schedules for collaborative activities [PA167.IG102.SP102.W101]
2. Defects, issues, and action items arising from reviews
[PA167.IG102.SP102.W102]
3. Critical dependencies [PA167.IG102.SP102.W103]
4. Commitments to address critical dependencies [PA167.IG102.SP102.W104]
5. Status of critical dependencies [PA167.IG102.SP102.W105]

Subpractices

1. Conduct reviews with relevant stakeholders. [PA167.IG102.SP102.SubP101]
2. Identify each critical dependency. [PA167.IG102.SP102.SubP102]
3. Establish need dates and plan dates for each critical dependency based on the project schedule. [PA167.IG102.SP102.SubP103]
4. Review and get agreement on the commitments to address each critical dependency with the people responsible for providing the work product and the people receiving the work product.
[PA167.IG102.SP102.SubP104]
5. Document the critical dependencies and commitments.
[PA167.IG102.SP102.SubP105]

Documentation of commitments typically includes the following:

[PA167.IG102.SP102.SubP105.N101]

- Describing the commitment
- Identifying who made the commitment
- Identifying who is responsible for satisfying the commitment
- Specifying when the commitment will be satisfied
- Specifying the criteria for determining if the commitment has been satisfied
6. Track the critical dependencies and commitments and taking corrective action as appropriate. [PA167.IG102.SP102.SubP106]

Tracking the critical dependencies typically includes the following:

[PA167.IG102.SP102.SubP106.N101]

- 9183 • Evaluating the effects of late and early completion for impacts on future activities
- 9184 and milestones
- 9185 • Resolving actual and potential problems with the responsible people where
- 9186 possible
- 9187 • Escalating to the appropriate managers the actual and potential problems not
- 9188 resolvable with the responsible people

9189 *Refer to the Project Monitoring and Control process area for more*
9190 *information about tracking commitments.* [PA167.IG102.SP102.SubP106.R101]

SP 2.3-1 Resolve Coordination Issues

Resolve issues with relevant stakeholders. [PA167.IG102.SP103]

Examples of coordination issues include the following: [PA167.IG102.SP103.N101]

- Late critical dependencies and commitments
- Product and product component requirements and design defects
- Product-level problems
- Unavailability of critical resources or personnel

Typical Work Products

1. Documented issues [PA167.IG102.SP103.W101]
2. Status of issues [PA167.IG102.SP103.W102]

Subpractices

1. Identify and document issues. [PA167.IG102.SP103.SubP101]
2. Communicate issues to the relevant stakeholders.
[PA167.IG102.SP103.SubP102]
3. Resolve issues with the relevant stakeholders. [PA167.IG102.SP103.SubP103]
4. Escalate to the appropriate managers those issues not resolvable
with the relevant stakeholders. [PA167.IG102.SP103.SubP104]
5. Track the issues to closure. [PA167.IG102.SP103.SubP105]
6. Communicate with the relevant stakeholders on the status and
resolution of the issues. [PA167.IG102.SP103.SubP106]

9212 The following two goals, SG 3 "Use the Project's Shared Vision (IPPD)" and SG 4
9213 "Organize Integrated Teams (IPPD)", are only required for the IPPD model.

9214 **SG 3 Use the Project's Shared Vision** [PA167.IG103]

9215 ***The project is conducted using the project's shared vision.***

9216 The purpose of creating a shared vision is to achieve a unity of
9217 purpose. Creating a shared vision requires that all people in the project
9218 have an opportunity to speak and be heard about what really matters to
9219 them. The project's shared vision captures the project's guiding
9220 principles including mission, objectives, expected behavior and values.
9221 The project's guiding principles should be consistent with those of the
9222 organization. The implementation of the project's shared vision in work
9223 can become part of the project's process for doing that work. As a
9224 result, it is subject to the same requirements for measurement, review,
9225 and corrective action as other processes. [PA167.IG103.N101]

9226 The value of a shared vision is that people understand and can adopt
9227 its principles to guide their actions and decisions. Shared visions tend to
9228 focus on an end state while leaving room for personal and team
9229 innovation, creativity, and enthusiasm. The activities of the individuals,
9230 teams, and project are aligned with the shared vision. Aligned means
9231 that the activities contribute to the achievement of the objectives
9232 expressed in the shared vision. [PA167.IG103.N102]

9233 **SP 3.1-1 Define Project's Shared Vision Context**

9234 ***Identify expectations, constraints, interfaces, and operational***
9235 ***conditions applicable to the project's shared vision.*** [PA167.IG103.SP101]

9236 *Refer to the Organizational Environment for Integration process area for*
9237 *more information about the organization's shared vision as an*
9238 *organizational process asset.* [PA167.IG103.SP101.R101]

9239 A project does not operate in isolation. Understanding organizational
9240 expectations and constraints allows for alignment of the project's
9241 direction, activities and vision with the organization's and helps create a
9242 common purpose within which project activities can be coordinated
9243 Understanding the interfaces with other stakeholders external to the
9244 project, the objectives and expectations of stakeholders (including
9245 members of the project), and conditions within which the project must
9246 operate), is critical to ensure that the project's direction and activities
9247 achieve a fit with any larger objectives. [PA167.IG103.SP101.N101]

9248 The project's shared vision context has both an external and internal
9249 aspect. The external aspect has to do with the overlying vision and
9250 objectives as well as interfaces outside of the project. The internal
9251 aspect is about aligning project member's personal aspirations and
9252 objectives with the project's vision and purpose. [PA167.IG103.SP101.N102]

9253 **Typical Work Products**

- 9254 1. Organizational expectations and constraints that apply to the
9255 project [PA167.IG103.SP101.W101]
- 9256 2. Summary of project members' personal aspirations for the project
9257 [PA167.IG103.SP101.W102]
- 9258 3. External interfaces that the project is required to observe
9259 [PA167.IG103.SP101.W103]
- 9260 4. Operational conditions that affect the project's activities
9261 [PA167.IG103.SP101.W104]
- 9262 5. Project's shared vision context [PA167.IG103.SP101.W105]

9263 **Subpractices**

- 9264 1. Identify behaviors, characteristics, and principles about the
9265 organizational and project situation that affect the project's shared
9266 vision. [PA167.IG103.SP101.SubP101]
- 9267 2. Use appropriate techniques to explore project member's mental
9268 models and personal aspirations for the project. [PA167.IG103.SP101.SubP102]
- 9269 3. Create a description of the project's shared vision context.
9270 [PA167.IG103.SP101.SubP103]

9271 **SP 3.2-1 Establish the Project's Shared Vision**

9272 ***Establish and maintain a shared vision for the project.*** [PA167.IG103.SP102]

9273 *Refer to the Organizational Environment for Integration process area for*
9274 *more information about the organization's shared vision.*

9275 [PA167.IG103.SP102.R101]

9276 A shared vision is created by the project and for the project, in
9277 alignment with the organization's shared vision. [PA167.IG103.SP102.N101]

9278 When creating a vision consider: [PA167.IG103.SP102.N102]

- 9279 • external stakeholder expectations and requirements
- 9280 • the aspirations and expectations of the leader and project
- 9281 members
- 9282 • the project's objectives

- 9283 • the conditions and outcomes the project will create
- 9284 • interfaces the project needs to maintain
- 9285 • the visions created by the organization and interfacing groups
- 9286 • the constraints imposed by outside authorities (e.g., environmental
- 9287 regulations)
- 9288 • project operation while working to achieve its objectives (both
- 9289 principles and behaviors)

9290 When creating a shared vision, all people in the project should be
9291 invited to participate. Although there may be a draft proposal, the larger
9292 population must have an opportunity to speak and be heard about what
9293 really matters to them. The vision is articulated in terms of both the core
9294 ideology (values, principles, and behaviors) and the desired future to
9295 which each member of the project can commit. [PA167.IG103.SP102.N103]

9296 An effective communications strategy is key to implementing and
9297 focusing the vision throughout the project. Promulgation of the shared
9298 vision is a public declaration of the commitment of the project to their
9299 shared vision and provides the opportunity for others to examine,
9300 understand and align their activities in a common direction. The vision
9301 should be communicated, and agreement and commitment of the
9302 relevant stakeholders should be attained. [PA167.IG103.SP102.N104]

9303 Effective communications are also especially important when
9304 incorporating new project members. New members of the project often
9305 need more or special attention to ensure that they understand the
9306 vision, have a stake in it, and are prepared to follow it in doing their
9307 work. [PA167.IG103.SP102.N105]

9308 **Typical Work Products**

- 9309 1. Meeting minutes for team building exercises [PA167.IG103.SP102.W101]
- 9310 2. Vision and objective statements [PA167.IG103.SP102.W102]
- 9311 3. Statement of values and principles [PA167.IG103.SP102.W103]
- 9312 4. Presentations to stakeholders, observers, and management
- 9313 [PA167.IG103.SP102.W104]
- 9314 5. Communications strategy [PA167.IG103.SP102.W105]
- 9315 6. Handbook for new members of the project [PA167.IG103.SP102.W106]
- 9316 7. Presentations to stakeholders and management [PA167.IG103.SP102.W107]
- 9317 8. Presentations and publications describing principles, vision
- 9318 statement and objectives [PA167.IG103.SP102.W108]

- 9319 9. Published principles, vision statement, mission statement and
9320 objectives (e.g., posters, wallet cards published on posters suitable
9321 for wall hanging) [PA167.IG103.SP102.W109]

9322 **Subpractices**

- 9323 1. Hold meetings or workshops to create the project's shared vision.
9324 [PA167.IG103.SP102.SubP101]
- 9325 2. Articulate the project's shared vision in terms of: purpose or
9326 mission, vision, values, and objectives. [PA167.IG103.SP102.SubP102]
- 9327 3. Reach consensus on the project's shared vision among those
9328 affected by it and participating in its creation. [PA167.IG103.SP102.SubP103]
- 9329 4. Establish a strategy to communicate the project's shared vision
9330 both externally and internally. [PA167.IG103.SP102.SubP104]
- 9331 5. Make presentations suitable for the various audiences that need to
9332 be informed about the project's shared vision. [PA167.IG103.SP102.SubP105]
- 9333 6. Check that project and individual activities and tasks are aligned
9334 with the project's shared vision. [PA167.IG103.SP102.SubP106]

9335 **SG 4 Organize Integrated Teams** [PA167.IG104]

9336 ***The integrated teams needed to execute the project are identified, defined,***
9337 ***structured, and tasked.***

9338 The purpose of this goal and its practices is to create an integrated
9339 team structure that will efficiently meet the project's requirements and
9340 produce a quality product. The integrated team structure partitions
9341 responsibilities, requirements, and resources to teams so that the right
9342 expertise and abilities are available to produce the assigned products.
9343 The integrated teams are organized to facilitate communications
9344 between teams and to honor interfaces between product components.

9345 [PA167.IG104.N101]

9346 Organizing integrated teams to realize Integrated Product and Process
9347 Development (IPPD) requires care and deliberation. As the project
9348 evolves, integrated team structures are reevaluated for continued
9349 applicability. For example, once the product component requirements
9350 are established, it may be appropriate to replace a leader having
9351 expertise in design with one having more expertise in manufacturing or
9352 in verification. [PA167.IG104.N102]

9353 The teams in the structure must be appropriately integrated with each
9354 other. The interface between two integrated teams should be specified
9355 when one team has responsibility for a work product that has an
9356 interface requirement referring to a work product of the other team. An
9357 interface between teams should be specified when one team produces
9358 a work product that will be used by another. An interface should exist
9359 when two teams share responsibility for a general requirement of the
9360 product. Each of these types of interfaces between integrated teams
9361 may require a different type of collaboration as appropriate. [PA167.IG104.N103]

9362 **SP 4.1-1 Determine Integrated Team Structure for the Project**

9363 ***Determine the integrated team structure that will best meet the***
9364 ***project objectives and constraints.*** [PA167.IG104.SP101]

9365 Product requirements, cost, schedule, risk, resource projections,
9366 business practices, the project's defined process, and organizational
9367 guidelines are evaluated to establish the basis for defining integrated
9368 teams and their responsibilities, authorities, and interrelationships.

9369 [PA167.IG104.SP101.N101]

9370 The simplest integrated team structure from an IPPD perspective
9371 evolves when the WBS is a work product-oriented hierarchy, and
9372 resources are available to staff a team with the expertise needed to
9373 adequately address the entire life cycle of the product for each work
9374 product in that hierarchy. More complex structuring occurs when the
9375 WBS is non-product oriented, product risks are not uniform, and
9376 resources are constrained. [PA167.IG104.SP101.N102]

9377 Structuring integrated teams is dependent on: [PA167.IG104.SP101.N103]

- 9378 • Product risk and complexity
- 9379 • Location and types of risks
- 9380 • Integration risks, including product component interfaces and inter-
9381 team communication
- 9382 • Resources, including availability of appropriately skilled people
- 9383 • Limitations on team size for effective collaboration
- 9384 • Need for team membership of stakeholders external to the project
- 9385 • Business practices
- 9386 • Organizational structure

9387 The integrated team structure can include the whole project as an
9388 integrated team. In this case the project team would need to satisfy the
9389 requirements of the Integrated Teaming process area (e.g., it would
9390 need a vision (created in Specific Goal 3 of this process area), a
9391 charter, clearly defined responsibilities, operating principles, and
9392 collaborative interfaces with other teams outside of the project).

9393 [PA167.IG104.SP101.N104]

9394 If a project team has too many members for effective collaboration, the
9395 project team should be divided into sub teams of appropriate size.

9396 [PA167.IG104.SP101.N105]

9397 **Typical Work Products**

- 9398 1. Assessments of the product and product architectures, including
9399 risk and complexity [PA167.IG104.SP101.W101]
- 9400 2. Integrated team structures based on work breakdown structure and
9401 adaptations [PA167.IG104.SP101.W102]
- 9402 3. Alternative concepts for integrated team structures that include
9403 responsibilities, scope, and interfaces. [PA167.IG104.SP101.W103]
- 9404 4. Selected integrated team structure [PA167.IG104.SP101.W104]

9405 **Subpractices**

- 9406 1. Determine the risks in the products and product suite.
9407 [PA167.IG104.SP101.SubP101]

9408 *Refer to the Risk Management process area for more information about*
9409 *practices associated with risk determination.* [PA167.IG104.SP101.SubP101.R101]

- 9410 2. Determine likely resource requirements and availability.
9411 [PA167.IG104.SP101.SubP102]

9412 Constraints on the available assets impact which teams are formed and how the
9413 teams are structured. [PA167.IG104.SP101.SubP102.N101]

9414 *Refer to the Project Planning process area for more information about*
9415 *resource assignments.* [PA167.IG104.SP101.SubP102.R101]

- 9416 3. Establish work product-based responsibilities. [PA167.IG104.SP101.SubP103]

9417 Each team in the team structure should have specified responsibility for tasks and
9418 work products. The team structure should tie to the work breakdown structure
9419 (WBS) used by the project. [PA167.IG104.SP101.SubP103.N101]

9420 *Refer to the Project Planning process area for more information about*
9421 *the Work Breakdown Structure (WBS).* [PA167.IG104.SP101.SubP103.R101]

9422 4. Consider organizational process assets for opportunities,
9423 constraints, and other factors that might influence integrated team
9424 structure. [PA167.IG104.SP101.SubP104]

9425 Organizational process assets can provide guidance to assist the project in
9426 structuring and implementing integrated teams. Such assets may include:

9427 [PA167.IG104.SP101.SubP104.N101]

- 9428 • Team formation and structures
- 9429 • Team authority guidelines
- 9430 • Implementation techniques for IPPD
- 9431 • Guidelines for managing risks in IPPD
- 9432 • Guidelines for establishing lines of communication and authority
- 9433 • Team leader selection criteria
- 9434 • Team responsibility guidelines

9435 5. Develop an understanding of the organization's shared vision, the
9436 project's shared vision, and the organization's standard processes
9437 and process assets applicable to teams and team structures.

9438 [PA167.IG104.SP101.SubP105]

9439 The shared visions for the organization and project are examined. These visions
9440 help the planners focus on attributes critical to the organization and the project.
9441 Organizational processes provide information to streamline the planning process.
9442 These may be particularly useful when establishing reporting mechanisms for
9443 integrated teams and when integrated team structures are constructed in hybrid
9444 situations such as project teams consisting of both functional and product teams.
9445 Additionally, organizational processes about organizing team structures when
9446 influenced by risk and product life cycle may be particularly useful.

9447 [PA167.IG104.SP101.SubP105.N101]

9448 The project's shared vision may evolve when the integrated team structure is
9449 established so that the teams may have some input to the project's shared vision.

9450 [PA167.IG104.SP101.SubP105.N102]

9451 6. Identify alternative integrated team structures. [PA167.IG104.SP101.SubP106]

9452 Alternative integrated team structures are frequently developed for collaborative
9453 evaluation prior to selection of the structure to be employed. Much like any other
9454 set of design alternatives, extreme cases should be included to test the adequacy
9455 of the solution set. Innovative concepts in integrated team structure that promote
9456 integration as well as efficiency can be overlooked if planning is limited to devising
9457 a single team structure. [PA167.IG104.SP101.SubP106.N101]

9458 7. Evaluate alternatives and select an integrated team structure.

9459 [PA167.IG104.SP101.SubP107]

9460 The integrated team structure that meets the objectives, subject to the constraints
9461 of time, money, and people, is collaboratively evaluated and selected from the
9462 alternative integrated team structures. From a team structure maintenance
9463 perspective, this activity would include assessments of the teams already
9464 deployed and candidate alternative structures. [PA167.IG104.SP101.SubP107.N101]

9465 It may be necessary to return to this specific practice if the development in the
9466 next specific practice proves to be infeasible. [PA167.IG104.SP101.SubP107.N102]

9467 *Refer to the Decision Analysis and Resolution process area for more*
9468 *information about structured decision making for selecting the team*
9469 *structure.* [PA167.IG104.SP101.SubP107.R101]

9470 **SP 4.2-1 Develop a Preliminary Distribution of Requirements to Integrated** 9471 **Teams**

9472 ***Develop a preliminary distribution of requirements,***
9473 ***responsibilities, authorities, tasks, and interfaces to teams in the***
9474 ***selected integrated team structure.*** [PA167.IG104.SP102]

9475 This preliminary distribution of requirements to integrated teams is done
9476 before any teams are formed to verify that the selected team structure
9477 is workable and covers all the necessary requirements, responsibilities,
9478 authorities, tasks, and interfaces. If this check is not satisfied it is
9479 necessary to repeat the selection of team structure to meet this check.
9480 This preliminary distribution is a useful compendium of information that
9481 the integrated teams must know to effectively carry out their tasks in an
9482 integrated way. [PA167.IG104.SP102.N101]

9483 **Typical Work Products**

- 9484 1. Preliminary distribution of integrated team authorities and
9485 responsibilities [PA167.IG104.SP102.W101]
- 9486 2. Preliminary distribution of the work product requirements, technical
9487 interfaces, and business (e.g., cost accounting, project
9488 management) interfaces each integrated team will be responsible
9489 for satisfying. [PA167.IG104.SP102.W102]

9490 **Subpractices**

- 9491 1. Assemble requirements and interfaces for integrated teams.
9492 [PA167.IG104.SP102.SubP101]

9493 Assemble for each integrated team the task and work products, along with their
9494 associated requirements and interfaces, for which the team will be responsible.
9495 [PA167.IG104.SP102.SubP101.N101]

- 9496 2. Check that the preliminary distribution of requirements and
9497 interfaces covers all specified product and other requirements.
9498 [PA167.IG104.SP102.SubP102]

9499 In the event that complete coverage of requirements is not achieved, corrective
9500 action should be taken to redistribute requirements or alter the integrated team
9501 structure. [PA167.IG104.SP102.SubP102.N101]

9502 **3. Define responsibilities and authorities for integrated teams.**

9503 [PA167.IG104.SP102.SubP103]

9504 Business, management and other non-technical responsibilities and authorities for
9505 the integrated team are necessary elements to proper team function. Integrated
9506 team responsibilities and authorities are normally developed by the project and
9507 are consistent with established organization practices. Such factors include:

9508 [PA167.IG104.SP102.SubP103.N101]

- 9509 • Authority of teams to pick their own leader
- 9510 • Authority of teams to implement sub teams (e.g., a product team forming an
9511 integration sub-team)
- 9512 • Reporting chains
- 9513 • Reporting requirements (cost, schedule, and performance status)
- 9514 • Progress reporting metrics and methods

9515 **4. Designate the sponsor for each integrated team.**

9516 [PA167.IG104.SP102.SubP104]

9517 An integrated team sponsor is a manager (individual or team) that is responsible
9518 for establishing an integrated team, monitoring its activities and progress, and
9519 taking corrective action when needed. A manager may sponsor one or many
9520 teams. [PA167.IG104.SP102.SubP104.N101]

9521 **SP 4.3-1 Establish Integrated Teams**

9522 ***Establish and maintain teams in the integrated team structure.***

9523 [PA167.IG104.SP103]

9524 The teams within the selected and satisfactory integrated team
9525 structure are established. This process encompasses the choosing of
9526 team leaders and the assignment of planned responsibilities and
9527 requirements for each team. It also involves providing the resources
9528 required to accomplish the tasks assigned to the team. [PA167.IG104.SP103.N101]

9529 The integrated team structure is a dynamic entity that must be able to
9530 adjust to changes in people, requirements and the nature of tasks, and
9531 to tackle many difficulties. The integrated team structure should be
9532 continuously monitored to detect malfunctions, mismanaged interfaces,
9533 and mismatches of the work to the staff. Corrective action should be
9534 taken when performance does not meet expectations. [PA167.IG104.SP103.N102]

9535 **Typical Work Products**

- 9536 1. A list of project integrated teams [PA167.IG104.SP103.W101]

- 9537 2. List of team leaders [PA167.IG104.SP103.W102]
- 9538 3. Responsibilities and authorities for each integrated team
9539 [PA167.IG104.SP103.W103]
- 9540 4. Requirements allocated to each integrated team [PA167.IG104.SP103.W104]
- 9541 5. Performance measures of integrated teams [PA167.IG104.SP103.W105]
- 9542 6. PPQA reports [PA167.IG104.SP103.W106]
- 9543 7. Periodic status reports [PA167.IG104.SP103.W107]
- 9544 8. New integrated team structures [PA167.IG104.SP103.W108]

Subpractices

- 9545 1. Choose integrated team leaders. [PA167.IG104.SP103.SubP101]
- 9546
- 9547 Integrated team leaders are selected who can achieve the expectations of the
9548 product in the context of organizational limitations (project priority and the needs
9549 of other projects). Integrated teams need a great deal of autonomy to faithfully
9550 implement IPPD. That autonomy is at risk if project or organizational leadership
9551 does not have confidence in the leader. The extent of organizational and project
9552 direction in selecting the leader is often a function of product risk and complexity.
9553 It can also be related to an organization's need to "grow" new leaders.
9554 [PA167.IG104.SP103.SubP101.N101]
- 9555 2. Allocate responsibilities and requirements to each integrated team.
9556 [PA167.IG104.SP103.SubP102]
- 9557 The planned responsibilities and requirements are issued to the integrated team.
9558 These items are discussed with the team to encourage collaborative buy-in. Some
9559 adjustments may be made at this time. [PA167.IG104.SP103.SubP102.N101]
- 9560 3. Allocate resources to each integrated team. [PA167.IG104.SP103.SubP103]
- 9561 The people and other resources are allocated to each integrated team. These
9562 items are discussed with the team to assure that the resources are adequate and
9563 that the people are adequate to carry out the tasks and that they are compatible
9564 with other members of the team. [PA167.IG104.SP103.SubP103.N101]
- 9565 4. Create each integrated team. [PA167.IG104.SP103.SubP104]
- 9566 For each integrated team in the selected structure, create a team that has a
9567 shared vision, charter, and operating principles as described in the Integrated
9568 Teaming process area. Creating the integrated team is a collaborative effort of the
9569 team sponsor and the members of the team. Other stakeholders may be involved
9570 in accord with the plan for stakeholder involvement. The teams that interface with
9571 the target team should be involved to assure that the specified interfaces are
9572 honored. [PA167.IG104.SP103.SubP104.N101]

9573 *Refer to the Integrated Teaming process area for more information*
9574 *about forming and sustaining each of the integrated teams in the team*
9575 *structure.* [PA167.IG104.SP103.SubP104.R101]

9576 5. Integrated team composition and structures are periodically
9577 evaluated and modified to best reflect project needs.

9578 [PA167.IG104.SP103.SubP105]

9579 Changes in team structure could include: [PA167.IG104.SP103.SubP105.N101]

9580 • Retiring a team for a period of time (e.g., while long duration manufacturing or
9581 verifications are done)

9582 • Disbanding a team when it is no longer cost-effective in serving the project

9583 • Combining teams to achieve operating efficiencies

9584 • Adding teams as new product components are identified for development.

9585 6. When a change of team leader or a significant change of
9586 membership of the team occurs, review the integrated team
9587 composition and its place in the integrated team structure.

9588 [PA167.IG104.SP103.SubP106]

9589 A change of this kind may significantly affect the ability of the team to accomplish
9590 its objectives. A review of the match between the new composition and the current
9591 responsibilities should be made. If the match is not satisfactory then the team
9592 composition should be changed or the team's responsibility should be modified.
9593 One complication of changed responsibility is that other teams may have to adjust
9594 and add tasks to cover the change. This fact may cause a domino effect in the
9595 team structure. Such a change should be undertaken carefully.

9596 [PA167.IG104.SP103.SubP106.N101]

9597 7. When a change in team responsibility occurs, review the team
9598 composition and its tasking. [PA167.IG104.SP103.SubP107]

9599 These changes often occur as the project moves from one phase to the next. For
9600 example, from completion of detailed design and move into fabrication and
9601 integration of product components is sometimes chosen as a transition point
9602 where less design expertise on teams may be necessary. [PA167.IG104.SP103.SubP107.N101]

9603 8. Manage the overall performance of the teams. [PA167.IG104.SP103.SubP108]

9604 *Refer to the Use the Project's Defined Process specific goal of the*
9605 *Integrated Project Management (IPPD) process area for more*
9606 *information about practices to manage the overall performance of the*
9607 *teams.* [PA167.IG104.SP103.SubP108.R101]

9608 *Refer to Project Monitor and Control process area for more information*
9609 *about monitoring the performance of the teams.* [PA167.IG104.SP103.SubP108.R102]

9610 *Refer to the Measurement and Analysis process area for more*
9611 *information about collecting and analyzing performance of the teams.*

9612 [PA167.IG104.SP103.SubP108.R103]

9613 Generic Practices by Goal

9614 **GG 1 Achieve Specific Goals**

9615 *The process supports and enables achievement of the specific goals of the*
9616 *process area by transforming identifiable input work products to produce*
9617 *identifiable output work products.*

9618 **GP 1.1 Identify Work Scope**

9619 *Identify the scope of the work to be performed and work products*
9620 *to be produced for integrated project management (IPPD), and*
9621 *communicate this information to those performing the work. [GP101]*

9622 **GP 1.2 Perform Base Practices**

9623 *Perform the base practices of the integrated project management*
9624 *(IPPD) process to develop work products and provide services to*
9625 *achieve the specific goals of the process area. [GP102]*

9626 **GG 2 Institutionalize a Managed Process**

9627 *The process is institutionalized as a managed process.*

9628 **GP 2.1 Establish an Organizational Policy**

9629 *Establish and maintain an organizational policy for planning and*
9630 *performing the integrated project management (IPPD) process.*
9631 *[GP103]*

9632 Elaboration:

9633 This policy establishes organizational expectations for using the
9634 project's defined process and coordinating and collaborating with
9635 relevant stakeholders. It also establishes organizational expectations
9636 for using Integrated Product and Process Development concepts for
9637 carrying out the objectives of the organization. [PA167.EL101]

9638 **GP 2.2 Plan the Process**

9639 *Establish and maintain the requirements and objectives, and plans*
9640 *for performing the integrated project management (IPPD) process.*
9641 *[GP104]*

9642 Elaboration:

9643 These requirements, objectives, and plans are described in the plan for
9644 integrated project management. This plan differs from the project plan
9645 and subordinate plans described in the specific practices in this process
9646 area. The project and subordinate plans address the specific needs
9647 and objectives for the project; whereas the plan for integrated project
9648 management addresses the overall planning of this process area and
9649 how the specific practices will be performed. [PA167.EL107]

9650 **GP 2.3 Provide Resources**

9651 ***Provide adequate resources for performing the integrated project***
9652 ***management (IPPD) process, developing the work products and***
9653 ***providing the services of the process.*** [GP105]

9654 Elaboration:

9655 Examples of tools used to perform project management are given in the
9656 Project Planning and Project Monitoring and Control process areas. In
9657 addition, examples of tools used in performing the activities of the
9658 Integrated Project Management (IPPD) process area include the
9659 following: [PA167.EL102]

- 9660 • Problem tracking and trouble reporting packages
- 9661 • Groupware
- 9662 • Video conferencing
- 9663 • Integrated decision database
- 9664 • Integrated product support environments

9666 **GP 2.4 Assign Responsibility**

9667 ***Assign responsibility and authority for performing the process,***
9668 ***developing the work products, and providing the services of the***
9669 ***integrated project management (IPPD) process.*** [GP106]

9670 **GP 2.5 Train People**

9671 ***Train the people performing or supporting the integrated project***
9672 ***management (IPPD) process as needed.*** [GP107]

9673

Elaboration:

9674

Examples of training topics include the following: [PA167.EL103]

9675

- Tailoring the organization's set of standard processes to meet the needs of the project

9676

9677

- Procedures for managing the project based on the project's defined process

9678

9679

- Using the organization's measurement repository

9680

- Using the organization's process assets

9681

- Building the project's shared vision

9682

- Team building

9683

- Integrated management

9684

- Intergroup coordination

9685

- Group problem solving

9686

9687

GP 2.6 Manage Configurations

9688

Place designated work products of the integrated project management (IPPD) process under appropriate levels of configuration management. [GP109]

9689

9690

9691

Elaboration:

9692

Examples of work products placed under configuration management include the following: [PA167.EL104]

9693

9694

- The project's defined process

9695

- Project plans

9696

- Subordinate plans

9697

- Integrated plans

9698

- Actual process and product measures collected from the project

9699

- Integrated team structure

9700

9701

GP 2.7 Identify and Involve Relevant Stakeholders

9702

Identify and involve the relevant stakeholders of the integrated project management (IPPD) process as planned. [GP124]

9703

9704 Elaboration:

9705 This generic practice is different from managing stakeholder
9706 involvement for the project, which is covered by specific practices within
9707 this process area. [PA167.EL108]

9708 Examples of activities for stakeholder involvement include: [PA167.EL110]

- 9709 • Resolving issues about the tailoring of the process assets
- 9710 • Resolving issues among the project plan and the subordinate plans
- 9711 • Reviewing project performance to align with current and projected
9712 needs, objectives, and requirements
- 9713 • Creating the project's shared vision
- 9714 • Defining the integrated team structure for the project

9715

9716 **GP 2.8 Monitor and Control the Process**

9717 ***Monitor and control the integrated project management (IPPD)***
9718 ***process against the plan and take appropriate corrective action.***

9719 [GP110]

9720 Elaboration:

9721 Examples of measures used in monitoring and controlling the activities
9722 of the Integrated Process Management process area include the
9723 following: [PA167.EL105]

- 9724 • Number of changes to the project's defined process
- 9725 • Schedule and effort to tailor the organization's set of standard
9726 processes
- 9727 • Interface coordination issue trends (i.e., number identified and
9728 number closed)
- 9729 • Project's shared vision usage and effectiveness
- 9730 • Integrated team structure usage and effectiveness - Select
9731 indicators of shared vision effectiveness that show there is unity of
9732 purpose within the project, and that the project is working together
9733 and meeting its objectives. Indicators should also show that
9734 behaviors and principles have been established and are being
9735 used while working to achieve the objective and that the shared
9736 vision of the project align with the existing visions of the
9737 organization and other projects, particularly those with which close
9738 interaction is expected.

9739

9740

GP 2.9 Objectively Evaluate Adherence

9741

9742

9743

9744

Objectively evaluate adherence of the integrated project management (IPPD) process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

9745

Elaboration:

9746

Examples of activities reviewed include the following: [PA167.EL106]

9747

- Establishing, maintaining, and using the project's defined process

9748

- Coordinating and collaborating with relevant stakeholders

9749

- Using the project's shared vision

9750

9751

Examples of work products reviewed include the following: [PA167.EL109]

9752

- Project's defined process

9753

- Project plans

9754

- Subordinate plans

9755

- Integrated plans

9756

- Shared vision statements

9757

9758

GP 2.10 Review Status with Higher-Level Management

9759

9760

9761

Review the activities, status, and results of the integrated project management (IPPD) process with higher-level management and resolve issues. [GP112]

9762

GG 3 Institutionalize a Defined Process

9763

The process is institutionalized as a defined process.

9764

GP 3.1 Establish a Defined Process

9765

9766

Establish and maintain the description of a defined integrated project management (IPPD) process. [GP114]

9767 **GP 3.2 Collect Improvement Information**

9768 *Collect work products, measures, measurement results, and*
9769 *improvement information derived from planning and performing*
9770 *the integrated project management (IPPD) process to support the*
9771 *future use and improvement of the organization's processes and*
9772 *process assets. [GP117]*

9773 **GG 4 Institutionalize a Quantitatively Managed Process**

9774 *The process is institutionalized as a quantitatively managed process.*

9775 **GP 4.1 Establish Quality Objectives**

9776 *Establish and maintain quantitative objectives for the integrated*
9777 *project management (IPPD) process about quality and process*
9778 *performance based on customer needs and business objectives.*
9779 *[GP118]*

9780 **GP 4.2 Stabilize Subprocess Performance**

9781 *Stabilize the performance of one or more subprocesses of the*
9782 *integrated project management (IPPD) process to determine its*
9783 *ability to achieve the established quantitative quality and process*
9784 *performance objectives. [GP119]*

9785 **GG 5 Institutionalize an Optimizing Process**

9786 *The process is institutionalized as an optimizing process.*

9787 **GP 5.1 Ensure Continuous Process Improvement**

9788 *Ensure continuous improvement of the integrated project*
9789 *management (IPPD) process in fulfilling the relevant business*
9790 *goals of the organization. [GP125]*

9791 **GP 5.2 Correct Common Cause of Problems**

9792 *Identify and correct the root causes of defects and other problems*
9793 *in the integrated project management (IPPD) process. [GP121]*

9794 RISK MANAGEMENT

9795 Project Management

9796 Purpose

9797 The purpose of Risk Management is to identify potential problems
9798 before they occur, so that risk-handling activities may be planned and
9799 invoked as needed across the life cycle to mitigate adverse impacts on
9800 achieving objectives. [PA148]

9801 Introductory Notes

9802 Risk Management is a continuous, forward-looking process that is an
9803 important part of business and technical management processes. Risk
9804 management needs to address issues that could endanger critical
9805 objectives. A continuous risk management approach is applied to
9806 ensure effective anticipation and mitigation of risks with critical impact
9807 across the project life cycle. [PA148.N101]

9808 Effective risk management includes early and aggressive risk
9809 identification through the collaboration and involvement of relevant
9810 stakeholders, as described in the stakeholder involvement plan
9811 developed in the Project Planning process area. Strong leadership
9812 across all affected parties is needed to establish an environment for the
9813 free and open disclosure and discussion of risk. [PA148.N102]

9814 While technical issues are a primary concern both early on and
9815 throughout all project phases, risk management must consider both
9816 internal and external sources for cost, schedule, and technical risk.
9817 Early and aggressive detection of risk is important because it is typically
9818 easier, less costly, and less disruptive to make changes and correct
9819 work efforts than to modify or revise products or project elements at the
9820 middle or end of the development process. [PA148.N103]

9821 Risk management may be divided into three parts: defining a risk
9822 management strategy; identifying and analyzing risks; and handling
9823 identified risks, including the implementation of risk mitigation plans
9824 when needed. [PA148.N104]

9825 As represented in the Project Planning process area and Project
9826 Monitoring and Control process area, organizations may initially focus
9827 simply on risk identification for awareness, and react to the realization
9828 of these risks as they occur. The Risk Management process area
9829 describes an evolution of these practices to systematically plan,
9830 anticipate, and mitigate risks to proactively minimize their impact to the
9831 project. [PA148.N105]

9832 Although the primary emphasis of the Risk Management process area
9833 is on the project, the concepts may also be applied to manage
9834 organizational risks. Risk mitigation strategies should be guided by a
9835 shared product vision to ensure the product's perspective is maintained.
9836 [PA148.N106]

9837 Related Process Areas

9838 *Refer to the Project Planning Process Area for more information about*
9839 *identification of project risks and planning for involvement of relevant*
9840 *stakeholders. [PA148.R101]*

9841 *Refer to the Project Monitoring and Control process area for more*
9842 *information about monitoring project risks. [PA148.R102]*

9843 *Refer to the Decision Analysis and Resolution process area for more*
9844 *information about using a structured decision-making approach to*
9845 *evaluate alternatives for selection and mitigation of identified risks.*
9846 [PA148.R103]

9847 Specific Goals

9848 **SG 1 Prepare for Risk Management** [PA148.IG101]

9849 ***Preparation for risk management is conducted.***

9850 **SG 2 Identify and Analyze Risks** [PA148.IG102]

9851 ***Risks are identified and analyzed to determine their relative importance.***

9852 **SG 3 Mitigate Risks** [PA148.IG103]

9853 ***Risks are handled and mitigated, where appropriate, to reduce adverse***
9854 ***impacts on achieving objectives.***

9855 Generic Goals

9856 **GG 1** **Achieve Specific Goals** [CL102.GL101]

9857 *The process supports and enables achievement of the specific goals of the*
9858 *process area by transforming identifiable input work products to produce*
9859 *identifiable output work products.*

9860 **GG 2** **Institutionalize a Managed Process** [CL103.GL101]

9861 *The process is institutionalized as a managed process.*

9862 **GG 3** **Institutionalize a Defined Process** [CL104.GL101]

9863 *The process is institutionalized as a defined process.*

9864 **GG 4** **Institutionalize a Quantitatively Managed Process** [CL105.GL101]

9865 *The process is institutionalized as a quantitatively managed process.*

9866 **GG 5** **Institutionalize an Optimizing Process** [CL106.GL101]

9867 *The process is institutionalized as an optimizing process.*

9868 Practice to Goal Relationship Table

- 9869 SG 1 Prepare for Risk Management [PA148.IG101]
- 9870 SP 1.1-1 Determine Risk Sources and Categories
- 9871 SP 1.2-1 Define Risk Parameters
- 9872 SP 1.3-1 Establish a Risk Management Strategy

- 9873 SG 2 Identify and Analyze Risks [PA148.IG102]
- 9874 SP 2.1-1 Identify Risks
- 9875 SP 2.2-1 Evaluate, Classify, and Prioritize Risks

- 9876 SG 3 Mitigate Risks [PA148.IG103]
- 9877 SP 3.1-1 Develop Risk Mitigation Plans
- 9878 SP 3.2-1 Implement Risk Mitigation Plans

- 9879 GG 1 Achieve Specific Goals [CL102.GL101]
- 9880 GP 1.1 Identify Work Scope
- 9881 GP 1.2 Perform Base Practices

- 9882 GG 2 Institutionalize a Managed Process [CL103.GL101]
- 9883 GP 2.1 Establish an Organizational Policy
- 9884 GP 2.2 Plan the Process
- 9885 GP 2.3 Provide Resources
- 9886 GP 2.4 Assign Responsibility
- 9887 GP 2.5 Train People
- 9888 GP 2.6 Manage Configurations
- 9889 GP 2.7 Identify and Involve Relevant Stakeholders
- 9890 GP 2.8 Monitor and Control the Process
- 9891 GP 2.9 Objectively Evaluate Adherence
- 9892 GP 2.10 Review Status with Higher-Level Management

- 9893 GG 3 Institutionalize a Defined Process [CL104.GL101]
- 9894 GP 3.1 Establish a Defined Process
- 9895 GP 3.2 Collect Improvement Information

- 9896 GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]
- 9897 GP 4.1 Establish Quality Objectives
- 9898 GP 4.2 Stabilize Subprocess Performance

- 9899 GG 5 Institutionalize an Optimizing Process [CL106.GL101]
- 9900 GP 5.1 Ensure Continuous Process Improvement
- 9901 GP 5.2 Correct Common Cause of Problems

9902 Specific Practices by Goal

9903 **SG 1 Prepare for Risk Management** [PA148.IG101]

9904 ***Preparation for risk management is conducted.***

9905 The strategy used to identify, analyze, and mitigate risks is established
9906 and maintained. This is typically documented in a project risk
9907 management plan. The risk management strategy addresses the
9908 specific actions, resources, and management approach used to apply
9909 and control the risk management program. This includes planning for
9910 the sources of risk, the scheme used to categorize risks, and the
9911 parameters used to evaluate, bound, and control risks for effective
9912 handling. [PA148.IG101.N101]

9913 **SP 1.1-1 Determine Risk Sources and Categories**

9914 ***Determine risk sources and categories.*** [PA148.IG101.SP101]

9915 Identification of risk sources provides a basis for systematically
9916 examining changing situations over time to uncover circumstances that
9917 impact the ability of the project to meet its objectives. Risk sources are
9918 both internal and external to the project. As the project progresses,
9919 additional sources of risk may be identified. Establishing categories for
9920 risks provides a mechanism for collecting and organizing risks as well
9921 as ensuring appropriate scrutiny and management attention for those
9922 risks that can have more serious consequences on meeting project
9923 objectives. [PA148.IG101.SP101.N101]

9924 **Typical Work Products**

- 9925 1. Risk source lists (external and internal) [PA148.IG101.SP101.W101]
- 9926 2. Risk categories list [PA148.IG101.SP101.W102]

9927 **Subpractices**

- 9928 1. Determine risk sources. [PA148.IG101.SP101.SubP101]

9929 There are many sources of risks, both internal (e.g., the ability to produce a
9930 design, known weaknesses in a process application such as requirements
9931 allocation) and external (e.g., funding stability, natural environment) to the project.
9932 Some typical important risk areas are as follows: [PA148.IG101.SP101.SubP101.N101]

- 9933 • uncertain requirements
- 9934 • design feasibility
- 9935 • test and evaluation adequacy
- 9936 • technology availability
- 9937 • support concept
- 9938 • producibility
- 9939 • overlap of essential activities
- 9940 • developer capability
- 9941 • cost or funding issues

- 9942 • insufficient monitoring
- 9943 • unrealistic schedule estimates or allocation
- 9944 • inadequate personnel resources
- 9945 • safety issues
- 9946 • health issues
- 9947 • security

9948 Often accepted without adequate planning are many external sources of risk,
9949 such as single, limited, and diminishing sources of supply, or the natural
9950 environment. Early identification of internal and external sources of risk can result
9951 in simple mitigation plans that can be implemented early in the project to preclude
9952 occurrence of the risk or reduce the consequences of its occurrence.

9953 [PA148.IG101.SP101.SubP101.N102]

9954 2. Determine risk categories [PA148.IG101.SP101.SubP102]

9955 Risk categories reflect the "bins" for collecting and organizing risks as well as
9956 establishing a common set of levels (or categories) that can be applied in
9957 assessing each risk. Categories include sources of risk (e.g., technology,
9958 environment, manufacturing, and design), and impacts of risk (cost, schedule, and
9959 performance). A risk taxonomy framework can be used to collect and organize
9960 risks according to common risk classes, elements, and attributes.

9961 [PA148.IG101.SP101.SubP102.N101]

9962 SP 1.2-1 Define Risk Parameters

9963 ***Define the parameters used to analyze and classify risks, and the***
9964 ***parameters used to control the risk management effort.***

9965 [PA148.IG101.SP102]

9966 Parameters for evaluating, classifying, and prioritizing risks include
9967 criteria for risk likelihood and consequence levels, thresholds (or control
9968 points) by category, and the bounds that define the extent those
9969 thresholds are applied. Control parameters for the risk management
9970 effort include the level of control for risks, the approval levels for
9971 implementing mitigation and accepting the results of that mitigation, risk
9972 reassessment intervals, and rules used to consolidate risks.

9973 [PA148.IG101.SP102.N101]

9974 Typical Work Products

- 9975 1. Risk evaluation, classification, and prioritization criteria

9976 [PA148.IG101.SP102.W101]

- 9977 2. Risk management requirements (control and approval levels,
9978 reassessment intervals, etc.) [PA148.IG101.SP102.W102]

Subpractices

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1. Define consistent criteria for evaluating and quantifying risk likelihood and severity levels. [PA148.IG101.SP102.SubP101]

Consistently used criteria (e.g., the bands on the likelihood and severity levels) allows the impacts of different risks to be commonly understood, receive the appropriate level of scrutiny, and obtain the management attention warranted. In managing dissimilar risks (for example, personnel safety versus environmental pollution), it is important to ensure consistency in end result (e.g., a high risk of environmental pollution is as important as a high risk to personnel safety).

[PA148.IG101.SP102.SubP101.N101]

2. Define thresholds for each risk category. [PA148.IG101.SP102.SubP102]

For each risk category, thresholds (or control points) can be established to determine acceptability or unacceptability of risks, prioritization of risks, or triggers for management action. For example, project wide thresholds could be established such as when product costs exceed 10% of the target cost. These may be refined later, for each identified risk, to establish points at which more aggressive risk monitoring is employed or to signal the implementation of mitigation plans. [PA148.IG101.SP102.SubP102.N101]

3. Define bounds on the extent to which thresholds are applied against or within a category. [PA148.IG101.SP102.SubP103]

There are few limits to what risks can be assessed in either a quantitative or qualitative fashion. Definition of bounds (or boundary conditions) can be used to help scope the extent of the risk management effort and avoid excessive resource expenditures. Bounds may include exclusion of a risk source from a category, for example, not including asteroids under environment risks. These bounds may also exclude any condition that occurs less than a given frequency, for example, exclude any events that have a likelihood of occurrence of less than 10% over the expected lifetime of the product. [PA148.IG101.SP102.SubP103.N101]

SP 1.3-1 Establish a Risk Management Strategy

Establish and maintain the strategy and methods to be used for risk management. [PA148.IG101.SP103]

A comprehensive risk management strategy addresses items such as the following: [PA148.IG101.SP103.N101]

- The scope used to bound the risk management effort
- Methods and tools to be used for risk identification, risk analysis, risk mitigation, risk monitoring, and communication
- Project-specific sources of risks
- How these risks are to be organized, classified, bounded and consolidated

- 10018 • Global thresholds, parameters and criteria for taking action on
- 10019 identified risks
- 10020 • Risk mitigation techniques to be used, such as prototyping,
- 10021 simulation, alternative designs, or evolutionary development
- 10022 • Responsibilities such as control or approval levels
- 10023 • Definition of risk measures to monitor the status of the risks
- 10024 • Time intervals for risk monitoring or reassessment
- 10025 The risk management strategy should be guided by a common vision of
- 10026 success that describes the desired future project outcomes, in terms of
- 10027 the product that is delivered, its cost, and its fitness for the task.
- 10028 [PA148.IG101.SP103.N102]
- 10029 The risk management strategy is often captured in a project risk
- 10030 management plan. The risk management strategy is reviewed with
- 10031 relevant stakeholders in order to promote commitment and
- 10032 understanding. [PA148.IG101.SP103.N103]
- 10033 **Typical Work Products**
- 10034 1. Project risk management plan [PA148.IG101.SP103.W101]

10035 **SG 2 Identify and Analyze Risks** [PA148.IG102]

10036 ***Risks are identified and analyzed to determine their relative importance.***

10037 The degree of risk impacts the resources assigned to handle an

10038 identified risk and in determining when appropriate management

10039 attention is required. [PA148.IG102.N101]

10040 Analyzing risks entails the identification of risks from the internal and

10041 external sources identified and then evaluating each identified risk to

10042 determine its likelihood and consequences. Classification of the risk,

10043 based on an evaluation against the established risk categories and

10044 criteria developed for the risk management strategy, provides the

10045 information needed for risk handling. Related risks may be grouped for

10046 efficient handling and effective use of risk management resources.

10047 [PA148.IG102.N102]

10048 **SP 2.1-1 Identify Risks**

10049 ***Identify and document the risks.*** [PA148.IG102.SP101]

For Integrated Product and Process Development

The particular risks associated with conducting the project using integrated teams need to be considered. For example, risks associated with loss of inter-team or intra-team coordination. [PA148.IG102.SP101.AMP101]

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The identification of potential issues, hazards, threats, vulnerabilities, etc., that could negatively affect work efforts or plans is the basis for sound and successful risk management. Risks must be identified, and described in an understandable way before they can be analyzed and managed properly. Risks are documented in a concise statement that includes the context, conditions, and consequences of risk occurrence.

[PA148.IG102.SP101.N101]

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Risk identification should be an organized, thorough approach to seek out probable or realistic risks in achieving objectives. To be effective, risk identification should not be an attempt to address every possible event regardless of how highly improbable it may be. Use of the categories and parameters developed in the risk management strategy, along with the identified sources of risk, can provide the discipline and streamlining appropriate to risk identification. The identified risks form a baseline to initiate risk management activities. The list of risks should be reviewed periodically to re-examine possible sources of risk and changing conditions to uncover sources and risks previously overlooked or non-existent when the risk management strategy was last updated.

[PA148.IG102.SP101.N102]

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Risk identification activities focus on the identification of risks, not placement of blame. The results of risk identification activities are not used by management to evaluate the performance of individuals.

[PA148.IG102.SP101.N104]

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There are many methods for identifying risks. Typical identification methods include the following: [PA148.IG102.SP101.N103]

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- Examine each element of the project work breakdown structure to uncover risks.
- Conduct a risk assessment using a risk taxonomy.
- Interview subject matter experts.
- Review risk management efforts from similar products.
- Examine lessons-learned documents or databases.
- Examine design specifications and agreement requirements.

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Typical Work Products

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1. List of identified risks, including the context, conditions, and consequences of risk occurrence [PA148.IG102.SP101.W101]

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Subpractices

1. Identify the risks associated with cost, schedule, and performance in all appropriate product life-cycle phases. [PA148.IG102.SP101.SubP101]

Cost, schedule, and performance risks should be examined during all phases of the product life cycle to the extent they impact project objectives. There may be potential risks discovered that are outside the scope of the project's objectives but vital to customer interests. For example, the risks in development costs, product acquisition costs, cost of spare (or replacement) products, and product disposition (or disposal) costs have design implications during development. The customer may not have provided requirements for the cost of supporting the fielded product. The customer should be informed of such risks but actively managing those risks may not be necessary. The mechanisms for making such decisions should be examined at project and organization levels and put in place if deemed appropriate, especially for risks that impact product validation.

[PA148.IG102.SP101.SubP101.N101]

In addition to the cost risks identified above, development cost risks can include those associated with funding levels, funding estimates, and distributed budget.

[PA148.IG102.SP101.SubP101.N102]

Development schedule risks can include those risks associated with planned activities, key events, and milestones. [PA148.IG102.SP101.SubP101.N103]

Performance risks may include risks associated with the following:

[PA148.IG102.SP101.SubP101.N104]

- Requirements
- Analysis and design
- Application of new technology
- Physical size
- Shape
- Weight
- Manufacturing and fabrication
- Functional performance and operation
- Verification
- Performance maintenance attributes

Performance maintenance attributes are those characteristics that enable an in-use product to provide originally required performance, for example, maintaining safety and security performance. [PA148.IG102.SP101.SubP101.N105]

There are other risks that do not fall "neatly" into cost, schedule, or performance categories. [PA148.IG102.SP101.SubP101.N106]

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Examples of these risks include the following: [PA148.IG102.SP101.SubP101.N107]

- Risks associated with strikes
- Diminishing sources of supply
- Technology cycle time
- Competition

2. Review environmental elements that may impact the project.

[PA148.IG102.SP101.SubP102]

Risks to a project that frequently are missed include those supposedly outside the scope of the project (i.e., the project does not control whether they occur but can mitigate their impact), such as weather, natural disasters, political changes, telecommunications failures, etc. [PA148.IG102.SP101.SubP102.N101]

3. Review all elements of the work breakdown structure as part of the risk identification process in order to help ensure that all aspects of the work effort have been considered. [PA148.IG102.SP101.SubP103]

4. Review all elements of the project plan as part of the risk identification process in order to help ensure that all aspects of the project have been considered. [PA148.IG102.SP101.SubP104]

Refer to the Project Planning process area for more information about identifying project risks. [PA148.IG102.SP101.SubP104.R101]

5. Document the context, conditions, and potential consequences of the risk. [PA148.IG102.SP101.SubP105]

Risks statements are typically captured in a standard format that contains the risk context, conditions, and consequences of occurrence. The risk context provides additional information such that the intent of the risk can be easily understood. In documenting the context of the risk, consider the relative time frame of the risk, the circumstances or conditions surrounding the risk that has brought about the concern, and any doubt or uncertainty. [PA148.IG102.SP101.SubP105.N101]

6. Identify the affected parties associated with each risk.

[PA148.IG102.SP101.SubP106]

SP 2.2-1 Evaluate, Classify, and Prioritize Risks

Evaluate and classify each identified risk using the defined risk categories and parameters, and determine its relative priority.

[PA148.IG102.SP102]

10162 The rating of risks is needed to assign relative importance to each
10163 identified risk, to be used in determining when appropriate management
10164 attention is required. Often it is useful to aggregate risks based on their
10165 inter-relationships, and develop options at an aggregate level. When an
10166 aggregate risk is formed by a roll-up of lower-level risks, care must be
10167 taken to assure that important lower-level risks are not ignored.

[PA148.IG102.SP102.N101]

10169 Risks are quantified using parameters such as likelihood (probability),
10170 and consequence (impact), but may also include additional parameters.
10171 A combination of these rated values is typically used to determine
10172 overall priority for risk handling. [PA148.IG102.SP102.N102]

10173 Collectively, the activities of risk evaluation, classification, and
10174 prioritization are sometimes called risk assessment or risk analysis.

[PA148.IG102.SP102.N103]

10176 **Typical Work Products**

- 10177 1. List of risks, with a rating of parameter values for each risk

10178 [PA148.IG102.SP102.W101]

10179 **Subpractices**

- 10180 1. Evaluate the identified risks using the defined risk parameters.

10181 [PA148.IG102.SP102.SubP101]

10182 Each risk is evaluated and assigned values in accordance with the defined risk
10183 evaluation parameters, which may include likelihood, consequence (severity, or
10184 impact), and timeframe. The assigned risk parameter values can be integrated to
10185 produce additional measures, such as risk exposure, which can be used to
10186 prioritize risks for handling. [PA148.IG102.SP102.SubP101.N101]

10187 Often a scale with three to five values is used to rate both likelihood and
10188 consequence. Likelihood, for example, can be categorized as remote, unlikely,
10189 likely, highly likely, or a near certainty. [PA148.IG102.SP102.SubP101.N102]

10190 Examples for consequences include: [PA148.IG102.SP102.SubP101.N104]

- 10191 • Low
- 10192 • Medium
- 10193 • High
- 10194 • Negligible
- 10195 • Marginal
- 10196 • Significant
- 10197 • Critical
- 10198 • Catastrophic

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10200 Probability values are frequently used to quantify likelihood. Consequences are
 10201 generally related to cost, schedule, environmental impact, or human measures
 10202 (such as labor hours lost and severity of injury). [PA148.IG102.SP102.SubP101.N105]

10203 This evaluation is often a difficult and time-consuming task. Specific expertise or
 10204 group techniques may be needed to assess the risks and gain confidence in the
 10205 ratings. In addition, ratings may require reevaluation as time progresses.
 10206 [PA148.IG102.SP102.SubP101.N103]

10207 **2. Classify and group risks according to the defined risk categories.**
 10208 [PA148.IG102.SP102.SubP102]

10209 Risks are classified into the defined risk categories, providing a means to look at
 10210 risks according to their source, taxonomy, or project component. Related or
 10211 equivalent risks may be grouped for efficient handling. The cause and effect
 10212 relationships between related risks are captured. [PA148.IG102.SP102.SubP102.N101]

10213 **3. Prioritize risks for mitigation.** [PA148.IG102.SP102.SubP103]

10214 A relative priority is determined for each risk, based on the assigned risk
 10215 parameters. Clear criteria should be used to determine the risk priority. The intent
 10216 of prioritization is to determine the most effective areas to apply resources for
 10217 mitigation of risks with the greatest impact to the project. [PA148.IG102.SP102.SubP103.N101]

10218 **SG 3 Mitigate Risks** [PA148.IG103]

10219 ***Risks are handled and mitigated, where appropriate, to reduce adverse***
 10220 ***impacts on achieving objectives.***

10221 The steps in handling risks include developing risk-handling options,
 10222 monitoring risks, and performing risk-handling activities when defined
 10223 thresholds are exceeded. Mitigation plans are developed and
 10224 implemented for selected risks to proactively reduce the potential
 10225 impact of risk occurrence. This may also include contingency plans to
 10226 deal with the impact of selected risks that may occur despite attempts to
 10227 mitigate them. The criteria, thresholds, and parameters used to trigger
 10228 risk-handling activities are defined by the risk management strategy.
 10229 [PA148.IG103.N101]

10230 **SP 3.1-1 Develop Risk Mitigation Plans**

10231 ***Develop a risk mitigation plan for the most important risks to the***
 10232 ***project, as defined by the risk management strategy.*** [PA148.IG103.SP101]

10233 A risk mitigation plan determines the levels and thresholds that define
 10234 when an identified risk becomes unacceptable, and triggers risk-
 10235 handling activity. Mitigation plans are often generated only for selected
 10236 risks of high consequence; other risks may be accepted and simply
 10237 monitored. [PA148.IG103.SP101.N101]

10238 A critical component of a risk mitigation plan is to develop alternative
10239 courses of action, workarounds, and fallback positions, with a
10240 recommended course of action for each critical risk. The risk mitigation
10241 plan for a given risk includes techniques and methods to avoid, reduce,
10242 and control the probability of occurrence of the risk, the extent of
10243 damage incurred should the risk occur (sometimes called a contingency
10244 plan), or both. These mitigation plans are deployed upon exceeding the
10245 established thresholds in order to return the impacted effort to an
10246 acceptable risk level. The risk management strategy defines the criteria,
10247 thresholds and parameters to be used in determining when risk-
10248 handling actions are necessary. [PA148.IG103.SP101.N102]

10249 Options for handling risks typically include alternatives such as the
10250 following: [PA148.IG103.SP101.N103]

- 10251 • Risk avoidance: Changing or lowering requirements while still
10252 meeting the user's needs
- 10253 • Risk control: Taking active steps to minimize risks
- 10254 • Risk transfer: Reallocating design requirements to lower the risks
- 10255 • Risk monitor: Watching and periodically reevaluating the risk for
10256 changes to the assigned risk parameters
- 10257 • Risk acceptance: Acknowledgment of risk but deciding not to take
10258 any action

10259 Often, especially for "high" risks, more than one approach to handling a
10260 risk should be generated. [PA148.IG103.SP101.N104]

10261 In many cases, risks will be accepted or watched, Risk acceptance is
10262 usually done when the risk is judged too low for formal mitigation, or
10263 when there appears to be no viable way to reduce the risk. If a risk is
10264 accepted, the rationale for this decision should be documented. Risks
10265 are watched when there is an objectively defined, verifiable and
10266 documented threshold of performance, time, or risk exposure (the
10267 combination of likelihood and consequence) that will trigger risk
10268 mitigation planning or invoke a contingency plan if it is needed.

10269 [PA148.IG103.SP101.N105]

10270 Adequate consideration should be given early to technology
10271 demonstrations, models, simulations, and prototypes as part of risk
10272 mitigation planning. [PA148.IG103.SP101.N106]

10273 **Typical Work Products**

- 10274 1. Documented handling options for each identified risk
10275 [PA148.IG103.SP101.W101]
- 10276 2. Mitigation plans [PA148.IG103.SP101.W102]
- 10277 3. List of those responsible for tracking and addressing each risk
10278 [PA148.IG103.SP101.W103]

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Subpractices

1. Determine the levels and thresholds that define when a risk becomes unacceptable, and triggers risk-handling activity.

[PA148.IG103.SP101.SubP101]

Risk level (derived using a risk model) is a measure combining the uncertainty of reaching an objective with the consequences of failing to reach the objective.

[PA148.IG103.SP101.SubP101.N101]

Risk levels and thresholds (or control points) that bound planned or acceptable performance need to be clearly understood and defined to provide a means with which risk can be understood. Proper classification of risk is essential for ensuring both appropriate priority based on severity and the associated management response. There may be multiple thresholds (or control points) employed to initiate varying levels of management response.

[PA148.IG103.SP101.SubP101.N102]

2. Identify the person or group responsible for addressing each risk.

[PA148.IG103.SP101.SubP102]

3. Determine the cost-benefit of implementing the mitigation plan for each risk. [PA148.IG103.SP101.SubP103]

Risk mitigation activities should be examined for the benefits they provide versus the resources to be expended. Just like any other design activity, alternative plans may need to be developed and the cost-benefits assessed. The most appropriate plan is then selected for implementation. At times, the risk is significant and the benefits small, but the risk must be mitigated (unacceptable consequences). [PA148.IG103.SP101.SubP103.N101]

4. Develop an overall mitigation plan for the project to orchestrate the implementation plan for each risk. [PA148.IG103.SP101.SubP104]

The complete set of risk mitigation plans may not be affordable. A tradeoff analysis should be performed to prioritize the mitigation plans for implementation.

[PA148.IG103.SP101.SubP104.N101]

5. Develop contingency plans for selected critical risks in the event their impacts are realized. [PA148.IG103.SP101.SubP105]

Risk mitigation plans are developed and implemented as needed to proactively reduce risks before they become problems. Despite best efforts, some risks may be unavoidable and are realized into problems that impact the project. Contingency plans may be developed for critical risks to describe the actions a project may take to deal with the occurrence of this impact. The intent is to define a proactive plan for handling the risk, either to reduce (mitigation) or respond (contingency) to a risk, but in either event as a managed risk.

[PA148.IG103.SP101.SubP105.N101]

10318 Some risk management literature may consider contingency plans a synonym or
10319 subset of mitigation plans. They also may be addressed together termed as risk
10320 handling or risk action plans. [PA148.IG103.SP101.SubP105.N102]

10321 **SP 3.2-1 Implement Risk Mitigation Plans**

10322 ***Monitor the status of each risk periodically and implement the risk***
10323 ***mitigation plan as appropriate.*** [PA148.IG103.SP102]

10324 To effectively control and manage risks through the duration of the work
10325 effort, follow a proactive program to regularly monitor risks and the
10326 status and results of the risk-handling actions. The risk management
10327 strategy defines the intervals at which the risk status should be
10328 revisited. This activity may result in the discovery of new risks or new
10329 risk-handling options that may require re-planning and reassessment.
10330 In either event, the acceptability thresholds associated with the risk
10331 should be compared against the status to determine the need for
10332 implementing a mitigation plan. [PA148.IG103.SP102.N101]

10333 **Typical Work Products**

- 10334 1. Updated lists of risk status [PA148.IG103.SP102.W101]
- 10335 2. Updated assessments of risk likelihood, consequence, ratings, and
10336 thresholds [PA148.IG103.SP102.W102]
- 10337 3. Updated lists of risk-handling options [PA148.IG103.SP102.W103]
- 10338 4. Updated list of actions taken to handle risks [PA148.IG103.SP102.W104]
- 10339 5. Mitigation plans [PA148.IG103.SP102.W105]

10340 **Subpractices**

- 10341 1. Monitor risk status. [PA148.IG103.SP102.SubP101]

10342 After a risk mitigation plan is initiated, the risk is still monitored.

10343 [PA148.IG103.SP102.SubP101.N101]

10344 A periodic mechanism for monitoring should be employed. [PA148.IG103.SP102.SubP101.N102]

- 10345 2. Provide a method for tracking open risk-handling action items to
10346 closure. [PA148.IG103.SP102.SubP102]

10347 *Refer to the Project Monitoring and Control process area for more*
10348 *information about tracking action items.* [PA148.IG103.SP102.SubP102.R101]

- 10349 3. Invoke selected risk-handling options when monitored risks exceed
10350 the defined thresholds. [PA148.IG103.SP102.SubP103]

- 10351 Quite often, risk-handling is only performed for those risks judged to be "high" and
10352 "medium." The risk-handling strategy for a given risk may include techniques and
10353 methods to avoid, reduce and control the likelihood of the risk or the extent of
10354 damage incurred should the risk (anticipated event or situation) occur or both. In
10355 this context, risk handling includes both risk mitigation plans and contingency
10356 plans. [PA148.IG103.SP102.SubP103.N101]
- 10357 Risk handling techniques are developed to avoid, reduce, and control adverse
10358 impact to project objectives and to bring about acceptable outcomes in light of
10359 probable impacts. Actions generated to handle a risk require proper resource
10360 loading and scheduling within plans and baseline schedules. This re-planning
10361 effort needs to closely consider the effects on adjacent or dependent work
10362 initiatives or activities. [PA148.IG103.SP102.SubP103.N102]
- 10363 *Refer to the Project Monitoring and Control process area for more*
10364 *information about revising the project plan.* [PA148.IG103.SP102.SubP103.N102.R101]
- 10365 4. Establish a schedule or period of performance for each risk-
10366 handling plan or activity that includes the start date and anticipated
10367 completion date. [PA148.IG103.SP102.SubP104]
- 10368 5. Provide continued commitment of resources for each plan to allow
10369 successful execution of the risk-handling strategy.
10370 [PA148.IG103.SP102.SubP105]
- 10371 6. Collect performance metrics on the risk handling activities.
10372 [PA148.IG103.SP102.SubP106]

10373 Generic Practices by Goal

10374 **GG 1 Achieve Specific Goals**

10375 ***The process supports and enables achievement of the specific goals of the***
10376 ***process area by transforming identifiable input work products to produce***
10377 ***identifiable output work products.***

10378 **GP 1.1 Identify Work Scope**

10379 ***Identify the scope of the work to be performed and work products***
10380 ***to be produced for risk management, and communicate this***
10381 ***information to those performing the work.*** [GP101]

10382 **GP 1.2 Perform Base Practices**

10383 ***Perform the base practices of the risk management process to***
10384 ***develop work products and provide services to achieve the***
10385 ***specific goals of the process area.*** [GP102]

10386 **GG 2 Institutionalize a Managed Process**

10387 ***The process is institutionalized as a managed process.***

10388 **GP 2.1 Establish an Organizational Policy**

10389 ***Establish and maintain an organizational policy for planning and***
10390 ***performing the risk management process.* [GP103]**

10391 Elaboration:

10392 This policy establishes organizational expectations for defining a risk
10393 management strategy and identifying, analyzing, and mitigating risks.

10394 [PA148.EL101]

10395 **GP 2.2 Plan the Process**

10396 ***Establish and maintain the requirements and objectives, and plans***
10397 ***for performing the risk management process.* [GP104]**

10398 Elaboration:

10399 These requirements, objectives, and plans are described in the plan for
10400 risk management. This plan for risk management differs from the risk
10401 management strategy described in the specific practice in this process
10402 area. The risk management strategy addresses risk sources,
10403 categories, parameters, and management control and reporting
10404 requirements; whereas the plan for risk management addresses high
10405 level planning for all the risk management activities. [PA148.EL103]

10406 **GP 2.3 Provide Resources**

10407 ***Provide adequate resources for performing the risk management***
10408 ***process, developing the work products and providing the services***
10409 ***of the process.* [GP105]**

10410 Elaboration:

10411 Examples of tools used in performing the activities of the Risk
10412 Management process area include the following: [PA148.EL106]

- 10413 • Risk management databases
- 10414 • Risk mitigation tools
- 10415 • Prototyping tools
- 10416 • Modeling and simulation

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GP 2.4 Assign Responsibility

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

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GP 2.5 Train People

Train the people performing or supporting the risk management process as needed. [GP107]

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Elaboration:

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Examples of training topics include the following: [PA148.EL108]

- Risk management concepts and practices (e.g., risk identification, evaluation, monitoring, mitigation)
- Metric selection for risk mitigation

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GP 2.6 Manage Configurations

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

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Elaboration:

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Examples of work products placed under configuration management include the following: [PA148.EL110]

- Risk management strategy
- Identified risk items
- Risk mitigation plans

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GP 2.7 Identify and Involve Relevant Stakeholders

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Identify and involve the relevant stakeholders of the risk management process as planned. [GP124]

10444 Elaboration:

10445 Examples of activities for stakeholder involvement include: [PA148.EL120]

- 10446 • Establishing a collaborative environment for free and open
- 10447 discussion of risk
- 10448 • Reviewing the risk strategy and risk management plan
- 10449 • Participating in risk identification, analysis, and mitigation activities
- 10450 • Communicating and reporting risk management status
- 10451

10452 **GP 2.8 Monitor and Control the Process**

10453 ***Monitor and control the risk management process against the plan***
10454 ***and take appropriate corrective action.*** [GP110]

10455 Elaboration:

10456 Examples of measures used in monitoring and controlling the activities
10457 of the Risk Management process area include the following: [PA148.EL113]

- 10458 • Number of risks identified, managed, tracked, and controlled
- 10459 • Risk exposure and changes to the risk exposure for each assessed
- 10460 risk, and as a summary percentage of management reserve
- 10461 • Change activity for the risk management plan (e.g., processes,
- 10462 schedule, funding)
- 10463 • Occurrence of unanticipated risks
- 10464 • Risk categorization volatility
- 10465 • Comparison of estimated vs. actual risk mitigation effort and impact
- 10466

10467 **GP 2.9 Objectively Evaluate Adherence**

10468 ***Objectively evaluate adherence of the risk management process***
10469 ***and the work products and services of the process to the***
10470 ***applicable requirements, objectives, and standards, and address***
10471 ***noncompliance.*** [GP113]

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Elaboration:

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Examples of activities reviewed include the following: [PA148.EL116]

10474

- Establishing and maintaining a risk management strategy

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- Identifying and analyzing risks

10476

- Mitigating risks

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Examples of work products reviewed include the following: [PA148.EL117]

10479

- Risk management strategy

10480

- Risk mitigation plans

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GP 2.10 Review Status with Higher-Level Management

10483

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

10484

10485

Elaboration:

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Reviews of the project risk status are held on a periodic and event-driven basis with appropriate levels of management, to provide visibility into the potential for project risk exposure and appropriate corrective action. [PA148.EL118]

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Typically, this will include a summary of the most critical risks, key risk parameters (such as likelihood and consequence of these risks), and the status of risk mitigation efforts. [PA148.EL119]

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GG 3 Institutionalize a Defined Process

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The process is institutionalized as a defined process.

10495

GP 3.1 Establish a Defined Process

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Establish and maintain the description of a defined risk management process. [GP114]

10497

10498 **GP 3.2 Collect Improvement Information**

10499 *Collect work products, measures, measurement results, and*
10500 *improvement information derived from planning and performing*
10501 *the risk management process to support the future use and*
10502 *improvement of the organization's processes and process assets.*
10503 [GP117]

10504 **GG 4 Institutionalize a Quantitatively Managed Process**

10505 *The process is institutionalized as a quantitatively managed process.*

10506 **GP 4.1 Establish Quality Objectives**

10507 *Establish and maintain quantitative objectives for the risk*
10508 *management process about quality and process performance*
10509 *based on customer needs and business objectives.* [GP118]

10510 **GP 4.2 Stabilize Subprocess Performance**

10511 *Stabilize the performance of one or more subprocesses of the risk*
10512 *management process to determine its ability to achieve the*
10513 *established quantitative quality and process performance*
10514 *objectives.* [GP119]

10515 **GG 5 Institutionalize an Optimizing Process**

10516 *The process is institutionalized as an optimizing process.*

10517 **GP 5.1 Ensure Continuous Process Improvement**

10518 *Ensure continuous improvement of the risk management process*
10519 *in fulfilling the relevant business goals of the organization.* [GP125]

10520 **GP 5.2 Correct Common Cause of Problems**

10521 *Identify and correct the root causes of defects and other problems*
10522 *in the risk management process.* [GP121]

10523 INTEGRATED TEAMING

10524 Project Management

10525 Purpose

10526 The purpose of Integrated Teaming is to form and sustain an integrated
10527 team for the development of work products. [PA170]

10528 Introductory Notes

10529 Integrated team members: [PA170.N101]

- 10530 • provide the needed skills and expertise to accomplish the team's
10531 tasks
- 10532 • provide the advocacy and representation necessary to address all
10533 essential phases of the product life cycle
- 10534 • collaborate internally among themselves and externally with other
10535 teams and stakeholders as appropriate
- 10536 • share a common understanding of the team's tasks and objectives.

10537 An integrated team (also known as an Integrated Product Team or IPT)
10538 is composed of stakeholders who generate and implement decisions for
10539 the work product being developed. The members of the integrated team
10540 are collectively responsible for delivering the work product. The
10541 integrated team receives its assignment from its sponsor. The sponsor
10542 of an integrated team is a person or a group (e.g., project manager or
10543 even another integrated team) who can assign work tasks and provide
10544 resources. [PA170.N102]

10545 The following characteristics distinguish an integrated team in an IPPD
10546 environment from other forms of specialty work or task groups:

10547 [PA170.N103]

- 10548 • Team members include empowered representatives from both
10549 technical and business functional organizations involved with the
10550 product. Within defined boundaries, these representatives have
10551 decision-making authority and the responsibility to act for their
10552 respective organizations during product development.
- 10553 • Team members may include customers, suppliers, and other
10554 stakeholders outside of the organization as appropriate to the
10555 product being developed.
- 10556 • An integrated team consists of people skilled in the functions that
10557 need to be performed to develop required work products. Some of
10558 them may be representing a functional organization. These people

- 10559 have a dual responsibility to focus on the product, while
10560 maintaining their connections with the functional organization that
10561 can assist the development with additional expertise and advice.
- 10562 • An integrated team is focused on the product life cycle to the extent
10563 required by the project. Team members share and integrate
10564 considerations, expectations, and requirements of the product life-
10565 cycle phases.
 - 10566 • An integrated team understands its role in the structure of teams
10567 for the overall project.
- 10568 Clearly defined and commonly understood objectives, tasks,
10569 responsibilities, authority, and context (of vertical and horizontal
10570 interfaces) provide a strong basis for implementing integrated teams.
10571 [PA170.N104]

10572 Related Process Areas

10573 *Refer to the Project Planning process area for more information about*
10574 *planning for project execution within an IPPD environment where*
10575 *integrated teaming is involved. [PA170.R101]*

10576 *Refer to the Organization Environment for Integration process area for*
10577 *more information about establishing and maintaining an integrated work*
10578 *environment and creating organizational process assets for IPPD,*
10579 *including an organizational shared vision. [PA170.R102]*

10580 *Refer to the Integrated Project Management (IPPD) process area for*
10581 *more information about coordinating and collaborating with*
10582 *stakeholders, establishing the team structure, and considering IPPD*
10583 *organizational process assets. [PA170.R103]*

10584 Specific Goals

10585 **SG 1 Establish Team Composition** [PA170.IG101]

10586 ***Team composition that provides the knowledge and skills required to deliver***
10587 ***the team's product is established and maintained.***

10588 **SG 2 Govern Team Operation** [PA170.IG102]

10589 ***Operation of the integrated team is governed according to established***
10590 ***principles.***

10591 Generic Goals

10592 **GG 1** **Achieve Specific Goals** [CL102.GL101]

10593 *The process supports and enables achievement of the specific goals of the*
10594 *process area by transforming identifiable input work products to produce*
10595 *identifiable output work products.*

10596 **GG 2** **Institutionalize a Managed Process** [CL103.GL101]

10597 *The process is institutionalized as a managed process.*

10598 **GG 3** **Institutionalize a Defined Process** [CL104.GL101]

10599 *The process is institutionalized as a defined process.*

10600 **GG 4** **Institutionalize a Quantitatively Managed Process** [CL105.GL101]

10601 *The process is institutionalized as a quantitatively managed process.*

10602 **GG 5** **Institutionalize an Optimizing Process** [CL106.GL101]

10603 *The process is institutionalized as an optimizing process.*

10604 Practice to Goal Relationship Table

- 10605 SG 1 Establish Team Composition [PA170.IG101]
- 10606 SP 1.1-1 Identify Team Tasks
- 10607 SP 1.2-1 Identify Needed Knowledge and Skills
- 10608 SP 1.3-1 Assign Appropriate Team Members

- 10609 SG 2 Govern Team Operation [PA170.IG102]
- 10610 SP 2.1-1 Establish a Shared Vision
- 10611 SP 2.2-1 Establish a Team Charter
- 10612 SP 2.3-1 Define Roles and Responsibilities
- 10613 SP 2.4-1 Establish Operating Procedures
- 10614 SP 2.5-1 Collaborate among Interfacing Teams

- 10615 GG 1 Achieve Specific Goals [CL102.GL101]
- 10616 GP 1.1 Identify Work Scope
- 10617 GP 1.2 Perform Base Practices

- 10618 GG 2 Institutionalize a Managed Process [CL103.GL101]
- 10619 GP 2.1 Establish an Organizational Policy
- 10620 GP 2.2 Plan the Process
- 10621 GP 2.3 Provide Resources
- 10622 GP 2.4 Assign Responsibility
- 10623 GP 2.5 Train People
- 10624 GP 2.6 Manage Configurations
- 10625 GP 2.7 Identify and Involve Relevant Stakeholders
- 10626 GP 2.8 Monitor and Control the Process
- 10627 GP 2.9 Objectively Evaluate Adherence
- 10628 GP 2.10 Review Status with Higher-Level Management

- 10629 GG 3 Institutionalize a Defined Process [CL104.GL101]
- 10630 GP 3.1 Establish a Defined Process
- 10631 GP 3.2 Collect Improvement Information

- 10632 GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]
- 10633 GP 4.1 Establish Quality Objectives
- 10634 GP 4.2 Stabilize Subprocess Performance

- 10635 GG 5 Institutionalize an Optimizing Process [CL106.GL101]
- 10636 GP 5.1 Ensure Continuous Process Improvement
- 10637 GP 5.2 Correct Common Cause of Problems

10638 Specific Practices by Goal

10639 **SG 1 Establish Team Composition** [PA170.IG101]

10640 ***Team composition that provides the knowledge and skills required to deliver***
 10641 ***the team's product is established and maintained.***

10642 Because one of the main attributes of an integrated team is to be self-
10643 managed and empowered, team membership is intended to be
10644 composed of people who can plan, execute, and implement life-cycle
10645 decisions for the work product being acquired and developed. Team
10646 member selection and skill mix should be based on its product-focused
10647 and life cycle objectives and, therefore, should be cross functional and
10648 involve relevant stakeholders. [PA170.IG101.N101]

10649 **SP 1.1-1 Identify Team Tasks**

10650 ***Identify and define the team's specific internal tasks to generate***
10651 ***the team's expected output.*** [PA170.IG101.SP101]

10652 The sponsor of an integrated team typically provides the assigned
10653 product requirements, the initial technical and business interfaces, and
10654 the high-level task(s) each team will be responsible for satisfying.
10655 Integrated team tasks are based on these product requirements and
10656 interfaces. An integrated team understands its relationship to both the
10657 project and the organization, and structures its tasks accordingly to
10658 develop the work products. [PA170.IG101.SP101.N101]

10659 *Refer to the Establish Project Tasks and Responsibilities specific*
10660 *practice in the Project Planning process area to see how this is done at*
10661 *the project level.* [PA170.IG101.SP101.N101.R101]

10662 **Typical Work Products**

- 10663 1. Descriptions of internal work tasks [PA170.IG101.SP101.W101]
10664 2. List of results the team is expected to achieve for all work tasks
10665 [PA170.IG101.SP101.W102]

10666 **Subpractices**

- 10667 1. Define team tasks required to deliver the assigned work products.
10668 [PA170.IG101.SP101.SubP101]
10669 2. Decide which tasks need team or individual member input.
10670 [PA170.IG101.SP101.SubP102]

10671 Not all work efforts require efforts of the entire team, but review and judgment is a
10672 team responsibility. [PA170.IG101.SP101.SubP102.N101]

10673 **SP 1.2-1 Identify Needed Knowledge and Skills**

10674 ***Identify the knowledge, skills, and functional expertise needed to***
10675 ***perform team tasks.*** [PA170.IG101.SP102]

10676 *Refer to the Plan for Needed Knowledge and Skills specific practice in*
10677 *the Project Planning process area. Staffing a team is similar to staffing*
10678 *a project, just at a lower level with respect to a work breakdown*
10679 *hierarchy.* [PA170.IG101.SP102.R101]

10680 The functional knowledge and related job skills within the integrated
10681 team are directly related to the specific team tasks and responsibilities.
10682 A fully effective integrated team is able to perform to all its tasks and is
10683 comprised of all the necessary technical and business specialties,
10684 expertise, and advocates to ensure appropriate coverage for all phases
10685 of the work product life cycle. A profile of essential skill mixes that are
10686 required at all team functions describes the core team, which can be
10687 supplemented with additional skill sets as needed for the extended
10688 team. [PA170.IG101.SP102.N101]

10689 **Typical Work Products**

- 10690 1. List of disciplines or functions required to perform the tasks
10691 [PA170.IG101.SP102.W101]
- 10692 2. List of the knowledge, key skills, and critical expertise
10693 [PA170.IG101.SP102.W102]
- 10694 3. Initial profiles of team skills and knowledge for the core team and
10695 the extended team [PA170.IG101.SP102.W103]

10696 **Subpractices**

- 10697 1. Identify the business functions or processes that the integrated
10698 team must maintain competence in to perform to its objectives.
10699 [PA170.IG101.SP102.SubP101]
- 10700 2. Identify the core competencies on which to base the integrated
10701 team's activities in order to sustain or achieve desired capability.
10702 [PA170.IG101.SP102.SubP102]
- 10703 3. Establish knowledge and skills profiles underlying each core and
10704 extended team competency. [PA170.IG101.SP102.SubP103]
- 10705 4. Define staffing and competency requirements. [PA170.IG101.SP102.SubP104]

10706 **SP 1.3-1 Assign Appropriate Team Members**

10707 ***Assign the appropriate personnel to be team members based on***
10708 ***required knowledge and skills.*** [PA170.IG101.SP103]

10709 Team members are selected and positioned to perform team tasks
10710 based on their ability to satisfy required knowledge, skills, and
10711 functional expertise, and compliment those of other team members.
10712 Team membership may not stay the same throughout the integrated
10713 team's period of performance. Selecting and assigning appropriate new
10714 members to the team, to perform team tasks, is an important element in
10715 maintaining proper team composition and output as members leave,
10716 team expectations change, or the team has evolved to the point where
10717 a different mix of personnel is necessary. [PA170.IG101.SP103.N101]

10718 Examples of relevant criteria for evaluating potential team members
10719 include: [PA170.IG101.SP103.N102]

- 10720 • Knowledge and skills related to tasks and responsibilities
10721 associated with the team's assigned work products
- 10722 • Interpersonal skills and ability to work in a team environment
- 10723 • Ability to complement the mix of knowledge and skills in the team
- 10724 • Potential to fulfill a significant responsibility on the team
- 10725 • Ability to acquire additional knowledge, skills, or expertise related
10726 to the team's tasks
- 10727 • Existing work load and time available to fulfill responsibilities to the
10728 team
- 10729 • Educational and cultural background
- 10730 • Personal (self) motivation
- 10731 • Ability to represent a functional area appropriately

10732 Individual team members are empowered, within defined limits, by their
10733 respective functional leadership/managers to make decisions. Team
10734 members can be selected from both within or outside of the
10735 organization and can include suppliers, customers and end users.
10736 Their roles and responsibilities in the team operation and product
10737 development process need to be clearly defined. [PA170.IG101.SP103.N103]

10738 **Typical Work Products**

- 10739 1. Set of selection criteria [PA170.IG101.SP103.W101]
- 10740 2. Revised skills matrix and knowledge profiles [PA170.IG101.SP103.W102]
- 10741 3. List of team members [PA170.IG101.SP103.W103]
- 10742 4. List of the level of effort and resources, including access to staff, to
10743 perform each team function [PA170.IG101.SP103.W104]

10744 **Subpractices**

- 10745 1. Establish relevant criteria for evaluating team members against
10746 established knowledge and skills profiles. [PA170.IG101.SP103.SubP101]

- 10747 2. Utilize the criteria to qualify appropriate candidates against the
10748 knowledge and skills profiles. [PA170.IG101.SP103.SubP102]
- 10749 3. Identify and orient team members to best contribute to the team's
10750 capability. [PA170.IG101.SP103.SubP103]
- 10751 4. Assess and determine the integrated team's capability to meet its
10752 objectives based on initial staffing and positioning.
10753 [PA170.IG101.SP103.SubP104]
- 10754 It may be required to supplement the team's internal capability with external
10755 sources to maximize the team's ability. [PA170.IG101.SP103.SubP104.N101]

10756 **SG 2 Govern Team Operation** [PA170.IG102]

10757 ***Operation of the integrated team is governed according to established***
10758 ***principles.***

10759 An integrated team operates in a disciplined way that brings about
10760 effectiveness and productivity in meeting its objectives. Established
10761 principles and operating practices help both the team leader and team
10762 members to manage group dynamics and to ensure successful
10763 interplay among the multiple functions within the team. [PA170.IG102.N101]

10764 **SP 2.1-1 Establish a Shared Vision**

10765 ***Establish and maintain a shared vision for the integrated team that***
10766 ***is aligned with any overarching or higher-level vision.***

10767 [PA170.IG102.SP101]

10768 *Refer to the Provide IPPD Infrastructure specific goal in the*
10769 *Organizational Environment for Integration process area for more*
10770 *information on the organization's shared vision.* [PA170.IG102.SP101.R101]

10771 *Refer to the Use the Project's Shared Vision specific goal in the*
10772 *Integrated Project Management (IPPD) process area for more*
10773 *information about the project's shared vision.* [PA170.IG102.SP101.R102]

10774 The purpose of a shared vision is to provide a statement of an
10775 envisioned future and establish common understanding of the
10776 aspirations and governing ideals of the team in the context of that
10777 desired end state. The shared vision anchors the team's governing
10778 ideas and principles and captures the objectives to be achieved. The
10779 shared vision guides the activities of the team and helps drive the team
10780 to achieve their mission and objectives. A shared vision facilitates
10781 working together and helps to attain unity of purpose among team
10782 members. [PA170.IG102.SP101.N101]

10783 No team operates in isolation and a shared vision for the integrated
 10784 team is critical to ensure the team's charter, direction, and activities
 10785 achieve a fit with any larger project objectives or other interfacing
 10786 teams. A team's sponsor(s) or leader may establish the vision for the
 10787 organization or a project for which the integrated team is a part. An
 10788 integrated team's shared vision, if developed on their own, must be
 10789 aligned with and support achievement of the project's and
 10790 organization's higher-level objectives as well as its own. When one
 10791 team falls short of or strays from of its objectives and vision, it is likely to
 10792 cause significant impact to the overall success of the project.

10793 [PA170.IG102.SP101.N102]

10794 Shared vision context has both an external and internal aspect. The
 10795 external aspect has to do with the overlying plan, objectives, and
 10796 interfaces of the team's sponsor and overall organization, while the
 10797 internal aspect is about aligning the group member's personal interests
 10798 and vision with the team's mission and purpose. The shared vision must
 10799 ensure a commitment of the integrated team members to both their
 10800 team and to other interfacing teams and project responsibilities.

10801 [PA170.IG102.SP101.N103]

10802 Aligning personal perceptions of the people within the team is an
 10803 important part of understanding and accepting the shared vision. As
 10804 such, a shared vision is usually not the product of one person's effort,
 10805 however, the team's sponsor(s) or leader may begin the discussion of
 10806 the vision for a team. It is important that all integrated team members
 10807 understand and commit to a shared vision. The team population should
 10808 openly discuss and be given the opportunity to provide feedback on the
 10809 vision and address inconsistencies and make revisions as appropriate.
 10810 This openness creates a vision that belongs to everyone (shared),
 10811 provides an end-state view of the implementation of the team's
 10812 responsibilities, is the basis for the team's charter, and is applied to all
 10813 work. Benefits of a shared vision are that people understand and can
 10814 adopt its principles to guide their own, as well as the whole team's,
 10815 actions and decisions. [PA170.IG102.SP101.N104]

10816 **Typical Work Products**

- 10817 1. Documented stakeholder exceptions and conclusions
- 10818 [PA170.IG102.SP101.W101]
- 10819 2. Boundary conditions and interfaces within which the team must
- 10820 operate. [PA170.IG102.SP101.W102]
- 10821 3. Documented vision statement [PA170.IG102.SP101.W103]
- 10822 4. Presentation material of the vision statement suitable for team
- 10823 members and various audiences that need to be informed

10824 [PA170.IG102.SP101.W104]

10859 It is important that integrated teams exercise a level of authority in
10860 managing their activities and in making decisions in pursuit of their
10861 objectives. Team members need to assess whether the amount of
10862 power and control over decision and actions has been properly
10863 delegated from upper management. The team decides whether the
10864 decision-making authority is appropriate to meet expectations and the
10865 tasks accepted by the team. The team negotiates any disagreements
10866 with the organizations or entities that assigned them. [PA170.IG102.SP102.N102]

10867 **Typical Work Products**

- 10868 1. Team charter [PA170.IG102.SP102.W101]
- 10869 2. Procedures for setting the expectations for the work to be done and
10870 for measuring the performance [PA170.IG102.SP102.W102]
- 10871 3. List of critical success factors [PA170.IG102.SP102.W103]
- 10872 4. List of specific strategies the team expects to employ
10873 [PA170.IG102.SP102.W104]

10874 **Subpractices**

- 10875 1. Define and list the team objectives. [PA170.IG102.SP102.SubP101]
- 10876 2. Identify specific strategies for achieving the team objectives.
10877 [PA170.IG102.SP102.SubP102]
- 10878 3. Establish the team's level of empowerment and independence.
10879 [PA170.IG102.SP102.SubP103]

10880 Empowerment is not likely to be unlimited. Every team must operate within some
10881 constraints, and these limits on authority must be identified and defined up front.
10882 [PA170.IG102.SP102.SubP103.N101]

10883 *Refer to the Manage People for Integration specific goal in the*
10884 *Organizational Environment for Integration process area for more*
10885 *information on the organization's guidelines for the degree of*
10886 *empowerment for people and integrated teams.*

10887 [PA170.IG102.SP102.SubP103.N101.R101]

- 10888 4. Identify how team and individual performance and accomplishment
10889 are measured. [PA170.IG102.SP102.SubP104]

10890 *Refer to the Organizational Environment for Integration process area for*
10891 *more information about recognizing team as well as individual*
10892 *accomplishments.* [PA170.IG102.SP102.SubP104.R101]

- 10893 5. Identify critical success factors. [PA170.IG102.SP102.SubP105]

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SP 2.3-1 Define Roles and Responsibilities

Clearly define and maintain each team member's roles and responsibilities. [PA170.IG102.SP103]

Defined roles and responsibilities provide clear understanding of the team members' contribution, level of involvement, interfaces (to team members and other teams or groups), and the degree of influence or control each member has on the success and functioning of the team. Allocation of roles and responsibilities should be based on each member's abilities, skills, and other commitments. Roles and responsibilities include the following: [PA170.IG102.SP103.N101]

- Interfaces among integrated team members
- How assignments are accepted
- How resources and input are accessed
- How work gets done
- Who checks and reviews work
- How work is approved
- How work is delivered and communicated
- Maintaining interfaces with their functional area

Typical Work Products

1. Descriptions of roles and responsibilities [PA170.IG102.SP103.W101]
2. Assignment statements [PA170.IG102.SP103.W102]
3. Responsibility matrix [PA170.IG102.SP103.W103]

Subpractices

1. Map the roles, responsibilities, and expertise of the team members to the team tasks and expected deliverables. [PA170.IG102.SP103.SubP101]

Ensure that assignments are made to integrate complementary knowledge and skills. [PA170.IG102.SP103.SubP101.N101]

2. Define the working relationship and reporting structure for team members. [PA170.IG102.SP103.SubP102]

Team members may have the responsibility to report to both the team leader and a functional organization and management chain. [PA170.IG102.SP103.SubP102.N101]

SP 2.4-1 Establish Operating Procedures

Establish and maintain integrated team operating procedures.

[PA170.IG102.SP104]

10928 Operating practices and ground rules serve to define and control how
10929 the team will interact and work together and promote effective
10930 integration of efforts, high performance, and productivity for
10931 accomplishing objectives. Members especially need to understand the
10932 intended standards for work and to participate according to those
10933 precepts. [PA170.IG102.SP104.N101]

10934 **Typical Work Products**

- 10935 1. Operating practices and ground rules [PA170.IG102.SP104.W101]
10936 2. Procedures for work expectations and performance measures
10937 [PA170.IG102.SP104.W102]

10938 **Subpractices**

- 10939 1. Define the expectations and rules that will guide how the team
10940 works together and what the team members will use to moderate
10941 participation and interpersonal interaction. [PA170.IG102.SP104.SubP101]
10942 2. Define the degree of collective decision-making and level of
10943 consensus needed for team decisions. [PA170.IG102.SP104.SubP102]

10944 *Refer to the Organizational Environment for Integration process area for*
10945 *more information about establishing a process for setting the context for*
10946 *decision-making.* [PA170.IG102.SP104.SubP102.R101]

- 10947 3. Define how conflicts and differences in opinion within the team are
10948 addressed and resolved. [PA170.IG102.SP104.SubP103]

10949 *Refer to the Organizational Environment for Integration process area for*
10950 *more information about establishing a process for resolving conflicts*
10951 *and differences in opinion.* [PA170.IG102.SP104.SubP103.R101]

10952 **SP 2.5-1 Collaborate among Interfacing Teams**

10953 ***Establish and maintain collaboration among interfacing teams.***

10954 [PA170.IG102.SP105]

10955 The success of a team-based project will be a function of how
10956 effectively and successfully the integrated teams collaborate with each
10957 other while achieving their own and the project's objectives.

10958 [PA170.IG102.SP105.N101]

10959 *Refer to the Integrated Project Management (IPPD) process area for*
10960 *more information about operating in an integrated environment, and*
10961 *about coordinating and collaborating with stakeholders.*

10962 [PA170.IG102.SP105.N101.R101]

10963 **Typical Work Products**

- 10964 1. Work product and process deployment charts [PA170.IG102.SP105.W101]

- 10965 2. Input to the integrated master plan and integrated schedules
10966 [PA170.IG102.SP105.W102]
- 10967 3. Team Work plans for the team's life cycle [PA170.IG102.SP105.W103]
- 10968 4. Commitment lists [PA170.IG102.SP105.W104]
- 10969 **Subpractices**
- 10970 1. Collaboratively establish and maintain the work product ownership
10971 boundaries among interfacing teams within the project or
10972 organization. [PA170.IG102.SP105.SubP101]
- 10973 2. Collaboratively establish and maintain interfaces and processes
10974 among interfacing teams for the exchange of inputs, outputs, or
10975 work products. [PA170.IG102.SP105.SubP102]
- 10976 *Refer to the Integrated Project Management (IPPD) process area for
10977 more information about coordinating and collaborating with
10978 stakeholders.* [PA170.IG102.SP105.SubP102.R101]
- 10979 3. Collaboratively develop, communicate, and distribute among
10980 interfacing teams commitment lists and work plans related to the
10981 work product or team interfaces. [PA170.IG102.SP105.SubP103]

10982 **Generic Practices by Goal**

10983 **GG 1 Achieve Specific Goals**

10984 ***The process supports and enables achievement of the specific goals of the
10985 process area by transforming identifiable input work products to produce
10986 identifiable output work products.***

10987 **GP 1.1 Identify Work Scope**

10988 ***Identify the scope of the work to be performed and work products
10989 to be produced for integrated teaming, and communicate this
10990 information to those performing the work.*** [GP101]

10991 **GP 1.2 Perform Base Practices**

10992 ***Perform the base practices of the integrated teaming process to
10993 develop work products and provide services to achieve the
10994 specific goals of the process area.*** [GP102]

10995 **GG 2 Institutionalize a Managed Process**

10996 ***The process is institutionalized as a managed process.***

10997 **GP 2.1 Establish an Organizational Policy**

10998 ***Establish and maintain an organizational policy for planning and***
10999 ***performing the integrated teaming process.*** [GP103]

11000 Elaboration:

11001 This policy establishes organizational expectations for establishing and
11002 maintaining team composition and governing team operation. [PA170.EL101]

11003 **GP 2.2 Plan the Process**

11004 ***Establish and maintain the requirements and objectives, and plans***
11005 ***for performing the integrated teaming process.*** [GP104]

11006 Elaboration:

11007 These requirements, objectives, and plans are described in the
11008 organization's plan for integrated teaming. [PA170.EL102]

11009 **GP 2.3 Provide Resources**

11010 ***Provide adequate resources for performing the integrated teaming***
11011 ***process, developing the work products and providing the services***
11012 ***of the process.*** [GP105]

11013 Elaboration:

11014 Examples of special equipment and facilities include: [PA170.EL103]

- 11015 • Team war rooms (for regular strategy development and
11016 communication meetings)

11017

11018 Examples of tools used in performing the activities of the Integrated
11019 Teaming process area include the following: [PA170.EL104]

- 11020 • Interactive electronic communication and data presentation
11021 tools (Groupware)
11022 • Team building tools

11023

11024 **GP 2.4 Assign Responsibility**

11025 ***Assign responsibility and authority for performing the process,***
11026 ***developing the work products, and providing the services of the***
11027 ***integrated teaming process.*** [GP106]

11028 **GP 2.5 Train People**

11029 ***Train the people performing or supporting the integrated teaming***
11030 ***process as needed.*** [GP107]

11031 Elaboration:

11032 Examples of training topics include the following: [PA170.EL105]

- 11033 • Use of integrated work environments
- 11034 • Interpersonal skills
- 11035 • Communication skills
- 11036 • Team building
- 11037 • Collaborative problem solving and decision making

11038

11039 **GP 2.6 Manage Configurations**

11040 ***Place designated work products of the integrated teaming process***
11041 ***under appropriate levels of configuration management.*** [GP109]

11042 Elaboration:

11043 Examples of work products placed under configuration management
11044 include the following: [PA170.EL106]

- 11045 • List of team members
- 11046 • List of the level of effort and resources, including access to staff, to
11047 perform each team function
- 11048 • Work task formal commitment lists
- 11049 • Team shared vision statement
- 11050 • Team charter

11051

11052 **GP 2.7 Identify and Involve Relevant Stakeholders**

11053 ***Identify and involve the relevant stakeholders of the integrated***
11054 ***teaming process as planned.*** [GP124]

11055 Elaboration:

11056 Examples of activities for stakeholder involvement include: [PA170.EL107]

- 11057 • Establishing and maintaining the team's shared vision
- 11058 • Establishing and maintaining the team's charter
- 11059 • Establishing and maintaining the team's operating procedures
- 11060 • Collaborating with interfacing teams

11061

11062 **GP 2.8 Monitor and Control the Process**

11063 ***Monitor and control the integrated teaming process against the***
11064 ***plan and take appropriate corrective action.*** [GP110]

11065 Elaboration:

11066 Examples of measures used in monitoring and controlling the activities
11067 of the Integrated Teaming process area include the following: [PA170.EL108]

- 11068 • Performance to and deviations from expected plans, commitments,
11069 and procedures for the integrated team
- 11070 • Ability to achieve team objectives

11071

11072 **GP 2.9 Objectively Evaluate Adherence**

11073 ***Objectively evaluate adherence of the integrated teaming process***
11074 ***and the work products and services of the process to the***
11075 ***applicable requirements, objectives, and standards, and address***
11076 ***noncompliance.*** [GP113]

11077 Elaboration:

11078 Examples of activities reviewed include the following: [PA170.EL109]

- 11079 • Defining roles and responsibilities
- 11080 • Communication activities within and among integrated teams

11081

11082 Examples of work products reviewed include the following: [PA170.EL110]

- 11083 • Descriptions of roles and responsibilities
- 11084 • Descriptions of product ownership boundaries and team interfaces

11085

11086 **GP 2.10 Review Status with Higher-Level Management**
11087 *Review the activities, status, and results of the integrated teaming*
11088 *process with higher-level management and resolve issues. [GP112]*

11089 **GG 3 Institutionalize a Defined Process**
11090 *The process is institutionalized as a defined process.*

11091 **GP 3.1 Establish a Defined Process**
11092 *Establish and maintain the description of a defined integrated*
11093 *teaming process. [GP114]*

11094 **GP 3.2 Collect Improvement Information**
11095 *Collect work products, measures, measurement results, and*
11096 *improvement information derived from planning and performing*
11097 *the integrated teaming process to support the future use and*
11098 *improvement of the organization's processes and process assets.*
11099 *[GP117]*

11100 **GG 4 Institutionalize a Quantitatively Managed Process**
11101 *The process is institutionalized as a quantitatively managed process.*

11102 **GP 4.1 Establish Quality Objectives**
11103 *Establish and maintain quantitative objectives for the integrated*
11104 *teaming process about quality and process performance based on*
11105 *customer needs and business objectives. [GP118]*

11106 **GP 4.2 Stabilize Subprocess Performance**
11107 *Stabilize the performance of one or more subprocesses of the*
11108 *integrated teaming process to determine its ability to achieve the*
11109 *established quantitative quality and process performance*
11110 *objectives. [GP119]*

11111 **GG 5 Institutionalize an Optimizing Process**
11112 *The process is institutionalized as an optimizing process.*

11113

GP 5.1 Ensure Continuous Process Improvement

11114

Ensure continuous improvement of the integrated teaming process in fulfilling the relevant business goals of the organization. [GP125]

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GP 5.2 Correct Common Cause of Problems

11118

Identify and correct the root causes of defects and other problems in the integrated teaming process. [GP121]

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11120 QUANTITATIVE PROJECT MANAGEMENT

11121 Project Management

11122 Purpose

11123 The purpose of the Quantitative Project Management process area is to
11124 quantitatively manage the project's defined process to achieve the
11125 project's established quality and process performance objectives. [PA165]

11126 Introductory Notes

11127 Quantitative Project Management involves the following: [PA165.N101]

- 11128 • Establishing and maintaining the project's quality and process
11129 performance objectives
- 11130 • Identifying suitable subprocesses that compose the project's
11131 defined process based on historical stability and capability data
11132 found in process performance baselines and/or models
- 11133 • Selecting the subprocesses of the project's defined process to be
11134 statistically managed
- 11135 • Selecting the measures and analytic techniques to be used in
11136 statistically managing the selected subprocesses
- 11137 • Establishing and maintaining statistical control of the selected
11138 subprocesses using the selected measures and analytic
11139 techniques
- 11140 • Determining whether the selected subprocesses are capable of
11141 satisfying their quality and process performance objectives, and
11142 taking corrective action as necessary
- 11143 • Determining whether the project's defined process is able to satisfy
11144 the project's objectives, and take corrective action when
11145 appropriate
- 11146 • Recording statistical and quality management data in the
11147 organization's measurement repository

11148 The process performance objectives, measures, and baselines
11149 identified above are developed through the Organizational Process
11150 Performance process area. Subsequently, the results of performing the
11151 Quantitative Project Management process area (measurement
11152 definitions, measurement data etc.) are part of the organizational assets
11153 referred to in the Organizational Process Performance process area.

11154 [PA165.N102]

11155 Prior to implementing this process area, the organization should have
11156 already established a set of standard processes and related process
11157 assets such as the organization's measurement repository and the
11158 process asset library for use by each project in establishing its defined
11159 process. The project's defined process is a set of subprocesses that
11160 form an integrated and coherent life cycle for the project. It is
11161 established in part through selecting and tailoring from the
11162 organization's set of standard processes. [PA165.N103]

11163 The organization's measurement repository and process asset library
11164 provide information that assist in composing a defined process that will
11165 achieve the objectives that have been established by the project.
11166 [PA165.N104]

11167 In this process area, the phrase "quality and process performance
11168 objectives" covers objectives and requirements for product quality,
11169 service quality, and process performance. As commonly used, the term
11170 process performance includes product quality. However, to emphasize
11171 the importance of product quality, the phrase "quality and process
11172 performance objectives" is used rather than just "process performance
11173 objectives." [PA165.N105]

11174 Process performance is a measure of the actual process results
11175 achieved. Process performance is characterized by both process
11176 measures (e.g., effort, cycle time, and defect removal efficiency) and
11177 product measures (e.g., reliability, defect density, and response time).
11178 [PA165.N106]

11179 Subprocesses are defined components of a larger defined process. For
11180 example, a typical organization's development process may be defined
11181 in terms of subprocesses such as requirements development, design,
11182 build, test, and peer review. The subprocesses themselves may be
11183 further decomposed as necessary into finer-grained process
11184 descriptions. [PA165.N107]

11185 One essential element of quantitative management is having
11186 confidence in estimates, i.e. being able to predict the extent to which
11187 the project can fulfill its quality and process performance objectives.
11188 The subprocesses that will be statistically managed are chosen based
11189 on identified needs for predictable performance. [PA165.N108]

11190 Another essential element of quantitative management is understanding
11191 the nature and extent of the variation experienced in process
11192 performance, and recognizing when the project's actual performance
11193 may not be adequate to achieving the project's quality and process
11194 performance objectives. This recognition is a basis for taking corrective
11195 action. [PA165.N109]

11196 Statistical management involves statistical thinking and the correct use
11197 of a variety of statistical techniques, such as run charts, control charts,
11198 confidence intervals, prediction intervals, and tests of hypotheses.
11199 Quantitative management uses data from statistical management to
11200 help the project predict whether it will be able to achieve its quality and
11201 process performance objectives and take corrective action when
11202 appropriate. [PA165.N110]

11203 This process area applies to managing a project, but the concepts
11204 found here also apply to managing other groups and functions. Applying
11205 these concepts to managing other groups and functions may not
11206 necessarily contribute to achieving the organization's business
11207 objectives, but may help these groups and functions control their own
11208 processes. [PA165.N111]

11209 Examples of other groups and functions include the following:

11210 [PA165.N113]

- 11211 • Quality assurance
- 11212 • Process definition and improvement
- 11213 • Effort reporting
- 11214 • Customer complaint handling
- 11215 • Problem tracking and reporting

11216
11217 In this process area, the term "product" refers to products or services or
11218 both, as appropriate. [PA165.N112]

11219 Related Process Areas

11220 *Refer to the Project Monitoring and Control process area for more*
11221 *information about monitoring and controlling project progress and*
11222 *performance.* [PA165.R101]

11223 *Refer to Measurement and Analysis process area for more information*
11224 *about establishing measurable objectives, specifying the measures and*
11225 *analyses to be performed, obtaining and analyzing measures, and*
11226 *providing objective results.* [PA165.R102]

11227 *Refer to the Organizational Process Performance process area for*
11228 *more information about the organization's quality and process*
11229 *performance objectives, process performance analyses, process*
11230 *performance baselines, and process performance models.* [PA165.R103]

11231 *Refer to the Organizational Process Definition process area for more*
11232 *information about the organizational process assets including the*
11233 *organization's measurement repository.* [PA165.R104]

11234 Refer to the Integrated Project Management (IPPD) process area for
11235 more information about establishing and maintaining the project's
11236 defined process. [PA165.R105]

11237 Refer to the Causal Analysis and Resolution process area for more
11238 information about how to identify the causes of defects and other
11239 problems and taking action to prevent them from occurring in the future.
11240 [PA165.R106]

11241 Refer to the Organizational Innovation and Deployment process area
11242 for more information about selecting and deploying improvements that
11243 support the organization's quality and process performance objectives.
11244 [PA165.R107]

11245 Specific Goals

11246 **SG 1 Quantitatively Manage the Project** [PA165.IG101]

11247 ***The project is quantitatively managed using quality and process performance***
11248 ***objectives.***

11249 **SG 2 Statistically Manage Subprocess Performance** [PA165.IG102]

11250 ***The performance of selected subprocesses within the project's defined***
11251 ***process is statistically managed.***

11252 Generic Goals

11253 **GG 1 Achieve Specific Goals** [CL102.GL101]

11254 ***The process supports and enables achievement of the specific goals of the***
11255 ***process area by transforming identifiable input work products to produce***
11256 ***identifiable output work products.***

11257 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

11258 ***The process is institutionalized as a managed process.***

11259 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

11260 ***The process is institutionalized as a defined process.***

11261 **GG 4 Institutionalize a Quantitatively Managed Process** [CL105.GL101]

11262 ***The process is institutionalized as a quantitatively managed process.***

11263 **GG 5 Institutionalize an Optimizing Process** [CL106.GL101]

11264 ***The process is institutionalized as an optimizing process.***

11265 Practice to Goal Relationship Table

11266 **SG 1 Quantitatively Manage the Project** [PA165.IG101]

- 11267 SP 1.1-1 Establish the Project's Objectives
- 11268 SP 1.2-1 Compose the Defined Process
- 11269 SP 1.3-1 Select the Subprocesses to be Managed
- 11270 SP 1.4-1 Manage Project Performance

11271 **SG 2 Statistically Manage Subprocess Performance** [PA165.IG102]

- 11272 SP 2.1-1 Select Measures and Analytic Techniques
- 11273 SP 2.2-1 Apply Statistical Methods to Understand Variation
- 11274 SP 2.3-1 Monitor Performance of the Selected Subprocesses
- 11275 SP 2.4-1 Record Statistical Management Data

11276 **GG 1 Achieve Specific Goals** [CL102.GL101]

- 11277 GP 1.1 Identify Work Scope
- 11278 GP 1.2 Perform Base Practices

11279 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

- 11280 GP 2.1 Establish an Organizational Policy
- 11281 GP 2.2 Plan the Process
- 11282 GP 2.3 Provide Resources
- 11283 GP 2.4 Assign Responsibility
- 11284 GP 2.5 Train People
- 11285 GP 2.6 Manage Configurations
- 11286 GP 2.7 Identify and Involve Relevant Stakeholders
- 11287 GP 2.8 Monitor and Control the Process
- 11288 GP 2.9 Objectively Evaluate Adherence
- 11289 GP 2.10 Review Status with Higher-Level Management

11290 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

- 11291 GP 3.1 Establish a Defined Process
- 11292 GP 3.2 Collect Improvement Information

11293 **GG 4 Institutionalize a Quantitatively Managed Process** [CL105.GL101]

- 11294 GP 4.1 Establish Quality Objectives
- 11295 GP 4.2 Stabilize Subprocess Performance

11296 **GG 5 Institutionalize an Optimizing Process** [CL106.GL101]

- 11297 GP 5.1 Ensure Continuous Process Improvement
- 11298 GP 5.2 Correct Common Cause of Problems

11299 Specific Practices by Goal

11300 **SG 1 Quantitatively Manage the Project** [PA165.IG101]

11301 ***The project is quantitatively managed using quality and process performance objectives.***

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SP 1.1-1 Establish the Project’s Objectives

Establish and maintain the project’s quality and process performance objectives. [PA165.IG101.SP101]

This specific practice is typically performed early during project planning. [PA165.IG101.SP101.N101]

Note that the first three specific practices for Goal 1 of this process area may be addressed concurrently. When establishing the project’s quality and process performance objectives, it is often useful to think ahead about which elements of the organization standard set of processes will be included in the projects defined process. Also, it is important to identify what subprocesses need to be statistically managed in order for the project to achieve those objectives The balance between project quality and performance objectives and the estimated performance of the projects defined process is typically developed through multiple iterations. Initially, project performance objectives are set. Then, the expected performance of the projects defined process is identified. If there is a difference between project quality and performance objectives and the defined project process performance estimate, negotiations between relevant stakeholders are required to eliminate the difference.

[PA165.IG101.SP101.N102]

Typical Work Products

1. The project’s documented quality and process performance objectives. [PA165.IG101.SP101.W101]

Subpractices

1. Review the organization's objectives for quality and process performance. [PA165.IG101.SP101.SubP101]

The intent of this review is to ensure the project understands the broader business context in which the project will need to operate. The project’s objectives for quality and process performance will be developed in the context of these overarching organizational objectives. [PA165.IG101.SP101.SubP101.N101]

Refer to the Organizational Process Performance process area for more information about the organization’s quality and process performance objectives. [PA165.IG101.SP101.SubP101.N101.R101]

2. Identify the quality and process performance needs and priorities of the customer, end users, and other relevant stakeholders.

[PA165.IG101.SP101.SubP102]

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Examples of quality and process performance attributes for which needs and priorities might be identified include the following: [PA165.IG101.SP101.SubP102.N101]

- Functionality
- Reliability
- Maintainability
- Usability
- Development cycle time
- Predictability
- Timeliness
- Accuracy

3. Identify how process performance is to be measured.

[PA165.IG101.SP101.SubP103]

Consider whether the measures established by the organization are adequate for assessing progress in fulfilling customer, end-users, and other stakeholder needs and priorities. It may be necessary to supplement these with additional measures.

[PA165.IG101.SP101.SubP103.N101]

Refer to the Measurement and Analysis process area for more information about defining measures. [PA165.IG101.SP101.SubP103.N101.R101]

4. Define and document measurable quality and process performance objectives for the project. [PA165.IG101.SP101.SubP104]

Defining and documenting objectives for the project involves the following:

[PA165.IG101.SP101.SubP104.N101]

- Incorporating the organization's quality and process performance objectives
- Writing objectives that reflect the quality and process performance needs and priorities of the customer, end-users, and other stakeholders and the way they should be measured

Examples of quality objectives include the following: [PA165.IG101.SP101.SubP104.N102]

- Mean time between failures
- Critical resource utilization
- Number and severity of defects in the released product
- Number and severity of customer complaints with respect to the provided service

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Examples of process performance objectives include the following:
[PA165.IG101.SP101.SubP104.N103]

- Percentage of defects removed by product verification activities (perhaps by type, e.g. peer reviews and testing)
- Defect escape rates
- Number and density of defects (by severity) found during the first year following product delivery (or start of service)
- Development cycle time
- Percentage of rework time

5. Derive interim objectives for each life-cycle stage, as appropriate, to monitor progress toward achieving the project's objectives.

[PA165.IG101.SP101.SubP105]

An example of a method to predict future results of a process is the use of process performance models to predict the latent defects in the delivered product using interim measures of defects identified during product verification activities (e.g., peer review and testing). [PA165.IG101.SP101.SubP105.N101]

6. Resolve conflicts among the project's quality and process performance objectives (e.g., if one objective cannot be achieved without compromising another objective). [PA165.IG101.SP101.SubP106]

Resolving conflicts includes the following: [PA165.IG101.SP101.SubP106.N101]

- Setting relative priorities for the objectives
- Considering alternative objectives in light of long-term business strategies as well as short-term needs
- Involving the customer, end users, senior management, project management, and other stakeholders in the tradeoff decisions
- Revising the objectives as necessary to reflect the results of the conflict resolution

7. Establish traceability to the project's quality and process performance objectives from their sources. [PA165.IG101.SP101.SubP107]

Examples of sources for objectives include the following: [PA165.IG101.SP101.SubP107.N101]

- Requirements
- Organization's quality and process performance objectives
- Customer's quality and process performance objectives
- Business objectives
- Discussions with customers and potential customers
- Market surveys

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An example of a method to identify and trace these needs and priorities is Quality Function Deployment (QFD). [PA165.IG101.SP101.SubP107.N102]

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8. Define and negotiate quality and process performance objectives for suppliers. [PA165.IG101.SP101.SubP108]

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Refer to the Supplier Agreement Management process area for more information about establishing and maintaining agreements with suppliers. [PA165.IG101.SP101.SubP108.R101]

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9. Revise the project's quality and process performance objectives as necessary. [PA165.IG101.SP101.SubP109]

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SP 1.2-1 Compose the Defined Process

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Select the processes and process elements that comprise the project's defined process based on historical stability and capability data. [PA165.IG101.SP102]

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Refer to the Integrated Project Management (IPPD) process area for more information about establishing and maintaining the project's defined process. [PA165.IG101.SP102.R101]

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Refer to the Organizational Process Definition process area for more information about the organization's process asset library that might include a new subprocess or process element of known and needed capability. [PA165.IG101.SP102.R102]

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Refer to the Organizational Process Performance process area for more information about the organization's process performance baseline and process performance models. [PA165.IG101.SP102.R103]

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Subprocesses are identified from the process elements in the organization's set of standard processes and the process artifacts in the organization's process asset library. [PA165.IG101.SP102.N101]

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Typical Work Products

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1. Criteria used in identifying which subprocesses are valid candidates for inclusion in the project's defined process [PA165.IG101.SP102.W101]

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2. Candidate subprocesses for inclusion in the project's defined process [PA165.IG101.SP102.W102]

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3. Subprocesses to be included in the project's defined process [PA165.IG101.SP102.W103]

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4. Identified risks when selected subprocesses lack a process performance history [PA165.IG101.SP102.W104]

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Subpractices

1. Establish the criteria to use in identifying which subprocesses are valid candidates for use. [PA165.IG101.SP102.SubP101]

Identification may be based on the following: [PA165.IG101.SP102.SubP101.N101]

- Quality and process performance objectives
- Product line standards
- Life-cycle models
- Customer requirements
- Laws and regulations

2. Determine whether the subprocesses that are to be statistically managed, and that were obtained from the organization's process assets, are suitable for statistical management.

[PA165.IG101.SP102.SubP102]

A subprocess may be more suitable for statistical management if it has a history of the following: [PA165.IG101.SP102.SubP102.N101]

- Stable performance in previous comparable instances
- Process performance data that satisfies the project's quality and process performance objectives

Historical data are primarily obtained from the organization's process performance baseline. However, these data may not be available for all subprocesses.

[PA165.IG101.SP102.SubP102.N102]

3. Analyze the interaction of subprocesses to understand the relationships among the subprocesses and the measured attributes of the subprocesses. [PA165.IG101.SP102.SubP103]

Examples of analysis techniques include system dynamics models and simulations. [PA165.IG101.SP102.SubP103.N101]

4. Identify the risk when no subprocess is available that is known to be capable of satisfying the quality and process performance objectives (i.e., no capable subprocess is available or the capability of the subprocess is not known). Risks may also occur when a selected subprocess has inadequate process performance data.

[PA165.IG101.SP102.SubP104]

Even when a subprocess has not been selected to be statistically managed, historical data and process performance models may indicate the subprocess is not capable of satisfying the quality and process performance objectives.

[PA165.IG101.SP102.SubP104.N101]

Refer to the Risk Management process area for more information about risk identification and analysis. [PA165.IG101.SP102.SubP104.N101.R101]

11486 **SP 1.3-1 Select the Subprocesses to be Managed**

11487 **Select the subprocesses of the project's defined process that will**
11488 **be statistically managed** [PA165.IG101.SP103]

11489 **Typical Work Products**

- 11490 1. Quality and process performance objectives that will be addressed
11491 by statistical management [PA165.IG101.SP103.W101]
- 11492 2. Criteria used in selecting which subprocesses will be statistically
11493 managed [PA165.IG101.SP103.W102]
- 11494 3. Subprocesses that will be statistically managed [PA165.IG101.SP103.W103]
- 11495 4. Identified process and product attributes of the selected
11496 subprocesses that should be measured and controlled
11497 [PA165.IG101.SP103.W104]

11498 **Subpractices**

- 11499 1. Identify which of the quality and process performance objectives of
11500 the project will be statistically managed. [PA165.IG101.SP103.SubP101]
- 11501 2. Select the subprocesses that are the main contributors to achieving
11502 the identified quality and process performance objectives and for
11503 which predictable performance is important. [PA165.IG101.SP103.SubP102]

11504 It may not be possible to statistically manage some subprocesses (e.g., where
11505 new subprocesses and technologies are being pilot tested). In other cases it may
11506 not be economically justifiable to apply statistical techniques to certain
11507 subprocesses. [PA165.IG101.SP103.SubP102.N101]

11508 Examples of criteria used in selecting subprocesses include the following:

11509 [PA165.IG101.SP103.SubP102.N102]

- 11510 • Customer requirements related to quality and process performance
- 11511 • Quality and process performance objectives established by the customer
- 11512 • Quality and process performance objectives established by the organization
- 11513 • Stable performance of the subprocess on other projects
- 11514 • Laws and regulations

- 11515
- 11516 3. Identify the product and process attributes of the selected
11517 subprocesses that will be measured and controlled.

11518 [PA165.IG101.SP103.SubP103]

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Examples of product and process attributes include the following:

[PA165.IG101.SP103.SubP103.N101]

- Defect density
- Cycle time
- Test coverage

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SP 1.4-1 Manage Project Performance

Monitor the project to determine whether the project's objectives for quality and process performance will be satisfied, and take corrective action as appropriate. [PA165.IG101.SP104]

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Refer to the Measurement and Analysis process area for more information about analyzing and using measures. [PA165.IG101.SP104.R101]

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A prerequisite for such a comparison is that the selected subprocesses of the project's defined process are being statistically managed and their process capability is understood. [PA165.IG101.SP104.N101]

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Typical Work Products

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1. Estimates (predictions) of the achievement of the project's quality and process performance objectives [PA165.IG101.SP104.W101]
2. Documentation of the risks in achieving the project's quality and process performance objectives [PA165.IG101.SP104.W102]
3. Documentation of actions needed to address the deficiencies in achieving the project's objectives [PA165.IG101.SP104.W103]

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Subpractices

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1. Periodically review the performance of each subprocess, and the capability of each subprocess selected to be statistically managed, to assess progress toward achieving the project's quality and process performance objectives. [PA165.IG101.SP104.SubP101]

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The process capability of each selected subprocess is determined with respect to that subprocess' established quality and process performance objectives. These objectives are derived from the project's quality and process performance objectives, which are for the project as a whole. [PA165.IG101.SP104.SubP101.N101]

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2. Periodically review the actual results achieved against the established interim objectives for each life-cycle stage to assess progress toward achieving the project's quality and process performance objectives. [PA165.IG101.SP104.SubP102]

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3. Track the suppliers' results for achieving their quality and process performance objectives. [PA165.IG101.SP104.SubP103]

11556 4. Use process performance models calibrated with obtained
11557 measures of critical attributes to estimate progress towards
11558 achieving the project's quality and process performance objectives.
11559 Process performance models are used to estimate progress toward
11560 achieving objectives that cannot be measured until a future phase
11561 in the life cycle. An example is the use of process performance
11562 models to predict the latent defects in the delivered product using
11563 interim measures of defects identified during peer reviews.
11564 [PA165.IG101.SP104.SubP104]

11565 The calibration is based on the results obtained from performing the previous
11566 subpractices. [PA165.IG101.SP104.SubP104.N101]

11567 *Refer to the Organizational Process Performance process area for*
11568 *more information about process performance models.*
11569 [PA165.IG101.SP104.SubP104.R101]

11570 5. Identify and manage the risks associated with achieving the
11571 project's quality and process performance objectives.
11572 [PA165.IG101.SP104.SubP105]

11573 Example sources for the risks include the following: [PA165.IG101.SP104.SubP105.N101]
11574 • Inadequate stability and capability data in the organization's measurement
11575 repository
11576 • Subprocesses having inadequate performance or capability
11577 • Suppliers not achieving their quality and process performance objectives
11578 • Lack of visibility into supplier capability
11579 • Accuracy of the organization's process performance models for predicting future
11580 performance
11581 • Predicted process performance (estimated progress) are deficient
11582 • Other identified risks associated with identified deficiencies

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11584 *Refer to the Risk Management process area for more information about*
11585 *identifying and managing risks.* [PA165.IG101.SP104.SubP105.R101]

11586 6. Determine and document actions needed to address the
11587 deficiencies in achieving the project's quality and process
11588 performance objectives. [PA165.IG101.SP104.SubP106]

11589 The intent of these actions are to plan and deploy the right set of activities,
11590 resources, and schedule to place the project back on track as much as possible to
11591 meet its objectives. [PA165.IG101.SP104.SubP106.N101]

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Examples of actions that can be taken to address deficiencies in achieving the project's objectives include the following: [PA165.IG101.SP104.SubP106.N102]

- Changing quality or process performance objectives so that they are within the expected range of the project's defined process
- Improving the implementation of the project's defined process so as to reduce its normal variability (reducing variability may bring the project's performance within the objectives without having to move the mean)
- Adopting new subprocesses and technologies that have the potential for satisfying the objectives and managing the associated risks
- Identifying the risk and risk mitigation strategies for the deficiencies
- Terminating the project

7. Track the identified actions to closure. [PA165.IG101.SP104.SubP107]

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SG 2 Statistically Manage Subprocess Performance [PA165.IG102]

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The performance of selected subprocesses within the project's defined process is statistically managed.

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This goal summarizes a means for achieving the goal of "Able processes," by selecting and statistically managing those subprocesses of the project's defined process that are important to achieving the project's objectives. When the selected subprocesses are brought under statistical control, their capability to achieve their objectives can be determined, and by this means, it will be possible to predict whether the project will be able to achieve its objectives, and if not, take appropriate corrective action. [PA165.IG102.N101]

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SP 2.1-1 Select Measures and Analytic Techniques

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Select the measures and analytic techniques to be used in statistically managing the selected subprocesses. [PA165.IG102.SP101]

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Refer to the Measurement and Analysis process area for more information about establishing measurable objectives; on defining, collecting, and analyzing measures; and on revising measures and statistical analysis techniques. [PA165.IG102.SP101.R101]

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Typical Work Products

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1. Definitions of the measures and analytic techniques to be used in (or proposed for) statistically managing the subprocesses

[PA165.IG102.SP101.W101]

2. Operational definitions of the measures, their collection points in the subprocesses, and how the measures will be validated

[PA165.IG102.SP101.W102]

11630 3. Traceability of measures back to the project's quality and process
11631 performance objectives [PA165.IG102.SP101.W103]

11632 4. Instrumented organizational support environment to support
11633 automatic data collection [PA165.IG102.SP101.W104]

11634 **Subpractices**

11635 1. Identify common measures from the organization's process assets
11636 that support the objectives of statistical management.

11637 [PA165.IG102.SP101.SubP101]

11638 Product lines or other stratification criteria may categorize common measures.

11639 [PA165.IG102.SP101.SubP101.N101]

11640 *Refer to the Organization Process Definition process area for more*
11641 *information about common measures.* [PA165.IG102.SP101.SubP101.R101]

11642 2. Identify additional measures that may be needed for this instance
11643 to cover critical product and process attributes of the selected
11644 subprocesses. [PA165.IG102.SP101.SubP102]

11645 Examples of additional measures include the following: [PA165.IG102.SP101.SubP102.N101]

- 11646 • A certain work product and task attribute required by the customer (e.g.,
11647 complexity) when the organization's standard work product and task attribute
11648 measure is size
- 11649 • Defect categories specified by a regulatory agency
- 11650 • Measures to address unique issues and concerns of the project

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11652 In some cases, measures may be research-oriented. Such measures should be
11653 explicitly identified. [PA165.IG102.SP101.SubP102.N102]

11654 3. Identify the measures that are appropriate for statistical
11655 management. [PA165.IG102.SP101.SubP103]

11656 Critical criteria for selecting statistical management measures include the
11657 following: [PA165.IG102.SP101.SubP103.N101]

- 11658 • Controllable (e.g., can a measure's values be changed by changing how the
11659 subprocess is implemented?)
- 11660 • Performance indicator (e.g., is the measure a good indicator of how well the
11661 subprocess is performing relative to the objectives of interest?)

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Examples of subprocess measures include the following: [PA165.IG102.SP101.SubP103.N102]

- Requirements volatility
- Ratios of estimated to measured values of the planning parameters (e.g., size, cost, and schedule)
- Coverage and efficiency of peer reviews
- Test coverage and efficiency
- Effectiveness of training (e.g., percent of planned training completed and test scores)
- Reliability
- Percentage of the total defects inserted or found in the different stages of the life cycle
- Percentage of the total effort expended in the different stages of the life cycle

4. Specify the operational definitions of the measures, their collection points in the subprocesses, and how the measures will be validated. [PA165.IG102.SP101.SubP104]

5. Analyze the relationship of the identified measures to the project's objectives and derive objectives that state specific target measures or ranges to be met for each measured attribute of each selected subprocess. [PA165.IG102.SP101.SubP105]

6. Instrument the organizational support environment to support collection, derivation, and analysis of statistical measures. [PA165.IG102.SP101.SubP106]

The instrumentation is based on the following: [PA165.IG102.SP101.SubP106.N101]

- Description of the organization's set of standard processes
- Description of the project's defined process
- Capabilities of the organizational support environment.

Refer to the Organizational Process Definition process area for more information about establishing and maintaining the organizational support environment. [PA165.IG102.SP101.SubP106.R101]

7. Identify the appropriate statistical analysis techniques that are expected to be useful in statistically managing the selected subprocesses. [PA165.IG102.SP101.SubP107]

The concept of "one size does not fit all" applies to statistical analysis techniques. What makes a particular technique appropriate is not just the type of measures, but more importantly, how the measures will be used and whether the situation warrants applying that technique. The appropriateness of the selection may need to be investigated from time to time. [PA165.IG102.SP101.SubP107.N101]

11700 Examples of statistical analysis techniques are given in the next specific practice.

11701 [PA165.IG102.SP101.SubP107.N102]

11702 8. Revise the measures and statistical analysis techniques as
11703 necessary. [PA165.IG102.SP101.SubP108]

11704 SP 2.2-1 Apply Statistical Methods to Understand Variation

11705 ***Establish and maintain an understanding of the variance of the***
11706 ***selected subprocesses using the selected measures and analytic***
11707 ***techniques.*** [PA165.IG102.SP102]

11708 *Refer to the Measurement and Analysis process area for more*
11709 *information about collecting, analyzing, and using measure results; and*
11710 *on verifying that collected measures are valid.* [PA165.IG102.SP102.R101]

11711 Understanding variation is achieved by collecting and analyzing process
11712 and product measures so that special causes of variation can be
11713 identified and addressed to achieve predictable performance.

11714 [PA165.IG102.SP102.N101]

11715 A special cause of variation is an unusual circumstance that causes an
11716 unexpected change in process performance. A transient circumstance
11717 can be a specific local condition, a single individual, or a small group of
11718 people performing in an unexpected way. Special causes are also
11719 known as "assignable causes" because they can be identified,
11720 analyzed, and addressed to prevent future problems. [PA165.IG102.SP102.N102]

11721 Typical Work Products

11722 1. Collected and verified measures including special causes of
11723 variation [PA165.IG102.SP102.W101]

11724 2. Natural bounds of process performance for each measured
11725 attribute of each selected subprocess [PA165.IG102.SP102.W102]

11726 3. Process performance compared to the natural bounds of process
11727 performance for each measured attribute of each selected
11728 subprocess [PA165.IG102.SP102.W103]

11729 Subpractices

11730 1. Establish trial natural bounds for subprocesses having suitable
11731 historical performance data. [PA165.IG102.SP102.SubP101]

11732 Natural bounds of an attribute are the range within which variation normally
11733 occurs. All processes will show some variation in process and product measures
11734 each time they are executed. The issue is whether this variation is due to common
11735 causes of variation in the normal performance of the process or to some special
11736 cause that can and should be identified and removed. [PA165.IG102.SP102.SubP101.N101]

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When a subprocess is initially executed, suitable data for establishing trial natural bounds are sometimes available from prior instances of the subprocess or comparable subprocesses. These data are typically contained in the organization's measurement repository. As the subprocess is executed, data specific to that instance are collected and used to update and replace the trial natural bounds. However, if the subprocess in question has been materially tailored, or if the conditions are materially different than in previous instantiations, the data in the repository may not be relevant and should not be used.

[PA165.IG102.SP102.SubP101.N102]

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In some cases there may be no historical comparable data (for example, when introducing a new subprocess, when entering a new application domain, or when significant changes have been made to the subprocess). In such cases, trial natural bounds will have to be made from early process data of this subprocess. These trial natural bounds must then be refined and updated as subprocess execution continues. [PA165.IG102.SP102.SubP101.N103]

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Examples of criteria for determining whether data are comparable include the following: [PA165.IG102.SP102.SubP101.N104]

- Product lines
- Application domain
- Work product and task attributes (e.g., size of product)
- Size of project

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Refer to the Organizational Process Performance process area for more information about organizational process performance baselines.

[PA165.IG102.SP102.SubP101.R101]

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2. Collect data on the selected measures as the subprocesses execute. [PA165.IG102.SP102.SubP102]
3. Calculate the natural bounds of process performance for each measured attribute. [PA165.IG102.SP102.SubP103]

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Examples where the natural bounds are calculated include the following:

[PA165.IG102.SP102.SubP103.N101]

- Control charts
- Confidence intervals (for parameters of distributions)
- Prediction intervals (for future outcomes)

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4. Identify special causes of variation. [PA165.IG102.SP102.SubP104]

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An example of a criterion for detecting a special cause of variation in a control chart is a data point that falls outside of the 3-sigma control limits.
[PA165.IG102.SP102.SubP104.N101]

The criteria for detecting special causes of variation are based on statistical theory and experience and depend on economic justification. As criteria are added, special causes are more likely to be identified if present, but the likelihood of false alarms also increases. [PA165.IG102.SP102.SubP104.N102]

5. Analyze the special cause of variation to determine the reasons the anomaly occurred. [PA165.IG102.SP102.SubP105]

Examples of techniques for analyzing the reasons for special causes of variation include the following: [PA165.IG102.SP102.SubP105.N101]

- Cause-and-effect (fishbone) diagrams
- Designed experiments
- Control charts (applied to subprocess inputs or to lower-level subprocesses)
- Subgrouping (analyzing the same data segregated into smaller groups based on an understanding of how the subprocess was implemented facilitates isolation of special causes)

Some anomalies may simply be extremes of the underlying distribution rather than problems. The people implementing a subprocess are usually the ones best able to analyze and understand special causes of variation.
[PA165.IG102.SP102.SubP105.N102]

6. Take corrective action as appropriate when special causes of variation are identified. [PA165.IG102.SP102.SubP106]

Removing a special cause of variation does not change the underlying subprocess. It addresses an error in the way the subprocess is being executed.
[PA165.IG102.SP102.SubP106.N101]

7. Recalculate the natural bounds for each measured attribute of the selected subprocesses as necessary. [PA165.IG102.SP102.SubP107]

Recalculating the (statistically estimated) natural bounds is based on measured values that signify that the subprocess has changed, not on expectations or arbitrary decisions. [PA165.IG102.SP102.SubP107.N101]

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Examples of when the natural bounds may need to be recalculated include the following: [PA165.IG102.SP102.SubP107.N102]

- There are incremental improvements to the subprocess
- New tools are deployed for the subprocess
- A new subprocess is deployed
- The collected measures suggest that the subprocess mean has permanently shifted or the subprocess variation has permanently changed

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SP 2.3-1 Monitor Performance of the Selected Subprocesses

Monitor the performance of the selected subprocesses to determine their capability to satisfy their quality and process performance objectives, and take corrective action as necessary.

[PA165.IG102.SP103]

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The intent of this specific practice is to do the following: [PA165.IG102.SP103.N101]

- Determine statistically the process behavior expected from the subprocess
- Assess the probability of the process to meet it's quality and process performance objectives
- Take corrective action, based upon a statistical analysis of the process performance data

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Corrective action may include renegotiating the affected project objectives, identifying and implementing alternative subprocesses, or identifying and measuring lower-level subprocesses to achieve greater detail in the performance data. Any or all of these actions are intended to help the project use a more capable process. [PA165.IG102.SP103.N102]

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Refer to the Causal Analysis and Resolution process area for more information about identifying and resolving special causes of process variation. [PA165.IG102.SP103.N102.R101]

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A capable process is one that is stable and meets or exceeds its quality and performance objectives and can be expected to do so in the future.

[PA165.IG102.SP103.N103]

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A prerequisite for comparing the capability of a selected subprocess against its quality and process performance objectives is that the performance of the subprocess is stable and predictable with respect to its measured attributes. [PA165.IG102.SP103.N104]

11841 Process capability is analyzed for those subprocesses and those
11842 measured attributes for which (derived) objectives have been
11843 established. Not all subprocesses or measured attributes that are
11844 statistically managed are analyzed regarding process capability.

11845 [PA165.IG102.SP103.N105]

11846 The historical data may be inadequate for initially determining whether
11847 the subprocess is capable. It also is possible that the estimated natural
11848 bounds for subprocess performance may shift away from the quality
11849 and process performance objectives. In either case, statistical control
11850 implies monitoring capability as well as stability. [PA165.IG102.SP103.N106]

11851 **Typical Work Products**

- 11852 1. Natural bounds of process performance for each selected
11853 subprocess compared to its established (derived) objectives
11854 [PA165.IG102.SP103.W101]
- 11855 2. For each subprocess, its process capability [PA165.IG102.SP103.W102]
- 11856 3. For each subprocess, the actions needed to address deficiencies
11857 in its process capability [PA165.IG102.SP103.W103]

11858 **Subpractices**

- 11859 1. Compare the quality and process performance objectives to the
11860 natural bounds of that measured attribute. [PA165.IG102.SP103.SubP101]

11861 This comparison provides an assessment of the process capability for each
11862 measured attribute of a subprocess. These comparisons can be displayed
11863 graphically, in ways that relate the estimated natural bounds to the objectives or
11864 as process capability indices, which summarize the relationship of the objectives
11865 to the natural bounds. [PA165.IG102.SP103.SubP101.N101]

- 11866 2. Monitor changes in quality and process performance objectives
11867 and a subprocess' process capability over time.
11868 [PA165.IG102.SP103.SubP102]
- 11869 3. Identify and document subprocess capability deficiencies.
11870 [PA165.IG102.SP103.SubP103]
- 11871 4. Determine and document actions needed to address subprocess
11872 capability deficiencies. [PA165.IG102.SP103.SubP104]

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Examples of actions that can be taken when a selected subprocess' performance does not satisfy its objectives include the following: [PA165.IG102.SP103.SubP104.N101]

- Changing quality and process performance objectives so that they are within the subprocess's process capability
- Improving the implementation of the existing subprocess so as to reduce its normal variability (reducing variability may bring the natural bounds within the objectives without having to move the mean)
- Adopting new process elements and subprocesses and technologies that have the potential for satisfying the objectives and managing the associated risks
- Identifying risks and risk mitigation strategies for each subprocess's process capability deficiency

5. Track the identified actions to closure. [PA165.IG102.SP103.SubP105]

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SP 2.4-1 Record Statistical Management Data

Record statistical and quality management data in the organization's measurement repository. [PA165.IG102.SP104]

Refer to the Measurement and Analysis process area for more information about managing and storing data, measurement definitions, and results. [PA165.IG102.SP104.R101]

Refer to the Organizational Process Definition process area for more information about the organization's measurement repository
[PA165.IG102.SP104.R102]

Typical Work Products

1. Statistical and quality management data recorded in the organization's measurement repository [PA165.IG102.SP104.W101]

11898 Generic Practices by Goal

11899 **GG 1 Achieve Specific Goals**

The process supports and enables achievement of the specific goals of the process area by transforming identifiable input work products to produce identifiable output work products.

11903 **GP 1.1 Identify Work Scope**

Identify the scope of the work to be performed and work products to be produced for quantitative project management , and communicate this information to those performing the work. [GP101]

11907 **GP 1.2 Perform Base Practices**

11908 *Perform the base practices of the quantitative project management*
11909 *process to develop work products and provide services to achieve*
11910 *the specific goals of the process area.* [GP102]

11911 **GG 2 Institutionalize a Managed Process**

11912 *The process is institutionalized as a managed process.*

11913 **GP 2.1 Establish an Organizational Policy**

11914 *Establish and maintain an organizational policy for planning and*
11915 *performing the quantitative project management process.* [GP103]

11916 Elaboration:

11917 This policy establishes organizational expectations for quantitatively
11918 managing the project using quality and process performance objectives,
11919 and statistically managing selected subprocesses within the project's
11920 defined process [PA165.EL101]

11921 **GP 2.2 Plan the Process**

11922 *Establish and maintain the requirements and objectives, and plans*
11923 *for performing the quantitative project management process.* [GP104]

11924 **GP 2.3 Provide Resources**

11925 *Provide adequate resources for performing the quantitative project*
11926 *management process, developing the work products and*
11927 *providing the services of the process.* [GP105]

11928 Elaboration:

11929 Special expertise in statistics and statistical process control may be
11930 needed to define the techniques for statistical management of selected
11931 subprocesses, but staff will use the tools and techniques to perform the
11932 statistical management. Special expertise in statistics may also be
11933 needed for analyzing and interpreting the measures resulting from
11934 statistical management. [PA165.EL102]

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Examples of tools used in performing the activities of the quantitative project management process include the following: [PA165.EL103]

- System dynamics models
- Automated test coverage analyzers
- Statistical process and quality control packages
- Statistical analysis packages

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GP 2.4 Assign Responsibility

Assign responsibility and authority for performing the process, developing the work products, and providing the services of the quantitative project management process. [GP106]

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GP 2.5 Train People

Train the people performing or supporting the quantitative project management process as needed. [GP107]

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Elaboration:

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Examples of training topics include the following: [PA165.EL104]

- Process modeling and analysis
- Process measurement data selection, definition, collection, and validation

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GP 2.6 Manage Configurations

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

11959 Elaboration:

11960 Examples of work products placed under configuration management
11961 include the following: [PA165.EL110]

- 11962 • Subprocesses to be included in the project's defined process
- 11963 • Operational definitions of the measures, their collection points in
11964 the subprocesses, and how the measures will be validated
- 11965 • Collected and verified measures, including special causes of
11966 variation

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11968 **GP 2.7 Identify and Involve Relevant Stakeholders**

11969 ***Identify and involve the relevant stakeholders of the quantitative***
11970 ***project management process as planned.*** [GP124]

11971 Elaboration:

11972 Examples of activities for stakeholder involvement include: [PA165.EL109]

- 11973 • Establishing project objectives
- 11974 • Resolving issues among the project's quality and process
11975 performance objectives
- 11976 • Assessing performance of the selected subprocesses
- 11977 • Identifying and managing the risks in achieving the project's quality
11978 and process performance objectives
- 11979 • Taking corrective action

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11981 **GP 2.8 Monitor and Control the Process**

11982 ***Monitor and control the quantitative project management process***
11983 ***against the plan and take appropriate corrective action.*** [GP110]

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Elaboration:

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Examples of measures used in monitoring and controlling the activities of the Quantitative Project Management process area include the following: [PA165.EL105]

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- Profile of subprocesses under statistical management (e.g., number planned to be under statistical management, number currently being statistically managed, and number that are statistically stable)
- Number of special causes of variation identified

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GP 2.9 Objectively Evaluate Adherence

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Objectively evaluate adherence of the quantitative project management process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

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Elaboration:

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Examples of activities reviewed include the following: [PA165.EL106]

- Quantitatively managing the project using quality and process performance objectives
- Statistically managing selected subprocesses within the project's defined process

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Examples of work products reviewed include the following: [PA165.EL108]

- Subprocesses to be included in the project's defined process
- Operational definitions of the measures
- Collected and verified measures including special causes of variation

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GP 2.10 Review Status with Higher-Level Management

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Review the activities, status, and results of the quantitative project management process with higher-level management and resolve issues. [GP112]

12016 **GG 3 Institutionalize a Defined Process**

12017 *The process is institutionalized as a defined process.*

12018 **GP 3.1 Establish a Defined Process**

12019 *Establish and maintain the description of a defined quantitative*
12020 *project management process. [GP114]*

12021 **GP 3.2 Collect Improvement Information**

12022 *Collect work products, measures, measurement results, and*
12023 *improvement information derived from planning and performing*
12024 *the quantitative project management process to support the*
12025 *future use and improvement of the organization's processes and*
12026 *process assets. [GP117]*

12027 **GG 4 Institutionalize a Quantitatively Managed Process**

12028 *The process is institutionalized as a quantitatively managed process.*

12029 **GP 4.1 Establish Quality Objectives**

12030 *Establish and maintain quantitative objectives for the quantitative*
12031 *project management process about quality and process*
12032 *performance based on customer needs and business objectives.*
12033 *[GP118]*

12034 **GP 4.2 Stabilize Subprocess Performance**

12035 *Stabilize the performance of one or more subprocesses of the*
12036 *quantitative project management process to determine its ability*
12037 *to achieve the established quantitative quality and process*
12038 *performance objectives. [GP119]*

12039 **GG 5 Institutionalize an Optimizing Process**

12040 *The process is institutionalized as an optimizing process.*

12041 **GP 5.1 Ensure Continuous Process Improvement**

12042 *Ensure continuous improvement of the quantitative project*
12043 *management process in fulfilling the relevant business goals of*
12044 *the organization. [GP125]*

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GP 5.2 Correct Common Cause of Problems

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Identify and correct the root causes of defects and other problems in the quantitative project management process. [GP121]

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12048 ENGINEERING

12049 The following section contains all of the process areas that belong to
12050 the Engineering process area category. The Engineering process areas
12051 of CMMI are as follows: [FM106.T101]

- 12052 • Requirements Management
- 12053 • Requirements Development
- 12054 • Technical Solution
- 12055 • Product Integration
- 12056 • Verification
- 12057 • Validation

12058 *Refer to the Understanding the Model chapter of the Overview section*
12059 *for more information about the Engineering process areas and how they*
12060 *interact.* [FM106.T101.R101]

12061 REQUIREMENTS MANAGEMENT

12062 Engineering

12063 Purpose

12064 The purpose of Requirements Management is to manage the
12065 requirements of the project's products and product components and to
12066 identify inconsistencies between those requirements and the project's
12067 plans and work products. [PA146]

12068 Introductory Notes

12069 The term "requirements" refers to product and product component
12070 requirements that are received by or generated by the project, including
12071 those requirements levied on the project by the organization. The
12072 requirements are both technical and non-technical. The practices in the
12073 Requirements Management process area are the source for the current,
12074 approved set of requirements upon which all of the practices in the
12075 other project process areas act. [PA146.N101]

12076 The project takes appropriate steps to ensure that the agreed-upon set
12077 of requirements is managed to support the planning and execution
12078 needs of the project. When a project receives requirements from an
12079 approved requirements provider, the requirements are reviewed with
12080 the requirements provider to resolve issues and prevent
12081 misunderstanding before the requirements are incorporated into the
12082 project's plans. After agreement between the requirements provider and
12083 the requirements receiver, commitment to the requirements is obtained
12084 from the project participants who have to do project activities and
12085 implement the requirements. The project manages changes to the
12086 requirements as they evolve during the project and identifies any
12087 inconsistencies that occur between the plans and work products and
12088 the requirements. [PA146.N102]

12089 Part of the management of requirements is to capture requirements
12090 changes and rationale and maintain bi-directional traceability among
12091 source requirements and all product and product component
12092 requirements. [PA146.N103]

12093 This process area is tightly coupled with the Requirements
12094 Development and the Technical Solution process areas, which address
12095 the processes for transforming stakeholder needs into product
12096 requirements and deciding how to allocate or distribute requirements
12097 among the product components. The practices in the Requirements
12098 Management process area should be done concurrently with the
12099 practices in the Requirements Development process area and the
12100 Technical Solution process area when those practices are
12101 implemented. [PA146.N104]

12102 Related Process Areas

12103 *Refer to the Requirements Development process area for more*
12104 *information regarding transforming stakeholder needs into product*
12105 *requirements and deciding how to allocate or distribute requirements*
12106 *among the product components.* [PA146.R101]

12107 *Refer to the Technical Solution process area for more information about*
12108 *transforming requirements into technical solutions.* [PA146.R102]

12109 *Refer to the Project Planning process area for more information about*
12110 *how project plans reflect requirements and need to be revised as*
12111 *requirements change.* [PA146.R103]

12112 *Refer to the Configuration Management process area for more*
12113 *information about baselining and controlling changes to configuration*
12114 *documentation for requirements* [PA146.R104]

12115 *Refer to the Project Monitoring and Control process area for more*
12116 *information about tracking and controlling the activities and work*
12117 *products that are based on the requirements.* [PA146.R105]

12118 Specific Goals

12119 **SG 1 Manage Requirements** [PA146.IG101]

12120 ***Requirements are managed and inconsistencies with project plans and work***
12121 ***products are identified.***

12122 Generic Goals

12123 **GG 1 Achieve Specific Goals** [CL102.GL101]

12124 ***The process supports and enables achievement of the specific goals of the***
12125 ***process area by transforming identifiable input work products to produce***
12126 ***identifiable output work products.***

12127 **GG 2** Institutionalize a Managed Process [CL103.GL101]

12128 *The process is institutionalized as a managed process.*

12129 **GG 3** Institutionalize a Defined Process [CL104.GL101]

12130 *The process is institutionalized as a defined process.*

12131 **GG 4** Institutionalize a Quantitatively Managed Process [CL105.GL101]

12132 *The process is institutionalized as a quantitatively managed process.*

12133 **GG 5** Institutionalize an Optimizing Process [CL106.GL101]

12134 *The process is institutionalized as an optimizing process.*

12135 Practice to Goal Relationship Table

12136	SG 1 Manage Requirements [PA146.IG101]	
12137	SP 1.1-1	Obtain an Understanding of Requirements
12138	SP 1.2-2	Obtain Commitment to Requirements
12139	SP 1.3-1	Manage Requirements Changes
12140	SP 1.4-2	Maintain Bi-directional Traceability of Requirements
12141	SP 1.5-1	Identify Inconsistencies between Project Work and Requirements
12142	GG 1 Achieve Specific Goals [CL102.GL101]	
12143	GP 1.1	Identify Work Scope
12144	GP 1.2	Perform Base Practices
12145	GG 2 Institutionalize a Managed Process [CL103.GL101]	
12146	GP 2.1	Establish an Organizational Policy
12147	GP 2.2	Plan the Process
12148	GP 2.3	Provide Resources
12149	GP 2.4	Assign Responsibility
12150	GP 2.5	Train People
12151	GP 2.6	Manage Configurations
12152	GP 2.7	Identify and Involve Relevant Stakeholders
12153	GP 2.8	Monitor and Control the Process
12154	GP 2.9	Objectively Evaluate Adherence
12155	GP 2.10	Review Status with Higher-Level Management
12156	GG 3 Institutionalize a Defined Process [CL104.GL101]	
12157	GP 3.1	Establish a Defined Process
12158	GP 3.2	Collect Improvement Information
12159	GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]	
12160	GP 4.1	Establish Quality Objectives
12161	GP 4.2	Stabilize Subprocess Performance
12162	GG 5 Institutionalize an Optimizing Process [CL106.GL101]	
12163	GP 5.1	Ensure Continuous Process Improvement
12164	GP 5.2	Correct Common Cause of Problems

12165 Specific Practices by Goal

12166 **SG 1 Manage Requirements** [PA146.IG101]

12167 ***Requirements are managed and inconsistencies with project plans and work***
 12168 ***products are identified.***

12169 The goal is to provide the project with a current, approved set of
 12170 requirements over the life of the project, manage all changes to the
 12171 requirements, make sure the relationships between the requirements
 12172 and other entities affected by the requirements are captured bi-
 12173 directionally and identify inconsistencies between the set of
 12174 requirements and the project plans and work products. Identified
 12175 inconsistencies then generate corrective actions. [PA146.IG101.N101]

12176 Refer to the *Technical Solution* process area for more information about
12177 determining the feasibility of the requirements. [PA146.IG101.N101.R101]

12178 Refer to the *Requirements Development* process area for more
12179 information about ensuring that the requirements reflect the needs and
12180 expectations of the customer. [PA146.IG101.N101.R102]

12181 **For Software Engineering**
12182 The requirements may be a subset of the overall product
12183 requirements, or they may constitute the entire product
12184 requirements [PA146.IG101.AMP101]

12185 **For Systems Engineering**
12186 Each level of product component design (e.g., segment,
12187 subsystem) receives the requirements from the higher level.
12188 [PA146.IG101.AMP102]

12189 **SP 1.1-1 Obtain an Understanding of Requirements**

12190 **Develop an understanding with the requirements providers on the**
12191 **meaning of the requirements.** [PA146.IG101.SP101]

12192 As the project matures and requirements are derived, all activities or
12193 disciplines will receive requirements. To avoid requirements creep or
12194 “leakage,” criteria are established to designate appropriate channels, or
12195 official sources, from which to receive requirements. The receiving
12196 activities conduct analyses of the requirements with the requirements
12197 provider to ensure that a compatible, shared understanding is reached
12198 on the meaning of the requirements. The result of this analysis and
12199 dialog is an agreed-to set of requirements. [PA146.IG101.SP101.N101]

12200 **Typical Work Products**

- 12201 1. Lists of criteria for distinguishing appropriate requirements
12202 providers [PA146.IG101.SP101.W101]
- 12203 2. Lists of criteria for establishing an understanding [PA146.IG101.SP101.W102]
- 12204 3. Results of analyses against criteria [PA146.IG101.SP101.W103]
- 12205 4. An agreed-to set of requirements [PA146.IG101.SP101.W104]

12206 **Subpractices**

- 12207 1. Establish criteria for distinguishing appropriate requirements
12208 providers. [PA146.IG101.SP101.SubP101]
- 12209 2. Establish objective criteria for the acceptance of requirements.
12210 [PA146.IG101.SP101.SubP102]

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Examples of criteria are as follows: [PA146.IG101.SP101.SubP102.N101]

- Clearly and properly stated
- Complete
- Consistent with each other
- Uniquely identified
- Appropriate to implement
- Verifiable (for example, testable)
- Traceable

3. Analyze requirements to assure the established criteria are met.

[PA146.IG101.SP101.SubP103]

4. Reach an understanding of the requirements with the requirements provider sufficient so the project participants can commit to them.

[PA146.IG101.SP101.SubP104]

SP 1.2-2 Obtain Commitment to Requirements

Obtain commitment to the requirements from the project participants. [PA146.IG101.SP102]

Refer to the Project Monitoring and Control process area for more information about monitoring the commitments made. [PA146.IG101.SP102.R101]

For Integrated Product and Process Development

When integrated teams are formed, the project participants are the integrated teams and their members. Commitment to the requirement for interacting with other integrated teams is as important for each integrated team as its commitments to product and other project requirements. [PA146.IG101.SP102.AMP101]

Whereas the previous practice dealt with reaching an understanding with the requirements provider, this practice deals with agreements and commitments among those who have to carry out the activities necessary to implement the requirements. Requirements evolve throughout the project, especially during the activities of the Requirements Development process area and the Technical Solution process area. As the requirements evolve, a commitment to the current, approved requirements and the subsequent changes in project plans, activities, and work products are required among all relevant stakeholders. [PA146.IG101.SP102.N101]

Subpractices

1. Assess the impact of requirements on existing commitments.

[PA146.IG101.SP102.SubP101]

12249 The impact on the project participants should be evaluated when the requirements
12250 change or at the start of a new requirement. [PA146.IG101.SP102.SubP101.N101]

12251 2. Record the commitment. [PA146.IG101.SP102.SubP102]

SP 1.3-1 Manage Requirements Changes

Manage changes to the requirements as they evolve during the project. [PA146.IG101.SP103]

12255 *Refer to the Configuration Management process area for more*
12256 *information about maintaining and controlling the requirements baseline*
12257 *and on making the requirements and change data available to the*
12258 *project.* [PA146.IG101.SP103.R101]

12259 During the project, requirements change for a variety of reasons. As
12260 needs change and as work proceeds, additional requirements are
12261 derived and changes may have to be made to the existing
12262 requirements. It is essential to manage these additions and changes
12263 efficiently and effectively. To effectively analyze the impact of the
12264 changes, it is necessary that the source of each requirement is known
12265 and the rationale for any change is documented. The project manager
12266 may, however, want to track appropriate measures of requirements
12267 volatility to judge whether new or revised controls are necessary.

12268 [PA146.IG101.SP103.N101]

Typical Work Products

- 12269 1. Requirements status [PA146.IG101.SP103.W101]
- 12270 2. Requirements database [PA146.IG101.SP103.W102]
- 12271 3. Requirements decision database [PA146.IG101.SP103.W103]
- 12272

Subpractices

- 12273 1. Capture all requirements and requirements changes that are given
12274 to or generated by the project. [PA146.IG101.SP103.SubP101]
- 12275 2. Maintain the requirements change history with the rationale for the
12276 changes. [PA146.IG101.SP103.SubP102]
- 12277

12278 Maintaining the change history helps track requirements volatility.

12279 [PA146.IG101.SP103.SubP102.N101]

- 12280 3. Evaluate the impact of requirement changes from the standpoint of
12281 relevant stakeholders. [PA146.IG101.SP103.SubP103]

- 12282 4. Make the requirements and change data available to the project.

12283 [PA146.IG101.SP103.SubP104]

SP 1.4-2 Maintain Bi-directional Traceability of Requirements

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Maintain bi-directional traceability among the requirements and the project plans and work products. [PA146.IG101.SP104]

The intent of this specific practice is to maintain the bi-directional traceability of requirements for each level of product decomposition. When the requirements are managed well, traceability can be established from the source requirement to its lower-level requirements and from the lower-level requirements back to their source. Such bi-directional traceability helps determine that all source requirements have been completely addressed and that all lower-level requirements can be traced to a valid source. Requirements traceability can also cover the relationships to other entities such as the product, changes in design documentation, test plans, verifications, validations, and work tasks. The traceability should cover the horizontal as well as the vertical relationships, such as across interfaces. Traceability is particularly needed in conducting the impact assessment of requirements changes on the project plans, activities, and work products. [PA146.IG101.SP104.N101]

Typical Work Products

1. Requirements traceability matrix [PA146.IG101.SP104.W101]
2. Requirements tracking system [PA146.IG101.SP104.W102]

Subpractices

1. Maintain requirements traceability to ensure that the source of lower-level (derived) requirements is captured. [PA146.IG101.SP104.SubP101]
2. Maintain requirements traceability from a requirement to its derived requirements and the allocation to functions, objects, people, and processes. [PA146.IG101.SP104.SubP102]
3. Maintain horizontal traceability from function to function and across interfaces. [PA146.IG101.SP104.SubP103]
4. Generate the requirements traceability matrix. [PA146.IG101.SP104.SubP104]

SP 1.5-1 Identify Inconsistencies between Project Work and Requirements

Identify inconsistencies between the project plans and work products and the requirements. [PA146.IG101.SP105]

Refer to the Project Monitoring and Control process area for more information about monitoring and controlling the project plans and work products for consistency with requirements. [PA146.IG101.SP105.R101]

12319 Although some work products resulting from this activity would be
 12320 updated project plans, activities, and work products, these are products
 12321 of the Project Planning process area, not Requirements Management.
 12322 This practice finds the inconsistencies between the requirements and
 12323 the project plans and work products and initiates the corrective action to
 12324 fix them. [PA146.IG101.SP105.N101]

12325 **Typical Work Products**

- 12326 1. Documentation of inconsistencies including sources, conditions,
 12327 rationales [PA146.IG101.SP105.W101]
- 12328 2. Corrective action requirements [PA146.IG101.SP105.W102]
- 12329 3. Corrective action [PA146.IG101.SP105.W103]

12330 **Subpractices**

- 12331 1. Review the project's plans, activities, and work products for
 12332 consistency with the requirements and the changes made to them.
 12333 [PA146.IG101.SP105.SubP101]
- 12334 2. Identify the source of the inconsistency and the rationale.
 12335 [PA146.IG101.SP105.SubP102]
- 12336 3. Identify changes that need to be made to the plans and work
 12337 products resulting from changes to the requirements baseline.
 12338 [PA146.IG101.SP105.SubP103]
- 12339 4. Initiate corrective actions. [PA146.IG101.SP105.SubP104]

12340 **Generic Practices by Goal**

12341 **GG 1 Achieve Specific Goals**

12342 *The process supports and enables achievement of the specific goals of the*
 12343 *process area by transforming identifiable input work products to produce*
 12344 *identifiable output work products.*

12345 **GP 1.1 Identify Work Scope**

12346 *Identify the scope of the work to be performed and work products*
 12347 *to be produced for requirements management, and communicate*
 12348 *this information to those performing the work.* [GP101]

12349 **GP 1.2 Perform Base Practices**

12350 *Perform the base practices of the requirements management*
 12351 *process to develop work products and provide services to achieve*
 12352 *the specific goals of the process area.* [GP102]

12353 **GG 2 Institutionalize a Managed Process**

12354 ***The process is institutionalized as a managed process.***

12355 **GP 2.1 Establish an Organizational Policy**

12356 ***Establish and maintain an organizational policy for planning and***
12357 ***performing the requirements management process.* [GP103]**

12358 Elaboration:

12359 This policy establishes organizational expectations for managing
12360 requirements and identifying inconsistencies between the requirements
12361 and the project plans and work products. [PA146.EL101]

12362 **GP 2.2 Plan the Process**

12363 ***Establish and maintain the requirements and objectives, and plans***
12364 ***for performing the requirements management process.* [GP104]**

12365 Elaboration:

12366 These requirements, objectives, and plans are typically described in the
12367 project plan as described in the Project Planning process area.
12368 [PA146.EL102]

12369 **GP 2.3 Provide Resources**

12370 ***Provide adequate resources for performing the requirements***
12371 ***management process, developing the work products and***
12372 ***providing the services of the process.* [GP105]**

12373 Elaboration:

12374 Examples of tools used in performing the activities of the Requirements
12375 Management process area include the following: [PA146.EL113]

- 12376 • Requirements tracking tools
- 12377 • Traceability tools

12378

12379 **GP 2.4 Assign Responsibility**

12380 ***Assign responsibility and authority for performing the process,***
12381 ***developing the work products, and providing the services of the***
12382 ***requirements management process.* [GP106]**

12383

GP 2.5 Train People

12384

Train the people performing or supporting the requirements management process as needed. [GP107]

12385

12386

Elaboration:

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Examples of training topics include the following: [PA146.EL105]

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- Application domain

12389

- Requirements definition, analysis, review, and management

12390

- Requirements management tools

12391

- Configuration management

12392

- Negotiation and conflict resolution

12393

12394

GP 2.6 Manage Configurations

12395

Place designated work products of the requirements management process under appropriate levels of configuration management.

12396

[GP109]

12397

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Elaboration:

12399

Examples of work products placed under configuration management include the following: [PA146.EL108]

12400

- Requirements

12401

- Requirements traceability matrix

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GP 2.7 Identify and Involve Relevant Stakeholders

12405

Identify and involve the relevant stakeholders of the requirements management process as planned. [GP124]

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12407

Elaboration:

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For engineering processes, consider stakeholders among customers, end-users, developers, producers, testers, suppliers, marketers, maintainers, disposal personnel, and others who may be affected by, or may affect, the product as well as the process. [PA146.EL115]

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Examples of activities for stakeholder involvement include: [PA146.EL116]

- Resolving issues on the understanding of the requirements
- Assessing the impact of requirements changes
- Communicating the bi-directional traceability
- Identifying inconsistencies between project work and requirements

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GP 2.8 Monitor and Control the Process

Monitor and control the requirements management process against the plan and take appropriate corrective action. [GP110]

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Elaboration:

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Examples of measures used in monitoring and controlling the activities of the Requirements Management process area include the following:
[PA146.EL111]

- Requirements volatility (percentage of requirements changed)

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GP 2.9 Objectively Evaluate Adherence

Objectively evaluate adherence of the requirements management process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

12432

Elaboration:

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Examples of activities reviewed include the following: [PA146.EL112]

- Managing requirements
- Identifying inconsistencies between the project plans and work products and the requirements

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Examples of work products reviewed include the following: [PA146.EL114]

- Requirements
- Requirements traceability matrix

12442 **GP 2.10 Review Status with Higher-Level Management**

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

12446 **GG 3 Institutionalize a Defined Process**

12447

The process is institutionalized as a defined process.

12448 **GP 3.1 Establish a Defined Process**

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Establish and maintain the description of a defined requirements management process. [GP114]

12451 **GP 3.2 Collect Improvement Information**

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Collect work products, measures, measurement results, and improvement information derived from planning and performing the requirements management process to support the future use and improvement of the organization's processes and process assets. [GP117]

12457 **GG 4 Institutionalize a Quantitatively Managed Process**

12458

The process is institutionalized as a quantitatively managed process.

12459 **GP 4.1 Establish Quality Objectives**

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Establish and maintain quantitative objectives for the requirements management process about quality and process performance based on customer needs and business objectives.
[GP118]

12464 **GP 4.2 Stabilize Subprocess Performance**

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12466
12467
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Stabilize the performance of one or more subprocesses of the requirements management process to determine its ability to achieve the established quantitative quality and process performance objectives. [GP119]

12469 **GG 5 Institutionalize an Optimizing Process**

12470

The process is institutionalized as an optimizing process.

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GP 5.1 Ensure Continuous Process Improvement

Ensure continuous improvement of the requirements management process in fulfilling the relevant business goals of the organization. [GP125]

12475
12476
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GP 5.2 Correct Common Cause of Problems

Identify and correct the root causes of defects and other problems in the requirements management process. [GP121]

12478 REQUIREMENTS DEVELOPMENT

12479 Engineering

12480 Purpose

12481 The purpose of Requirements Development is to produce and analyze
12482 customer, product, and product component requirements. [PA157]

12483 Introductory Notes

12484 The Requirements Development process area includes three principal
12485 groups of practices. The first includes those required to define a
12486 complete set of customer requirements to use in the development of
12487 product requirements. The second includes those required to define a
12488 complete set of product and product component requirements to use in
12489 the design of the products and product components. The third includes
12490 those for performing the necessary analysis to define, derive and
12491 understand the requirements. The three groups of practices may
12492 interact recursively with each other and the definition of alternative
12493 solutions and preferred product concepts developed in the Technical
12494 Solution process area. [PA157.N101]

12495 Requirements are developed that will be the basis for design. This
12496 includes the following: [PA157.N102]

- 12497 • Collection and coordination of stakeholder needs
- 12498 • Development of the life-cycle requirements of the product
- 12499 • Establishment of the customer requirements
- 12500 • Establishment of initial product and product component
12501 requirements consistent with customer requirements
- 12502 • Elicitation, analysis, and communication of customer needs,
12503 expectations, and constraints to obtain customer requirements that
12504 constitute an understanding of what will satisfy stakeholders

12505 This process area addresses all customer requirements rather than only
12506 product-level requirements because the customer may also provide
12507 specific design requirements. [PA157.N103]

12508 Customer requirements are further refined into product and product
12509 component requirements. In addition to customer requirements, product
12510 and product component requirements are derived from the selected
12511 solution. [PA157.N104]

12512 Requirements evolve throughout the product life cycle. Design
12513 decisions, subsequent corrective actions, and feedback from
12514 production, integration, verification, validation, product operations,
12515 support, and disposal are analyzed for impact on derived and allocated
12516 requirements. [PA157.N105]

12517 Analyses are used to understand, define, and select the requirements
12518 at all levels from competing alternatives. Analysis includes the
12519 following: [PA157.N106]

- 12520 • Analysis of needs and requirements
- 12521 • Development of an operational concept
- 12522 • Definition of the required functionality
- 12523 • Development of manufacturing and support concepts to address
12524 cost and affordability

12525 The definition of functionality, also referred to as functional analysis, is
12526 not the same as structured analysis in software development and does
12527 not presume a functionally oriented software design. In object oriented
12528 software design, it relates to defining the services. The definition of
12529 functions, their logical groupings, and association with requirements is
12530 referred to as a functional architecture. [PA157.N107]

12531 Analyses occur recursively at successively more detailed layers of a
12532 product's architecture, until sufficient detail is available to enable
12533 detailed design, acquisition, and testing of the product to proceed. As a
12534 result of the analysis of requirements and the operational concept
12535 (including functionality, support, maintenance, and disposal) and the
12536 manufacturing or production concept produces more derived
12537 requirements including consideration of the following the following:

12538 [PA157.N108]

- 12539 • Constraints of various types
- 12540 • Technological limitations
- 12541 • Cost and cost drivers
- 12542 • Time constraints and schedule drivers
- 12543 • Risks
- 12544 • Consideration of issues implied but not explicitly stated by the
12545 customer or end-user
- 12546 • Factors introduced by the developer's unique business
12547 considerations, regulations, and laws

12548 A hierarchy of logical entities (functions and subfunctions, object
12549 classes and subclasses) is established through iteration with the
12550 evolving operational concept. Requirements are refined, derived and
12551 allocated to these logical entities. Requirements and logical entities are
12552 allocated to products, product components, people, associated
12553 processes, or services. [PA157.N109]

12554 Involvement of all relevant stakeholders in both requirements
12555 development and analysis gives them visibility into the evolution of
12556 requirements. This activity continually assures them that the
12557 requirements are being properly defined. [PA157.N110]

12558 Related Process Areas

12559 *Refer to the Requirements Management process area for more*
12560 *information about managing customer and product requirements,*
12561 *obtaining agreement with the requirements provider, obtaining*
12562 *commitments with those implementing the requirements, and*
12563 *maintaining traceability.* [PA157.R101]

12564 *Refer to the Technical Solution process area for more information about*
12565 *how the outputs of the Requirements Development process area are*
12566 *used, and the development of alternative solutions and designs used in*
12567 *refining and deriving requirements.* [PA157.R102]

12568 *Refer to the Product Integration process area for more information*
12569 *about interface requirements and interface management.* [PA157.R103]

12570 *Refer to the Verification process area for more information about*
12571 *verifying that the resulting product meets the requirements.* [PA157.R104]

12572 *Refer to the Validation process area for more information about how the*
12573 *product built will be validated against the customer needs.* [PA157.R105]

12574 *Refer to the Risk Management process area for more information about*
12575 *identifying and managing risks that are related to requirements.* [PA157.R106]

12576 *Refer to the Configuration Management process area for information*
12577 *about ensuring that key work products are controlled and managed.*
12578 [PA157.R107]

12579 Specific Goals

12580 **SG 1 Develop Customer Requirements** [PA157.IG101]

12581 ***Stakeholder needs, expectations, constraints, and interfaces are collected and***
12582 ***translated into customer requirements.***

12583 **SG 2** **Develop Product Requirements** [PA157.IG103]

12584 *Customer requirements are refined and elaborated to develop product and*
12585 *product component requirements for the product life cycle.*

12586 **SG 3** **Analyze and Validate Requirements** [PA157.IG102]

12587 *The requirements are analyzed and validated, and a definition of required*
12588 *functionality is developed.*

12589 **Generic Goals**

12590 **GG 1** **Achieve Specific Goals** [CL102.GL101]

12591 *The process supports and enables achievement of the specific goals of the*
12592 *process area by transforming identifiable input work products to produce*
12593 *identifiable output work products.*

12594 **GG 2** **Institutionalize a Managed Process** [CL103.GL101]

12595 *The process is institutionalized as a managed process.*

12596 **GG 3** **Institutionalize a Defined Process** [CL104.GL101]

12597 *The process is institutionalized as a defined process.*

12598 **GG 4** **Institutionalize a Quantitatively Managed Process** [CL105.GL101]

12599 *The process is institutionalized as a quantitatively managed process.*

12600 **GG 5** **Institutionalize an Optimizing Process** [CL106.GL101]

12601 *The process is institutionalized as an optimizing process.*

12602	Practice to Goal Relationship Table	
<hr/>		
12603	SG 1 Develop Customer Requirements [PA157.IG101]	
12604	SP 1.1-1	Collect Stakeholder Needs
12605	SP 1.1-2	Elicit Needs
12606	SP 1.2-1	Transform Stakeholder Needs, Expectations, Constraints, and Inter-
12607		faces into Customer Requirements
12608	SG 2 Develop Product Requirements [PA157.IG103]	
12609	SP 2.1-1	Establish Product and Product Component Requirements
12610	SP 2.2-1	Allocate Product Component Requirements
12611	SP 2.3-1	Identify Interface Requirements
12612	SG 3 Analyze and Validate Requirements [PA157.IG102]	
12613	SP 3.1-1	Establish Operational Concepts and Scenarios
12614	SP 3.2-1	Establish a Definition of Required Functionality
12615	SP 3.3-1	Analyze Requirements
12616	SP 3.4-3	Evaluate Product Cost, Schedule and Risk
12617	SP 3.5-1	Validate Requirements
12618	SP 3.5-2	Validate Requirements with Comprehensive Methods
12619	GG 1 Achieve Specific Goals [CL102.GL101]	
12620	GP 1.1	Identify Work Scope
12621	GP 1.2	Perform Base Practices
12622	GG 2 Institutionalize a Managed Process [CL103.GL101]	
12623	GP 2.1	Establish an Organizational Policy
12624	GP 2.2	Plan the Process
12625	GP 2.3	Provide Resources
12626	GP 2.4	Assign Responsibility
12627	GP 2.5	Train People
12628	GP 2.6	Manage Configurations
12629	GP 2.7	Identify and Involve Relevant Stakeholders
12630	GP 2.8	Monitor and Control the Process
12631	GP 2.9	Objectively Evaluate Adherence
12632	GP 2.10	Review Status with Higher-Level Management
12633	GG 3 Institutionalize a Defined Process [CL104.GL101]	
12634	GP 3.1	Establish a Defined Process
12635	GP 3.2	Collect Improvement Information
12636	GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]	
12637	GP 4.1	Establish Quality Objectives
12638	GP 4.2	Stabilize Subprocess Performance
12639	GG 5 Institutionalize an Optimizing Process [CL106.GL101]	
12640	GP 5.1	Ensure Continuous Process Improvement
12641	GP 5.2	Correct Common Cause of Problems
12642	Specific Practices by Goal	
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12643 **SG 1 Develop Customer Requirements** [PA157.IG101]

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Stakeholder needs, expectations, constraints, and interfaces are collected and translated into customer requirements.

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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. [PA157.IG101.N101]

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Frequently, stakeholder needs, expectations, constraints, and interfaces are poorly identified or conflicting. Stakeholder needs, expectations, constraints, and limitations must be clearly identified and understood. An iterative process is used throughout the life of the project to accomplish this objective. In the case of non-negotiated situations, the surrogate for the end-user or customer is frequently 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. Environmental, legal, and other constraints that may be external to the customer must also be applied when creating and resolving the set of customer requirements. [PA157.IG101.N102]

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SP 1.1-1 Collect Stakeholder Needs

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Identify and collect stakeholder needs, expectations, constraints, and interfaces for all phases of the product's life cycle.

[PA157.IG101.SP101]

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In the staged representation, this specific practice is only included as informative material and appears after specific practice 1.1-2 Elicit Needs

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The basic activity addresses the receipt of requirements that a customer provides to define what is needed or desired. These may or may not be in stated technical terms. They should address the various life-cycle activities and their impact on the product. [PA157.IG101.SP101.N101]

12673

Subpractices

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1. The basic activity addresses the receipt of requirements that a customer provides to define what is needed or desired. These may or may not be in technical terms. They should address the various life-cycle activities and their impact on the product.

[PA157.IG101.SP101.SubP101]

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Inputs include needs, expectations, constraints and external interfaces.

[PA157.IG101.SP101.SubP101.N101]

12681

SP 1.1-2 Elicit Needs

12682

Elicit stakeholder needs, expectations, constraints, and interfaces for all phases of the product's life cycle. [PA157.IG101.SP102]

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In the staged representation, this specific practice takes the place of specific practice: SP 1.1-1 Collect Stakeholder Needs.

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Eliciting goes beyond collecting requirements to proactively identify additional requirements not explicitly provided by customers. They should address the various life-cycle activities and their impact on the product. [PA157.IG101.SP102.N102]

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Examples of techniques to elicit needs include the following:

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[PA157.IG101.SP102.N103]

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- Technology demonstrations

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- Interface control working groups

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- Technical control working groups

12695

- Interim project reviews

12696

- Questionnaires, interviews, and operational scenarios obtained from end users

12697

- Prototypes and models

12698

- Brainstorming

12699

- Quality function development

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- Market surveys

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- Beta testing

12702

- Extraction from sources such as documents, standards, or specifications

12703

- Observation of existing products, environments, and workflow patterns

12704

- Use cases

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- Business case analysis

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- Reverse engineering (for legacy products)

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Subpractices

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1. Engage relevant stakeholders using methods for eliciting needs, expectations, constraints, and external interfaces (e.g., dialogue, scenario reviews, models, simulations, prototypes, or new technology demonstrations). [PA157.IG101.SP102.SubP101]

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- 12716 2. Remove conflicts in stakeholder needs, expectations, constraints,
12717 and interfaces and organize into related subjects based on
12718 analysis. [PA157.IG101.SP102.SubP102]

12719 **SP 1.2-1 Transform Stakeholder Needs, Expectations, Constraints, and In-**
12720 **terfaces into Customer Requirements**

12721 ***Transform stakeholder needs, expectations, constraints, and***
12722 ***interfaces into customer requirements.*** [PA157.IG101.SP103]

12723 *For Integrated Product and Process Development*

12724 *Stakeholders representing all phases of the product's life cycle*
12725 *should include business as well as technical functions. In this*
12726 *way, concepts for all product-related life cycle processes are*
12727 *considered concurrently with the concepts for the products.*
12728 *Customers requirements result from informed decisions on the*
12729 *business as well as technical effects of their requirements.*

12730 [PA157.IG101.SP103.AMP101]

12731 The various inputs from the customer need to be consolidated, missing
12732 information obtained, conflicts resolved and documented as the
12733 recognized set of customer requirements. The customer requirements
12734 may include needs, expectations, and constraints with regard to
12735 verification and validation. [PA157.IG101.SP103.N101]

12736 **Typical Work Products**

- 12737 1. Customer requirements [PA157.IG101.SP103.W101]
12738 2. Requirements for verification process [PA157.IG101.SP103.W102]
12739 3. Requirements for validation process [PA157.IG101.SP103.W103]
12740 4. Test cases and expected results [PA157.IG101.SP103.W104]

12741 **Subpractices**

- 12742 1. Translate the stakeholder needs, expectations, constraints, and
12743 interfaces into documented customer requirements.

12744 [PA157.IG101.SP103.SubP101]

- 12745 2. Define methods, criteria, and constraints for the verification and
12746 validation processes. [PA157.IG101.SP103.SubP102]

12747 **SG 2 Develop Product Requirements** [PA157.IG103]

12748 ***Customer requirements are refined and elaborated to develop product and***
12749 ***product component requirements for the product life cycle.***

12750 Customer requirements are analyzed in conjunction with the
12751 development of the operational concept to derive a more detailed and
12752 precise sets of requirements called "product and product component
12753 requirements." Derived requirements arise from constraints,
12754 consideration of issues implied, but not explicitly stated in the customer
12755 requirements baseline, and factors introduced by the selected
12756 architecture, the design, and the developer's unique business
12757 considerations. The requirements are re-examined with each
12758 successive, lower-level set of requirements and functional architecture,
12759 and the preferred product concept is refined. [PA157.IG103.N101]

12760 The requirements are allocated to product functions and product
12761 components including objects, people, and processes. The traceability
12762 of requirements to functions, objects, tests, issues, or other entities is
12763 captured. The allocated requirements and functions are the basis for
12764 the synthesis of the technical solution. As internal components are
12765 developed, additional interfaces are defined and interface requirements
12766 established. [PA157.IG103.N102]

12767 **SP 2.1-1 Establish Product and Product Component Requirements**

12768 ***Establish and maintain, from the customer requirements, product***
12769 ***and product component requirements essential to product and***
12770 ***product component effectiveness and affordability.*** [PA157.IG103.SP101]

12771 The customer requirements may be expressed in the customer's terms
12772 and may be non-technical descriptions. The product requirements are
12773 the expression of these requirements in technical terms that can be
12774 used for design decisions. An example of this translation is found in the
12775 first House of Quality Functional Deployment, which maps customer
12776 desires into technical parameters. For instance, "solid sounding door"
12777 might be mapped to size, weight, fit, dampening, resonant frequencies,
12778 etc. [PA157.IG103.SP101.N101]

12779 Design constraints include specifications on product components that
12780 derive from design decisions, rather than higher level requirements.
12781 [PA157.IG103.SP101.N102]

12782 ***For Software Engineering***

12783 ***For example, application components that must interface with***
12784 ***an off-the-shelf database component must comply with***
12785 ***interface requirements imposed by the selected database;***
12786 ***such product component requirements are generally not***
12787 ***traceable to higher level requirements.*** [PA157.IG103.SP101.N102.AMP101]

12788

12789 Derived requirements also address the cost and performance of other
12790 life-cycle phases (e.g., production, operations, and disposal), to the
12791 extent compatible with business objectives. [PA157.IG103.SP101.N103]

12792 **Typical Work Products**

- 12793 1. Derived requirements [PA157.IG103.SP101.W101]
12794 2. Product requirements [PA157.IG103.SP101.W102]
12795 3. Product component requirements [PA157.IG103.SP101.W103]
12796 4. House of quality [PA157.IG103.SP101.W104]

12797 **Subpractices**

- 12798 1. Develop requirements in technical terms necessary for product and
12799 product component design. [PA157.IG103.SP101.SubP101]
12800 2. Derive requirements that result from design decisions.
12801 [PA157.IG103.SP101.SubP102]

12802 Selection of a technology brings additional requirements. For instance, use of
12803 electronics necessitates additional technology specific requirements such as
12804 electromagnetic interference limits. [PA157.IG103.SP101.SubP102.N101]

12805 *Refer to the Technical Solution process area for more information about*
12806 *developing the solutions that generate additional derived requirements.*
12807 [PA157.IG103.SP101.SubP102.R101]

- 12808 3. Establish and maintain relationships between requirements for
12809 consideration during change management and requirements
12810 allocation. [PA157.IG103.SP101.SubP103]

12811 Relationships between requirements can aid in evaluating the impact of changes.
12812 [PA157.IG103.SP101.SubP103.N101]

12813 *Refer to the Requirements Management process area for more*
12814 *information about maintaining requirements traceability.*
12815 [PA157.IG103.SP101.SubP103.R101]

12816 **SP 2.2-1 Allocate Product Component Requirements**

12817 ***Allocate the requirements for each product component.***
12818 [PA157.IG103.SP102]

12819 *Refer to the Technical Solution process area for more information about*
12820 *allocation of requirements to products and product components. This*
12821 *practice provides information for defining the allocation of requirements*
12822 *but must interact with the practices in the Technical Solution process*
12823 *area to establish solutions to which the requirements are allocated.*
12824 [PA157.IG103.SP102.R101]

12825 The requirements for product components of the defined solution
 12826 include allocation of product performance, design constraints, and fit,
 12827 form, and function to meet requirements and facilitate production. In
 12828 cases where a higher level requirement specifies performance that will
 12829 be the responsibility of two or more product components, the
 12830 performance must be partitioned for unique allocation to each product
 12831 component as a derived requirement. [PA157.IG103.SP102.N101]

12832 **Typical Work Products**

- 12833 1. Requirement allocation sheets [PA157.IG103.SP102.W101]
- 12834 2. Provisional requirement allocations [PA157.IG103.SP102.W102]
- 12835 3. Design constraints [PA157.IG103.SP102.W103]
- 12836 4. Derived requirements [PA157.IG103.SP102.W104]
- 12837 5. Relationships between derived requirements [PA157.IG103.SP102.W105]
- 12838 6. Specifications [PA157.IG103.SP102.W106]

12839 **Subpractices**

- 12840 1. Allocate requirements to functions. [PA157.IG103.SP102.SubP101]
 - 12841 2. Allocate requirements to product components. [PA157.IG103.SP102.SubP102]
 - 12842 3. Allocate design constraints to product components.
 12843 [PA157.IG103.SP102.SubP103]
 - 12844 4. Document relationships between allocated requirements.
 12845 [PA157.IG103.SP102.SubP104]
- 12846 Relationships include dependencies such that a change in one requirement may
 12847 affect other requirements. [PA157.IG103.SP102.SubP104.N101]

12848 **SP 2.3-1 Identify Interface Requirements**

12849 ***Identify interface requirements.*** [PA157.IG103.SP103]

12850 Interfaces between functions (or between objects) are defined.
 12851 Functional interfaces may drive the development of alternative solutions
 12852 in the Technical Solution process area. [PA157.IG103.SP103.N101]

12853 *Refer to the Product Integration process area for more information*
 12854 *about the management of interfaces and the integration of products and*
 12855 *product components.* [PA157.IG103.SP103.N101.R101]

12856 Interface requirements between products or product components
 12857 identified in the architecture and design are defined. They are
 12858 controlled as part of product and product component integration.
 12859 [PA157.IG103.SP103.N102]

12860 Life-cycle process interfaces must also be identified. [PA157.IG103.SP103.N103]

12861 Examples of these interfaces include interfaces with test equipment,
12862 transportation systems, support systems, and manufacturing facilities.
12863 [PA157.IG103.SP103.N104]

12864

12865 **Typical Work Products**

12866 1. Interface requirements [PA157.IG103.SP103.W101]

12867 **Subpractices**

12868 1. Identify interface requirements both external to the product and
12869 internal to the product (i.e., between functional partitions or
12870 objects). [PA157.IG103.SP103.SubP101]

12871 2. Fully define interfaces in terms of origination, destination, stimulus,
12872 and data characteristics for software, electrical, and mechanical
12873 characteristics for hardware. [PA157.IG103.SP103.SubP102]

12874 For internal interfaces, this information may be created as part of the design
12875 process. [PA157.IG103.SP103.SubP102.N101]

12876 *Refer to the Technical Solution process area for information about*
12877 *generating interface requirements during the design process. As*
12878 *architectures are determined and interfaces are created, new interfaces*
12879 *are created. Also, as interface designs are defined, the design*
12880 *becomes a requirement for products and product components that are*
12881 *affected by the interface* [PA157.IG103.SP103.SubP102.R101]

12882 **SG 3 Analyze and Validate Requirements** [PA157.IG102]

12883 ***The requirements are analyzed and validated, and a definition of required***
12884 ***functionality is developed.***

12885 Analyses are performed to determine what impact the intended
12886 operational environment will have on the ability to satisfy the
12887 stakeholders' needs, expectations, constraints, and interfaces.
12888 Considerations such as feasibility, mission needs, cost constraints,
12889 potential market size, and acquisition strategy must all be taken into
12890 account, depending on the product context. A definition of required
12891 functionality is also established. All specified usage modes for the
12892 product are considered, and a time line analysis is generated for time
12893 critical sequencing of functions. [PA157.IG102.N101]

12894 The objectives of the analyses are to determine candidate requirements
12895 for product concepts that will satisfy stakeholder needs, expectations,
12896 and constraints; and then translate these concepts into requirements. In
12897 parallel with this activity, the parameters that will be used to evaluate
12898 the effectiveness of the product are determined based on customer
12899 input and the preliminary product concept. [PA157.IG102.N102]

12900 Requirements are validated to increase probability that the resulting
12901 product will perform as intended in the use environment. [PA157.IG102.N103]

SP 3.1-1 Establish Operational Concepts and Scenarios

Establish and maintain operational concepts and scenarios.

[PA157.IG102.SP101]

Refer to the Technical Solution process area for detailed development of operations that are dependent on the selected designs.

[PA157.IG102.SP101.R101]

12908 A scenario is a sequence of events that might occur in the use of the
12909 product that is used to make explicit some of the needs of the
12910 stakeholders. In contrast, an operational concept for a product usually
12911 depends on both the design solution and the scenario. For example, the
12912 operational concept for a satellite-based communications product is
12913 quite different from one based on landlines. Since the alternative
12914 solutions have not usually been defined when preparing the initial
12915 operational concepts, conceptual solutions are developed for use when
12916 analyzing the requirements. The operational concepts are refined as
12917 solution decisions are made and lower-level detailed requirements are
12918 developed. [PA157.IG102.SP101.N101]

12919 Just as a design decision for a product may become a requirement for
12920 product components, the operational concept may become the
12921 scenarios (requirements) for product components. [PA157.IG102.SP101.N102]

12922 The scenarios may include operational sequences, provided those
12923 sequences are an expression of customer requirements rather than
12924 operational concepts. [PA157.IG102.SP101.N103]

Typical Work Products

- 12925 1. Operational concept [PA157.IG102.SP101.W101]
- 12926 2. Product installation, operational, maintenance and support
12927 concepts [PA157.IG102.SP101.W102]
- 12928 3. Disposal concepts [PA157.IG102.SP101.W103]
- 12929 4. Use cases [PA157.IG102.SP101.W104]
- 12930 5. Timeline scenarios [PA157.IG102.SP101.W105]
- 12931

- 12932 6. New requirements [PA157.IG102.SP101.W106]
- 12933 **Subpractices**
- 12934 1. Develop operational concepts and scenarios that include
- 12935 functionality, performance, maintenance, support, and disposal as
- 12936 appropriate. [PA157.IG102.SP101.SubP101]
- 12937 Identify and develop scenarios, consistent with the level of detail in the
- 12938 stakeholder needs, expectations and constraints, in which the proposed product is
- 12939 expected to operate. [PA157.IG102.SP101.SubP101.N101]
- 12940 2. Define the environment the product will operate in, including
- 12941 boundaries and constraints. [PA157.IG102.SP101.SubP102]
- 12942 3. Review operational concepts and scenarios to refine and discover
- 12943 requirements. [PA157.IG102.SP101.SubP103]
- 12944 Operational concept and scenario development is an iterative process. The
- 12945 reviews should be held periodically to ensure that they agree with the
- 12946 requirements. The review may be in the form of a walkthrough.
- 12947 [PA157.IG102.SP101.SubP103.N101]
- 12948 4. Develop a detailed operational concept as products and product
- 12949 components are selected that define the interaction of the product,
- 12950 the end-user, and the environment, that satisfies the operational,
- 12951 maintenance, support, and disposal needs. [PA157.IG102.SP101.SubP104]

12952 **SP 3.2-1 Establish a Definition of Required Functionality**

12953 ***Establish and maintain a definition of required functionality.***

12954 [PA157.IG102.SP102]

12955 The definition of functionality, also referred to as functional analysis, is

12956 the description of what the product is intended to do. The definition of

12957 functionality can include actions, sequence, inputs, outputs or other

12958 information that communicates the manner in which the product will be

12959 used. [PA157.IG102.SP102.N101]

12960 Functional analysis is not the same as structured analysis in software

12961 development and does not presume a functionally oriented software

12962 design. In object oriented software design, it relates to defining the

12963 services. The definition of functions, their logical groupings and

12964 association with requirements is referred to as a functional architecture.

12965 [PA157.IG102.SP102.N102]

12966 **Typical Work Products**

- 12967 1. Functional architecture [PA157.IG102.SP102.W101]
- 12968 2. Activity diagrams and use cases [PA157.IG102.SP102.W102]

- 12969 3. Object oriented analysis with services identified [PA157.IG102.SP102.W103]
- 12970 **Subpractices**
- 12971 1. Analyze and quantify functionality required by end users.
12972 [PA157.IG102.SP102.SubP101]
- 12973 2. Analyze requirements to identify logical or functional partitions
12974 (e.g., subfunctions). [PA157.IG102.SP102.SubP102]
- 12975 3. Partition requirements into groups, based on established criteria
12976 (e.g., similar functionality, performance, or coupling) to facilitate
12977 and focus the requirements analysis. [PA157.IG102.SP102.SubP103]
- 12978 4. Consider the sequencing of time-critical functions both initially and
12979 subsequently during product component development.
12980 [PA157.IG102.SP102.SubP104]
- 12981 5. Allocate customer requirements to functional partitions, objects,
12982 people, or support elements to support the synthesis of solutions.
12983 [PA157.IG102.SP102.SubP105]
- 12984 6. Allocate functional and performance requirements to functions and
12985 subfunctions. [PA157.IG102.SP102.SubP106]

SP 3.3-1 Analyze Requirements

Analyze derived requirements to ensure that they are necessary and sufficient. [PA157.IG102.SP103]

12989 The derived requirements are analyzed in light of the operational
12990 concept and scenarios to support the development of a more detailed
12991 and precise set of product or product component requirements. The
12992 analysis makes sure that the derived requirements are necessary and
12993 sufficient to meet the objectives of higher level requirements.
12994 [PA157.IG102.SP103.N102]

12995 As requirements are defined, their relationship to higher level
12996 requirements and the higher level defined functionality must be
12997 understood. One of the other key actions is the determination of which
12998 requirements will be identified to track technical progress against. For
12999 instance, the weight of a product or size of a software product may be
13000 monitored through development based on its risk. [PA157.IG102.SP103.N101]

Typical Work Products

- 13001 1. Requirements defects reports [PA157.IG102.SP103.W101]
- 13002 2. Proposed requirements changes to resolve defects
13003 [PA157.IG102.SP103.W102]
- 13004 3. Key requirements [PA157.IG102.SP103.W103]
- 13005

- 13006 4. Technical performance measures [PA157.IG102.SP103.W104]
- 13007 **Subpractices**
- 13008 1. Analyze stakeholder needs, expectations, constraints, and external
13009 interfaces to remove conflicts and to organize into related subjects.
13010 [PA157.IG102.SP103.SubP101]
- 13011 2. Analyze derived requirements to determine whether they satisfy
13012 the objectives of higher-level requirements. [PA157.IG102.SP103.SubP102]
- 13013 3. Analyze requirements to ensure that they are complete, feasible,
13014 realizable, and verifiable. [PA157.IG102.SP103.SubP103]
- 13015 While design determines the feasibility of a particular solution, this subpractice
13016 addresses the understanding of which requirements impact feasibility.
13017 [PA157.IG102.SP103.SubP103.N101]
- 13018 4. Identify key requirements that have a strong influence on cost,
13019 schedule, functionality, risk, or performance. [PA157.IG102.SP103.SubP104]
- 13020 5. Identify technical performance measures that will be tracked during
13021 the development effort. [PA157.IG102.SP103.SubP105]
- 13022 *Refer to the Measurement and Analysis process area for more*
13023 *information on the general use of measurements.* [PA157.IG102.SP103.SubP105.R101]
- 13024 6. Analyze operational concepts and scenarios to refine the customer
13025 needs, constraints and interfaces and discover new requirements.
13026 [PA157.IG102.SP103.SubP106]
- 13027 This analysis may result in more detailed operational concepts and scenarios as
13028 well as supporting the derivation of new requirements. [PA157.IG102.SP103.SubP106.N101]

13029 **SP 3.4-3 Evaluate Product Cost, Schedule and Risk**

13030 ***Analyze requirements with the purpose of reducing the life-cycle***
13031 ***cost, schedule and risk of product development.*** [PA157.IG102.SP104]

13032 Use validated models, simulations, and prototyping to analyze the cost
13033 and risk associated with the customer requirements. Results of the
13034 analyses can be used to reduce the cost of the product and the risk in
13035 developing the product. [PA157.IG102.SP104.N101]

13036 **Typical Work Products**

- 13037 1. Assessment of risks related to requirements [PA157.IG102.SP104.W101]

13038 **Subpractices**

- 13039 1. Perform a risk assessment on the requirements and functional
13040 architecture. [PA157.IG102.SP104.SubP101]

13041 Refer to the Risk Management process area for information about
13042 performing a risk assessment on customer and product requirements
13043 and the functional architecture. [PA157.IG102.SP104.SubP101.R101]

13044 2. Examine life-cycle concepts for impacts of requirements on risks.
13045 [PA157.IG102.SP104.SubP102]

13046 **SP 3.5-1 Validate Requirements**

13047 ***Validate requirements to ensure the resulting product will perform***
13048 ***appropriately in its intended use environment.*** [PA157.IG102.SP105]

13049 In the staged representation, this specific practice is only included as informative
13050 material and appears after specific practice 3.5-2 Validate Requirements with
13051 Comprehensive Methods

13052 Requirements validation is performed early in the development effort to
13053 gain confidence that the requirements are capable of guiding a
13054 development that results in successful final validation. This activity
13055 should be integrated with the risk management activities.

13056 [PA157.IG102.SP105.N101]

13057 **Typical Work Products**

13058 1. Results of requirements validation [PA157.IG102.SP105.W101]

13059 **Subpractices**

13060 1. Analyze the requirements to determine the risk that the resulting
13061 product will not perform appropriately in its intended use
13062 environment. [PA157.IG102.SP105.SubP101]

13063 **SP 3.5-2 Validate Requirements with Comprehensive Methods**

13064 ***Validate requirements to ensure the resulting product will perform***
13065 ***as intended in the user's environment using multiple techniques***
13066 ***as appropriate.*** [PA157.IG102.SP106]

13067 In the staged representation, this specific practice takes the place of specific
13068 practice: SP 3.5-1 Validate Requirements.

13069 Requirements validation is performed early in the development effort to
 13070 gain confidence that the requirements are capable of guiding a
 13071 development that results in successful final validation. This activity
 13072 should be integrated with the risk management activities. Mature
 13073 organizations will typically perform requirements validation in a more
 13074 sophisticated way and will broaden the basis of the validation to include
 13075 other stakeholder needs and expectations. These organizations will
 13076 typically perform analyses, simulations, or prototypes to ensure that
 13077 requirements will satisfy stakeholder needs and expectations.
 13078 [PA157.IG102.SP106.N102]

13079 **Typical Work Products**

- 13080 1. Record of analysis methods and results [PA157.IG102.SP106.W101]

13081 **Subpractices**

- 13082 1. Analyze the requirements to determine the risk that the resulting
 13083 product will not perform appropriately in its intended use
 13084 environment. [PA157.IG102.SP106.SubP101]
- 13085 2. Explore the adequacy and completeness of requirements by
 13086 showing the customers and end users prototypes, simulations,
 13087 analyses, scenarios, and storyboards. [PA157.IG102.SP106.SubP102]
- 13088 3. Assess the design as it matures in the context of the requirements
 13089 validation environment to identify validation issues and expose
 13090 unstated needs and customer requirements. [PA157.IG102.SP106.SubP103]

13091 **Generic Practices by Goal**

13092 **GG 1 Achieve Specific Goals**

13093 *The process supports and enables achievement of the specific goals of the*
 13094 *process area by transforming identifiable input work products to produce*
 13095 *identifiable output work products.*

13096 **GP 1.1 Identify Work Scope**

13097 *Identify the scope of the work to be performed and work products*
 13098 *to be produced for requirements development, and communicate*
 13099 *this information to those performing the work.* [GP101]

13100 **GP 1.2 Perform Base Practices**

13101 *Perform the base practices of the requirements development*
 13102 *process to develop work products and provide services to achieve*
 13103 *the specific goals of the process area.* [GP102]

13104 **GG 2 Institutionalize a Managed Process**

13105 ***The process is institutionalized as a managed process.***

13106 **GP 2.1 Establish an Organizational Policy**

13107 ***Establish and maintain an organizational policy for planning and***
13108 ***performing the requirements development process.* [GP103]**

13109 Elaboration:

13110 This policy establishes organizational expectations for collecting
13111 stakeholder needs, formulating product and product component
13112 requirements, and analyzing and validating those requirements.

13113 [PA157.EL101]

13114 **GP 2.2 Plan the Process**

13115 ***Establish and maintain the requirements and objectives, and plans***
13116 ***for performing the requirements development process.* [GP104]**

13117 Elaboration:

13118 These requirements, objectives, and plans are typically described in the
13119 project plan as described in the Project Planning process area.

13120 [PA157.EL102]

13121 **GP 2.3 Provide Resources**

13122 ***Provide adequate resources for performing the requirements***
13123 ***development process, developing the work products and***
13124 ***providing the services of the process.* [GP105]**

13125 Elaboration:

13126 Special expertise in the application domain, methods for eliciting
13127 stakeholder needs, and methods and tools for specifying and analyzing
13128 customer, product and product component requirements may be
13129 required. [PA157.EL103]

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Examples of tools used to perform the activities of the Requirements Development process area include the following: [PA157.EL104]

- Requirements specification tools
- Simulators and modeling tools
- Prototyping tools
- Scenario definition and management tools
- Requirements tracking tools

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GP 2.4 Assign Responsibility

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

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13144

GP 2.5 Train People

Train the people performing or supporting the requirements development process as needed. [GP107]

13145

Elaboration:

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Examples of training topics include the following: [PA157.EL105]

- Application domain
- Requirements definition and analysis
- Requirements elicitation
- Requirements specification and modeling
- Requirements tracking

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13156

GP 2.6 Manage Configurations

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

13157

Elaboration:

13158

Examples of work products placed under configuration management include the following: [PA157.EL106]

13159

13160

- Customer requirements

13161

- Functional architecture

13162

- Product and product component requirements

13163

- Interface requirements

13164

13165

GP 2.7 Identify and Involve Relevant Stakeholders

13166

Identify and involve the relevant stakeholders of the requirements development process as planned. [GP124]

13167

13168

Elaboration:

13169

For engineering processes, consider stakeholders among customers, end users, developers, producers, testers, suppliers, marketers, maintainers, disposal personnel, and others who may be affected by, or may affect, the product as well as the process. [PA157.EL113]

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Examples of activities for stakeholder involvement include: [PA157.EL114]

13174

- Reviewing adequacy of requirements to meet needs, expectations, constraints, and interfaces.

13175

13176

- Establishing operational concepts and scenarios

13177

- Assessing the adequacy of requirements

13178

- Establishing product and product component requirements

13179

- Assessing product cost, schedule, and risk

13180

13181

GP 2.8 Monitor and Control the Process

13182

Monitor and control the requirements development process against the plan and take appropriate corrective action. [GP110]

13183

13184 Elaboration:

13185 Examples of measures used in monitoring and controlling the activities
13186 of the Requirements Development process area include the following:

13187 [PA157.EL110]

- 13188 • Cost, schedule, and effort expended for rework
- 13189 • Defect density of requirements specifications

13190

13191 **GP 2.9 Objectively Evaluate Adherence**

13192 ***Objectively evaluate adherence of the requirements development***
13193 ***process and the work products and services of the process to the***
13194 ***applicable requirements, objectives, and standards, and address***
13195 ***noncompliance.*** [GP113]

13196 Elaboration:

13197 Examples of activities reviewed include the following: [PA157.EL111]

- 13198 • Collecting stakeholder needs
- 13199 • Formulating product and product component requirements
- 13200 • Analyzing and validating product and product component
- 13201 requirements

13202

13203 Examples of work products reviewed include the following: [PA157.EL112]

- 13204 • Product requirements
- 13205 • Product component requirements
- 13206 • Interface requirements
- 13207 • Functional architecture

13208

13209 **GP 2.10 Review Status with Higher-Level Management**

13210 ***Review the activities, status, and results of the requirements***
13211 ***development process with higher-level management and resolve***
13212 ***issues.*** [GP112]

13213 **GG 3 Institutionalize a Defined Process**

13214 ***The process is institutionalized as a defined process.***

13215	GP 3.1	Establish a Defined Process
13216		<i>Establish and maintain the description of a defined requirements development process. [GP114]</i>
13217		
13218	GP 3.2	Collect Improvement Information
13219		<i>Collect work products, measures, measurement results, and improvement information derived from planning and performing the requirements development process to support the future use and improvement of the organization's processes and process assets. [GP117]</i>
13220		
13221		
13222		
13223		
13224	GG 4	Institutionalize a Quantitatively Managed Process
13225		<i>The process is institutionalized as a quantitatively managed process.</i>
13226	GP 4.1	Establish Quality Objectives
13227		<i>Establish and maintain quantitative objectives for the requirements development process about quality and process performance based on customer needs and business objectives. [GP118]</i>
13228		
13229		
13230		
13231	GP 4.2	Stabilize Subprocess Performance
13232		<i>Stabilize the performance of one or more subprocesses of the requirements development process to determine its ability to achieve the established quantitative quality and process performance objectives. [GP119]</i>
13233		
13234		
13235		
13236	GG 5	Institutionalize an Optimizing Process
13237		<i>The process is institutionalized as an optimizing process.</i>
13238	GP 5.1	Ensure Continuous Process Improvement
13239		<i>Ensure continuous improvement of the requirements development process in fulfilling the relevant business goals of the organization. [GP125]</i>
13240		
13241		
13242	GP 5.2	Correct Common Cause of Problems
13243		<i>Identify and correct the root causes of defects and other problems in the requirements development process. [GP121]</i>
13244		

13245 TECHNICAL SOLUTION

13246 Engineering

13247 Purpose

13248 The purpose of Technical Solution is to develop, design, and implement
13249 solutions to requirements. Solutions, designs and implementations
13250 encompass products, product components, and product related
13251 processes either singly or in combinations as appropriate. [PA160]

13252 Introductory Notes

13253 The Technical Solution process area is applicable at any level of the
13254 product architecture and to every product, product component, life cycle
13255 process, and service. The process area focuses on the following:

13256 [PA160.N101]

- 13257 • Evaluating and selecting solutions (sometimes referred to as
13258 design approaches, design concepts or preliminary designs) that
13259 potentially satisfy an appropriate set of allocated requirements
- 13260 • Developing detailed designs for the selected solutions (detailed in
13261 the context of containing all the information needed to
13262 manufacture, code, or otherwise implement the design as a
13263 product or product component)
- 13264 • Implementing the designs as a product or product component

13265 In practice, these activities interactively support with each other. Some
13266 level of design, at times fairly detailed, may be needed to select
13267 solutions. Product component prototypes may be used as a means of
13268 gaining sufficient knowledge to develop a complete technical data
13269 package or a complete set of requirements. [PA160.N102]

13270 Technical Solution practices apply not only to the product and product
13271 components but also to services and product-related processes. The
13272 product-related processes are developed in concert with product, or
13273 product component, development. Such development may include
13274 selecting and adapting existing processes (including standard
13275 processes) for use as well as developing new processes. [PA160.N103]

13276 Requirements for the product that originate in the Requirements
13277 Development process area or elsewhere are received from the
13278 Requirements Management process area after they have been placed
13279 under appropriate configuration management and after the traceability
13280 to previous requirements has been accomplished. [PA160.N104]

13281 For a sustainment organization, the requirements in need of
13282 maintenance actions or redesign may be driven by user needs or latent
13283 defects in the product components. New requirements may arise from
13284 changes in the life cycle utilization or other aspects of the operating
13285 environment for which modifications may be necessary (e.g., changes
13286 in stress spectrum resulting in unplanned for and accelerated
13287 mechanical aging or changes in the operating system software). Such
13288 occurrences are uncovered during continuous verification of the
13289 product(s) as used in their operating environment. These verifications
13290 expose actual performance delivered which can be compared against
13291 the performance specified and unacceptable degradation identified. The
13292 Technical Solution practices should be used to perform the sustainment
13293 design efforts. [PA160.N105]

13294 Related Process Areas

13295 *Refer to the Requirements Development process area for more*
13296 *information about requirements allocations, establishing operational*
13297 *concept, and interface requirements definition. Technical solutions are*
13298 *developed interactively with requirements definition and both evolve*
13299 *with requirements and stimulate requirements to be refined as the*
13300 *technical solution matures. [PA160.R101]*

13301 *Refer to the Verification process area for more information about*
13302 *conducting peer reviews, and verifying that the product and product*
13303 *components meet requirements. As verification issues are identified,*
13304 *the design may need to change. [PA160.R102]*

13305 *Refer to the Decision Analysis and Resolution process area for more*
13306 *information about structured decision making. Selecting the solution*
13307 *from a set of design alternatives is one place the structured Decision*
13308 *Analysis and Resolution process area should be used. [PA160.R103]*

13309 *Refer to the Requirements Management process area for more*
13310 *information about managing requirements. The practices in*
13311 *Requirements Management should be executed concurrently with*
13312 *Technical Solution. [PA160.R104]*

13313 *Refer to the Organizational Innovation and Deployment process area*
13314 *for more information about the organization's technology processes.*
13315 [PA160.R105]

13316 Specific Goals

13317 **SG 1** **Select Product Component Solutions** [PA160.IG101]

13318 *Product or product component solutions, including applicable product related*
13319 *processes, are selected from alternative solutions.*

13320 **SG 2** **Develop the Design** [PA160.IG102]

13321 *Product or product component designs are developed.*

13322 **SG 3** **Implement the Product Design** [PA160.IG103]

13323 *Product components, and associated support documentation, are*
13324 *implemented from their designs.*

13325 Generic Goals

13326 **GG 1** **Achieve Specific Goals** [CL102.GL101]

13327 *The process supports and enables achievement of the specific goals of the*
13328 *process area by transforming identifiable input work products to produce*
13329 *identifiable output work products.*

13330 **GG 2** **Institutionalize a Managed Process** [CL103.GL101]

13331 *The process is institutionalized as a managed process.*

13332 **GG 3** **Institutionalize a Defined Process** [CL104.GL101]

13333 *The process is institutionalized as a defined process.*

13334 **GG 4** **Institutionalize a Quantitatively Managed Process** [CL105.GL101]

13335 *The process is institutionalized as a quantitatively managed process.*

13336 **GG 5** **Institutionalize an Optimizing Process** [CL106.GL101]

13337 *The process is institutionalized as an optimizing process.*

13338 Practice to Goal Relationship Table

- 13339 SG 1 Select Product Component Solutions [PA160.IG101]
- 13340 SP 1.1-1 Develop Alternative Solutions and Selection Criteria
- 13341 SP 1.1-2 Develop Detailed Alternative Solutions and Selection Criteria
- 13342 SP 1.2-2 Evolve Operational Concepts and Scenarios
- 13343 SP 1.3-1 Select Product Component Solutions

- 13344 SG 2 Develop the Design [PA160.IG102]
- 13345 SP 2.1-1 Use Effective Design Methods
- 13346 SP 2.2-1 Develop a Technical Data Package
- 13347 SP 2.2-3 Establish a Complete Technical Data Package
- 13348 SP 2.3-1 Establish Interface Descriptions
- 13349 SP 2.3-3 Design Comprehensive Interface
- 13350 SP 2.4-3 Perform Make, Buy, or Reuse Analyses

- 13351 SG 3 Implement the Product Design [PA160.IG103]
- 13352 SP 3.1-1 Implement the Design
- 13353 SP 3.2-1 Establish Product Support Documentation

- 13354 GG 1 Achieve Specific Goals [CL102.GL101]
- 13355 GP 1.1 Identify Work Scope
- 13356 GP 1.2 Perform Base Practices

- 13357 GG 2 Institutionalize a Managed Process [CL103.GL101]
- 13358 GP 2.1 Establish an Organizational Policy
- 13359 GP 2.2 Plan the Process
- 13360 GP 2.3 Provide Resources
- 13361 GP 2.4 Assign Responsibility
- 13362 GP 2.5 Train People
- 13363 GP 2.6 Manage Configurations
- 13364 GP 2.7 Identify and Involve Relevant Stakeholders
- 13365 GP 2.8 Monitor and Control the Process
- 13366 GP 2.9 Objectively Evaluate Adherence
- 13367 GP 2.10 Review Status with Higher-Level Management

- 13368 GG 3 Institutionalize a Defined Process [CL104.GL101]
- 13369 GP 3.1 Establish a Defined Process
- 13370 GP 3.2 Collect Improvement Information

- 13371 GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]
- 13372 GP 4.1 Establish Quality Objectives
- 13373 GP 4.2 Stabilize Subprocess Performance

- 13374 GG 5 Institutionalize an Optimizing Process [CL106.GL101]
- 13375 GP 5.1 Ensure Continuous Process Improvement
- 13376 GP 5.2 Correct Common Cause of Problems

13377 Specific Practices by Goal

13378 **SG 1 Select Product Component Solutions** [PA160.IG101]

13379 ***Product or product component solutions, including applicable product related***
 13380 ***processes, are selected from alternative solutions.***

13381 Alternative solutions and their relative merits are considered in advance
 13382 of selecting a solution. Key requirements, design issues and constraints
 13383 are established for use in alternative solutions analysis. Architectural
 13384 features that provide a foundation for product improvement and
 13385 evolution are considered. Use of commercial-off-the-shelf (COTS)
 13386 product components are considered relative to cost, schedule,
 13387 performance, and risk. COTS alternatives may be used with or without
 13388 modification. Sometimes such items may require modifications to
 13389 aspects such as interfaces or a customization of some of the features
 13390 to better achieve product requirements. [PA160.IG101.N101]

13391 One indicator of a good design process is that the design was chosen
 13392 after comparing and evaluating it against alternative solutions.
 13393 Decisions on architecture, custom development versus off-the-shelf,
 13394 and component modularization are typical of the design choices that are
 13395 addressed. [PA160.IG101.N102]

13396 Sometimes the search for solutions examines alternative instances of
 13397 the same requirements with no allocations needed to lower-level
 13398 components. Such is the case at the bottom of the product
 13399 architecture. There are also cases where one or more of the solutions
 13400 is fixed (e.g., a specific solution is directed or available products
 13401 components, such as COTS, are investigated for use). [PA160.IG101.N103]

13402 In the general case, solutions are defined as a set. That is, when
 13403 defining the next layer of product components, the solution for each of
 13404 the product components in the set are established together. The
 13405 alternative solutions are not only different ways of addressing the same
 13406 requirements, but they also reflect a different allocation of requirements
 13407 among the product components comprising the solution set. The
 13408 objective is to optimize the set as a whole and not the individual pieces.
 13409 There will be significant interaction with the Requirements Development
 13410 process area to support the provisional allocations to product
 13411 components until a solution set is selected and “final” allocations
 13412 established. [PA160.IG101.N104]

13413 **SP 1.1-1 Develop Alternative Solutions and Selection Criteria**

13414 ***Develop alternative solutions and establish selection criteria.***

13415 [PA160.IG101.SP101]

13416 In the staged representation, this specific practice is only included as informative
 13417 material and appears after specific practice 1.1-2 Develop Detailed Alternative
 13418 Solutions and Selection Criteria

13419 *Refer to the Allocate Product Component Requirements specific*
 13420 *practice in the Requirements Development process area for more*
 13421 *information about obtaining provisional allocations of requirements to*
 13422 *solution alternatives for the product components.* [PA160.IG101.SP101.R101]

13423 *Refer to the Decision Analysis and Resolution process area for*
13424 *practices used to determine the need for establishing when alternatives*
13425 *may not be useful.* [PA160.IG101.SP101.R102]

13426 *Refer to the Requirements Management process area for more*
13427 *information about managing the provisional and established allocated*
13428 *requirements.* [PA160.IG101.SP101.R103]

13429 Alternatives frequently span a design space that explores the feasible
13430 solutions available. As selections are made, the design space may be
13431 constricted and other alternatives examined until the most promising
13432 (i.e., optimal) solutions that meet requirements and established criteria
13433 are identified. The selection criteria identify the key factors that provide
13434 a basis for the selection of the solution. These criteria should provide
13435 meaningful discrimination and an indication of success or goodness in
13436 arriving at a life cycle balanced solution. They typically include
13437 measures of cost, schedule, performance, and risk. The alternative
13438 solutions evaluated frequently encompass alternative requirement
13439 allocations to different product components. These alternatives may
13440 also be structured to evaluate the use of COTS solutions in the product
13441 architecture. Practices such as those in the Requirements
13442 Development process area would then be employed to provide a more
13443 complete and robust provisional allocation of requirements to the
13444 alternative solutions. Selection of the “best” solution establishes the
13445 requirements provisionally allocated to that solution as the set of
13446 allocated requirements. The circumstances in which it would be “not
13447 useful” to examine alternative solutions are infrequent in new
13448 developments. However, developments of precedented product
13449 components are candidates for not examining, or only minimally
13450 examining, alternative solutions. [PA160.IG101.SP101.N101]

13451 **Typical Work Products**

- 13452 1. Alternative solutions [PA160.IG101.SP101.W101]
13453 2. Selection criteria [PA160.IG101.SP101.W102]

13454 **Subpractices**

- 13455 1. Establish and maintain a process or processes for identifying
13456 solution alternatives, selection criteria, and design issues.
13457 [PA160.IG101.SP101.SubP101]

13458 Selection criteria are influenced by a wide variety of factors driven by the
 13459 requirements imposed on the develop program as well as the life cycle of the
 13460 product. For example, criteria related to mitigating cost and schedule risks may
 13461 influence a greater preference for COTS solutions provided such selections do not
 13462 result in unacceptable risks in the remaining product components to be
 13463 developed. When using existing items, such as COTS, either with or without
 13464 modification, criteria dealing with diminishing sources of supply or technological
 13465 obsolescence should be examined as well as criteria capturing the benefits of
 13466 standardization, maintaining relationships with suppliers and so forth. The criteria
 13467 used in selections should provide a balanced approach to costs, benefits, and
 13468 risks. [PA160.IG101.SP101.SubP101.N101]

13469 2. Identify alternative groupings of requirements that characterize sets
 13470 of solution alternatives that span the feasible design space.
 13471 [PA160.IG101.SP101.SubP102]

13472 Effective employment of COTS alternatives can provide special challenges.
 13473 Knowledgeable designers familiar with candidate COTS alternatives may explore
 13474 architectural opportunities to exploit potential COTS payoff.
 13475 [PA160.IG101.SP101.SubP102.N101]

13476 3. Identify design issues for each solution alternative in each set of
 13477 alternatives. [PA160.IG101.SP101.SubP103]

13478 4. Characterize design issues and take appropriate action.
 13479 [PA160.IG101.SP101.SubP104]

13480 Appropriate actions could range from characterizing the issues as a risk for risk
 13481 management, adjusting the solution alternative to preclude the issue, rejecting the
 13482 solution alternative and replacing it with a different alternative.
 13483 [PA160.IG101.SP101.SubP104.N101]

13484 5. Obtain a complete requirements allocation for each alternative.
 13485 [PA160.IG101.SP101.SubP105]

13486 6. Establish the rationale for each alternative set of solutions.
 13487 [PA160.IG101.SP101.SubP106]

13488 **SP 1.1-2 Develop Detailed Alternative Solutions and Selection Criteria**

13489 ***Develop detailed alternative solutions and selection criteria.***

13490 [PA160.IG101.SP102]

13491 In the staged representation, this specific practice takes the place of specific
 13492 practice: SP 1.1-1 Develop Alternative Solutions and Selection Criteria.

13493 *Refer to the Decision Analysis and Resolution process area for more*
 13494 *information about establishing criteria used in making structured*
 13495 *decisions.* [PA160.IG101.SP102.R101]

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For Integrated Product and Process Development

The practice of selecting alternative solutions and issues to be subject to decision analyses and trade studies is accomplished by the involvement of relevant stakeholders, representing both business and technical functions and the concurrent development of the life cycle processes (e.g., manufacturing, support, training, verification and disposal) with the product. In this way, important issues surface earlier in the product development than with traditional practices and can be addressed before they become costly mistakes.

[PA160.IG101.SP102.AMP101]

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Detailed alternative solutions are an essential concept of Technical Solution. They provide more accurate and comprehensive information about the solution than non-detailed alternatives. For example, characterization of performance based on design content rather than on simple estimating enables effective assessment and understanding of environment and operating concept impacts. Alternative solutions need to be identified and analyzed to enable the selection of a life cycle balanced solution in terms of cost, schedule, and technical performance. Alternative solutions span the acceptable range of cost, schedule, and performance. The product component requirements are received and used along with design issues, constraints, and criteria to develop the alternative solutions. Selection criteria would typically address costs (e.g., time, people, money), benefits (e.g., performance, capability, effectiveness), and risks (e.g., executability, technical, cost, schedule). Detailed alternative solutions and selection criteria include the following: [PA160.IG101.SP102.N102]

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- Cost (development, procurement/reprocurement, support, life cycle)
- Technical performance
- Complexity of the product component and related life cycle processes
- Robustness to product operating and use conditions, operating modes, environments, and variations in related life-cycle processes
- Product expansion and growth
- Technology limitations
- Sensitivity to construction methods and materials
- Risk
- Evolution of requirements and technology
- Disposal

13537 The considerations listed above are a basic set; organizations should
13538 develop a list of screening criteria for alternatives that are consistent
13539 with business objectives. Life-cycle cost, while being a desirable
13540 parameter to minimize, may be outside the control of development
13541 organizations. A customer may not be willing to pay for features that
13542 cost more in the short term but ultimately decrease cost over the life of
13543 the product. In such cases, customers should at least be advised of
13544 any potential for reducing life-cycle costs. The criteria used in
13545 selections should provide a balanced approach to costs, benefits, and
13546 risks. [PA160.IG101.SP102.N103]

13547 **Typical Work Products**

- 13548 1. Alternative solutions [PA160.IG101.SP102.W101]
- 13549 2. Selection criteria [PA160.IG101.SP102.W102]
- 13550 3. Checklists for alternative solution screening criteria
13551 [PA160.IG101.SP102.W103]
- 13552 4. Evaluations of new technologies [PA160.IG101.SP102.W104]

13553 **Subpractices**

- 13554 1. Identify screening criteria to select a set of alternative solutions for
13555 consideration. [PA160.IG101.SP102.SubP101]
- 13556 2. Identify technologies currently in use and new product technologies
13557 for competitive advantage. [PA160.IG101.SP102.SubP102]

13558 The project should identify technologies applied to current products and
13559 processes and monitor the progress of currently used technologies through their
13560 life cycle. The project should identify, select, evaluate, and invest in new
13561 technologies to achieve competitive advantage. Alternative solutions could include
13562 newly developed technologies, but could also include applying mature
13563 technologies in different applications or to maintain current methods.
13564 [PA160.IG101.SP102.SubP102.N101]

13565 *Refer to the Organizational Innovation and Deployment process area*
13566 *for more information about the organization's technology processes.*
13567 [PA160.IG101.SP102.SubP102.R101]

- 13568 3. Generate alternative solutions. [PA160.IG101.SP102.SubP103]
- 13569 4. Obtain a complete requirements allocation for each alternative.
13570 [PA160.IG101.SP102.SubP104]
- 13571 5. Establish the criteria for selecting the best alternative solution.
13572 [PA160.IG101.SP102.SubP105]

13573 Criteria should be included addressing life cycle design issues such as provisions
13574 for more easily inserting new technologies or ability to better exploit commercial
13575 products. Examples would include criteria related to open design or open
13576 architecture concepts for the alternatives being evaluated. [PA160.IG101.SP102.SubP105.N101]

13577 6. Develop timeline scenarios for product operation and user
13578 interaction for each alternative solution. [PA160.IG101.SP102.SubP106]

13579 **SP 1.2-2 Evolve Operational Concepts and Scenarios**

13580 ***Evolve the operational concept, scenarios, and environments to***
13581 ***describe the conditions, operating modes, and operating states***
13582 ***specific to each product component.*** [PA160.IG101.SP103]

13583 *Refer to the Establish Operational Concepts and Scenarios specific*
13584 *practice of the Requirements Development process area for information*
13585 *on product-level influences and implications of product component*
13586 *operations.* [PA160.IG101.SP103.R101]

13587 ***For Systems Engineering***
13588 *Integrate the operational concepts and scenarios produced by*
13589 *various individuals or groups for each level of physical product*
13590 *decomposition.* [PA160.IG101.SP103.AMP101]

13591 Operational concepts and scenarios document the stimulus-response
13592 time sequenced behavior of the interaction of the product components
13593 with the environment, users, and other components. They should be
13594 documented for operations, product deployment/delivery, support
13595 (including maintenance and sustainment), training, and disposal and for
13596 all modes and states. The environments (operating, support, training,
13597 etc.) also need to be evolved. The environment experienced by any
13598 given product component will be influenced by other product
13599 components as well as the external environment. The environments
13600 may include thermal, stress, and electromagnetic and other elements
13601 that need to be documented. [PA160.IG101.SP103.N101]

13602 **Typical Work Products**

13603 1. Product component operational concepts, scenarios, and
13604 environments for all pertinent life-cycle processes (operations,
13605 support, training, manufacturing, verification,
13606 deployment/fielding/delivery/disposal) [PA160.IG101.SP103.W101]

13607 2. Timeline analyses of product component interactions
13608 [PA160.IG101.SP103.W102]

13609 3. Event trace diagrams [PA160.IG101.SP103.W103]

13610 4. Use cases [PA160.IG101.SP103.W104]

SP 1.3-1 Select Product Component Solutions

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Select the product component solutions that best satisfy the criteria established. [PA160.IG101.SP104]

Refer to the Allocate Product Component Requirements and Identify Interface Requirements specific practices of the Requirements Development process area for information on establishing the allocated requirements for product components and interface requirements between product components. [PA160.IG101.SP104.R101]

Refer to the Decision Analysis and Resolution process area for more information about structured decision making. [PA160.IG101.SP104.R102]

Selection of the product components that best satisfies the criteria establishes the requirement allocations to product components. The selected alternative is either evolved as lower-level requirements or used to develop the technical data package. The product component to product component interface requirements will be described predominately functionally. Physical interface descriptions will be included in the technical data package when the interface is to items/activities external to the product. [PA160.IG101.SP104.N101]

The description of the solutions and the rationale for selection are documented in an initial technical data package. The technical data package evolves throughout development as solutions and detailed designs are developed and those designs implemented. Maintaining a record of rationale is critical to downstream decision making. Such records keep downstream stakeholders from redoing work and provide insights to apply technology, as it becomes available in applicable circumstances. [PA160.IG101.SP104.N102]

Typical Work Products

1. Product component selection decisions and rationale [PA160.IG101.SP104.W101]
2. Documented relationships between requirements and product components [PA160.IG101.SP104.W102]
3. Initial product component technical data package. [PA160.IG101.SP104.W103]

Subpractices

1. Evaluate each alternative solution/set of solutions against the selection criteria established in the context of the operating concepts, operating modes, and operating states. [PA160.IG101.SP104.SubP101]
2. Based on the evaluation of alternatives, assess the adequacy of the selection criteria and update these criteria as necessary. [PA160.IG101.SP104.SubP102]

- 13651 3. Identify and resolve issues with the alternative solutions and
13652 requirements. [PA160.IG101.SP104.SubP103]
- 13653 4. Select the “best” set of alternative solutions that satisfy the
13654 established selection criteria. [PA160.IG101.SP104.SubP104]
- 13655 5. Establish the requirements associated with the selected set of
13656 alternatives to be the set of allocated requirements to those
13657 product components. [PA160.IG101.SP104.SubP105]
- 13658 6. Establish and maintain the documentation of the solutions,
13659 evaluations, and rationale. [PA160.IG101.SP104.SubP106]

13660 **SG 2 Develop the Design** [PA160.IG102]

13661 ***Product or product component designs are developed.***

13662 Product or product component designs must provide the appropriate
13663 life-cycle content not just for implementation, but also for modification,
13664 reprocurement, maintenance, sustainment, and installation. The design
13665 documentation provides a reference to support mutual understanding of
13666 the design by relevant stakeholders and supports future changes to the
13667 design both during development and downstream in the product life
13668 cycle. A complete design description is documented in a technical data
13669 package that includes a full range of features and parameters including
13670 form, fit, function, interface, manufacturing process characteristics, and
13671 other parameters. Established organizational or project design
13672 standards (e.g., checklists, templates) form the basis for achieving a
13673 high degree of definition and completeness in design documentation.
13674 [PA160.IG102.N101]

13675 ***For Integrated Product and Process Development***

13676 *The integrated teams develop the designs of the appropriate*
13677 *life cycle processes, e.g., the manufacturing process and the*
13678 *support process, concurrently with the design of the product*
13679 *unless these processes are selected and not modified from*
13680 *the organization’s set of standard processes.* [PA160.IG102.AMP101]

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13682 **SP 2.1-1 Use Effective Design Methods**

13683 ***Establish and use effective design methods.*** [PA160.IG102.SP101]

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For Software Engineering

Use effective methods to design software. Examples of techniques and methods that facilitate effective software design include the following: [PA160.IG102.SP101.AMP101]

- *Prototypes*
- *Structural models*
- *Object-oriented design*
- *Essential systems analysis*
- *Entity relationship models*
- *Design reuse*
- *Design patterns*

Effective design methods can embody a wide range of activities, tools, and descriptive techniques. Whether a given method is effective or not depends on the situation. For example, software design tools are not particularly effective methods to use when designing hydraulic pumps. Two companies may have very effective design methods for products they specialize in but these methods may not be effective in cooperative ventures. Highly sophisticated methods are not necessarily effective in the hands of designers that have not been trained in the used of the methods. [PA160.IG102.SP101.N101]

Whether or not a method is effective also depends on how much assistance it provides the designer, and the cost effectiveness of that assistance. For example, a multi-year prototyping effort may not be appropriate for a pump or a software module but might be the right thing to do for an unprecedented, expensive, and complex product development. Rapid prototyping techniques (for example, stereo lithography for the pump), however, may be highly effective for product components of that product. Methods that use tools to ensure that a design will encompass all the necessary attributes needed to implement the product component design can be very effective. For example, a design tool that “knows” the capabilities of the manufacturing processes can allow the variability of the manufacturing process to be accounted for in the design tolerances. [PA160.IG102.SP101.N102]

Typical Work Products

1. Criteria for design methods [PA160.IG102.SP101.W101]
2. Design methods [PA160.IG102.SP101.W102]
3. Criteria for selection of the design method [PA160.IG102.SP101.W103]
4. Design tools [PA160.IG102.SP101.W104]

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5. Design processes/activities [PA160.IG102.SP101.W105]

Subpractices

1. Establish and maintain criteria against which the effectiveness of design methods can be determined. [PA160.IG102.SP101.SubP101]
2. Identify, develop, or acquire the design methods that satisfy the criteria. [PA160.IG102.SP101.SubP102]
3. Ensure that the design methods adhere to applicable design standards and criteria. [PA160.IG102.SP101.SubP103]

Examples of design standards include the following (some or all of these "standards" may be design criteria, particularly in circumstances where the standards have not been established): [PA160.IG102.SP101.SubP103.N101]

- Operator interface standards
- Safety standards
- Production constraints
- Design tolerances
- Parts standards (e.g., production scrap and waste)

Examples of attributes for which design criteria can be established may include the following: [PA160.IG102.SP101.SubP103.N102]

- Modularity
- Clarity
- Simplicity
- Maintainability
- Verifiability
- Portability
- Reliability
- Accuracy
- Security
- Performance
- Scalability
- Usability

4. Establish the design methods and their applicability to various aspects of product component design. [PA160.IG102.SP101.SubP104]

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For example, this may include a mechanism for determining whether prototyping or other techniques are appropriate parts of the design process.

[PA160.IG102.SP101.SubP104.N101]

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5. Use the design method(s) that have been established as effective for the applicable portions of the design. [PA160.IG102.SP101.SubP105]

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SP 2.2-1 Develop a Technical Data Package

Develop a product or product component technical data package.

[PA160.IG102.SP102]

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In the staged representation, this specific practice is only included as informative material and appears after specific practice 2.2-3 Establish a Complete Technical Data Package

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The technical data package provides the description of a product or product component (including product-related processes if not handled as separate product components) that supports an acquisition strategy, or the implementation, production, engineering, and logistics support portions of the product life cycle. The description includes the definition of the required design configuration and procedures to ensure adequacy of product or product component performance. It includes all applicable technical data such as drawings, associated lists, specifications, standards, performance requirements, quality assurance provisions, and packaging details. The technical data package includes a description of the selected alternative solution that was chosen for implementation. [PA160.IG102.SP102.N101]

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Typical Work Products

1. Technical data package [PA160.IG102.SP102.W101]

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SP 2.2-3 Establish a Complete Technical Data Package

Establish and maintain a complete technical data package.

[PA160.IG102.SP103]

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In the staged representation, this specific practice takes the place of specific practice: SP 2.2-1 Develop a Technical Data Package.

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A complete technical data package provides the developer with a comprehensive description of the product or product component as it develops. Such a package also provides procurement flexibility in a variety of circumstances such as performance-based contracting or build-to-print. [PA160.IG102.SP103.N102]

13794 A complete technical data package would provide the following if such
13795 information is appropriate to the type of product and product component
13796 (for example, material or manufacturing requirements may not be useful
13797 for software only, service, or process product components):

13798 [PA160.IG102.SP103.N103]

- 13799 • product component descriptions in terms of required life-cycle
13800 functionality and performance
- 13801 • product-related process descriptions if not described as separate
13802 product components
- 13803 • key product characteristics
- 13804 • required physical characteristics and constraints
- 13805 • interface requirements
- 13806 • materials requirements (bills of material and material
13807 characteristics)
- 13808 • fabrication/manufacturing requirements (for both the original
13809 equipment manufacturer and field support)
- 13810 • the verification criteria used to ensure requirements have been
13811 achieved
- 13812 • conditions of use (environments) and operating/usage scenarios,
13813 modes and states for operations, support, training, manufacturing,
13814 disposal, and verifications throughout the life cycle
- 13815 • rationale for decisions and characteristics (requirements,
13816 requirement allocations; design choices)

13817 Because design descriptions can involve a very large amount of data
13818 and be crucial to successful product component development, it is
13819 advisable to establish criteria for organizing the data and for selecting
13820 the data content. A particularly useful approach is to choose a
13821 taxonomy in which the top level consists of design views such as the
13822 following: [PA160.IG102.SP103.N104]

- 13823 • customers
- 13824 • the environment
- 13825 • functionality
- 13826 • data
- 13827 • states/modes
- 13828 • construction
- 13829 • management

13830 These views are captured in the complete technical data package.

13831 [PA160.IG102.SP103.N105]

- 13832 **Typical Work Products**
- 13833 1. Complete technical data package [PA160.IG102.SP103.W101]
- 13834 **Subpractices**
- 13835 1. Determine the number of levels of design and the appropriate level
- 13836 of documentation for each design level. [PA160.IG102.SP103.SubP101]
- 13837 Determining the number of levels of product components (e.g., subsystem,
- 13838 hardware configuration item, circuit board, computer software configuration item
- 13839 (CSCI), computer software component, computer software unit) that require
- 13840 documentation and requirements traceability is important to manage
- 13841 documentation costs and to support integration and verification plans.
- 13842 [PA160.IG102.SP103.SubP101.N101]
- 13843 2. Base detailed designs on the allocated product component
- 13844 requirements, architecture, and higher level designs.
- 13845 [PA160.IG102.SP103.SubP102]
- 13846 3. Document the design in the technical data package.
- 13847 [PA160.IG102.SP103.SubP103]
- 13848 4. Capture the rationale for key (i.e., significant effect on cost,
- 13849 schedule or technical performance) decisions made or defined.
- 13850 [PA160.IG102.SP103.SubP104]
- 13851 5. Revise the design as necessary. [PA160.IG102.SP103.SubP105]

13852 **SP 2.3-1 Establish Interface Descriptions**

13853 ***Establish and maintain the solution for product component***

13854 ***interfaces.*** [PA160.IG102.SP104]

13855 In the staged representation, this specific practice is only included as informative

13856 material and appears after specific practice 2.3-3 Design Comprehensive

13857 Interface

13858 The product component interface description documents:

13859 [PA160.IG102.SP104.N101]

- 13860 • product component-to-product component
- 13861 • lower-level component-to-higher level component
- 13862 • product component-to-product related process
- 13863 (infrastructure/existing, reused, or developed)
- 13864 • product component-to-external item interfaces

13865 **Typical Work Products**

- 13866 1. Interface design [PA160.IG102.SP104.W101]
- 13867 2. Interface design documents [PA160.IG102.SP104.W102]

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SP 2.3-3 Design Comprehensive Interface

13869

Design product component interfaces in terms of established and maintained criteria. [PA160.IG102.SP105]

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13871

In the staged representation, this specific practice takes the place of specific practice: SP 2.3-1 Establish Interface Descriptions.

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13873

Interface designs include the following: [PA160.IG102.SP105.N101]

13874

- Origination

13875

- Destination

13876

- Stimulus and data characteristics for software

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- Electrical, mechanical, and functional characteristics for hardware.

13878

The criteria for interfaces frequently reflect a comprehensive list of critical parameters that must be defined, or at least investigated, to ascertain their applicability. These parameters are often peculiar to a given type of product (e.g., software, mechanical, electrical) and are often associated with safety, security, durability, and mission critical characteristics. [PA160.IG102.SP105.N102]

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Typical Work Products

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1. Interface specifications [PA160.IG102.SP105.W101]

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2. Interface control documents [PA160.IG102.SP105.W102]

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3. Interface specification criteria and templates [PA160.IG102.SP105.W103]

13888

4. Updates to interface specification templates [PA160.IG102.SP105.W104]

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SP 2.4-3 Perform Make, Buy, or Reuse Analyses

13890

Evaluate whether the product components should be developed, purchased, or reused based on established criteria. [PA160.IG102.SP106]

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13892

Refer to the Decision Analysis and Resolution process area for more information about defining criteria, alternatives and performing structured decision making. Make, buy, and reuse decisions significantly impact both project and organization success.

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[PA160.IG102.SP106.R101]

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Refer to the Supplier Agreement Management process area for more information about how to address the acquisition of the product components that will be purchased. [PA160.IG102.SP106.R102]

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13899

13900 As technology evolves, so does the rationale for choosing to develop or
 13901 purchase a product component. While complex development efforts
 13902 may favor purchasing an off-the-shelf component, advances in
 13903 productivity and tools may provide an opposing rationale. Off-the-shelf
 13904 products may have incomplete or inaccurate documentation and may or
 13905 may not be supported in the future. [PA160.IG102.SP106.N101]

13906 Once the decision is made to purchase an off-the-shelf product
 13907 component, the requirements are used to establish a supplier
 13908 agreement. There are times when "off-the-shelf" refers to an existing
 13909 item that may not be readily available in the marketplace. For example,
 13910 some types of aircraft, engines, etc, are not truly "on-the-shelf" but can
 13911 be readily procured. In some cases the use of such non-developed
 13912 items is in situations where the specifics of the performance and other
 13913 product characteristics expected need to be within the limits specified.
 13914 In these cases, inclusion of the requirements, and acceptance criteria,
 13915 may need to be in the supplier agreement and managed. In other
 13916 cases, the off-the-shelf product is literally off-the-shelf (word processing
 13917 software for example) and there is no agreement with the supplier that
 13918 needs to be managed. [PA160.IG102.SP106.N102]

13919 **Typical Work Products**

- 13920 1. Criteria for design and component reuse [PA160.IG102.SP106.W101]
- 13921 2. Make or buy analyses [PA160.IG102.SP106.W102]
- 13922 3. Guidelines for choosing COTS components [PA160.IG102.SP106.W103]

13923 **Subpractices**

- 13924 1. When purchased or non-developmental (COTS, government off-
 13925 the-shelf, and reuse) items are selected, plan for their
 13926 maintenance. [PA160.IG102.SP106.SubP101]

13927 *For Software Engineering*
 13928 *Consider how the compatibility of future releases of an*
 13929 *operating system and a database manager will be handled.*
 13930 [PA160.IG102.SP106.SubP101.AMP101]

13931 **SG 3 Implement the Product Design** [PA160.IG103]

Product components, and associated support documentation, are implemented from their designs.

13934 Product components are implemented from the designs established by
 13935 the practices in Goal 2. The implementation usually includes unit testing
 13936 of the product components before sending them to Product Integration
 13937 and development of end-user documentation. [PA160.IG103.N101]

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SP 3.1-1 Implement the Design

Implement the designs of the product components. [PA160.IG103.SP101]

For Software Engineering

Software code is a typical software product component.

[PA160.IG103.SP101.AMP101]

Once the design has been completed, it is implemented as a product component. The characteristics of that implementation depend on the type of product component. [PA160.IG103.SP101.N101]

Examples characteristics of this implementation are: [PA160.IG103.SP101.N102]

- Software is coded.
- Data is documented.
- Services are documented.
- Electrical and mechanical parts are fabricated.
- Product unique manufacturing processes are put into operation.
- Processes are documented (hardware and software and their integrated product components that are part of the process are built, coded, and integrated as appropriate).
- Facilities are constructed.
- Materials are produced (e.g., a product-unique material could be: a petroleum, oil, or lubricant; or a new alloy).

Typical Work Products

1. Implemented design [PA160.IG103.SP101.W101]

Subpractices

1. Use effective methods to implement the product components.

[PA160.IG103.SP101.SubP101]

For Software Engineering

Examples of software coding methods include the following:

[PA160.IG103.SP101.SubP101.AMP101]

- *Structured programming*
- *Object-oriented programming*
- *Automatic code generation*
- *Software code reuse*
- *Use of applicable design patterns*

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For Systems Engineering

Examples of appropriate fabrication methods the following:

[PA160.IG103.SP101.SubP101.AMP102]

- *Casting*
- *Molding*
- *Forming*
- *Joining*
- *Machining*
- *Tooling*
- *Welding*
- *Extruding*

Methods to implement the product components are documented, either directly or by reference, in the project's defined process. *[PA160.IG103.SP101.SubP101.N101]*

2. Adhere to applicable standards and criteria. *[PA160.IG103.SP101.SubP102]*

For Software Engineering

Examples of software coding standards include the following:

[PA160.IG103.SP101.SubP102.AMP101]

- *Languages standards*
- *Naming conventions for variables*
- *Acceptable language structures*
- *Structure and hierarchy of software components*
- *Format of code and comments*

For Software Engineering

Examples of software coding criteria include the following:

[PA160.IG103.SP101.SubP102.AMP102]

- *Modularity*
- *Clarity*
- *Simplicity*
- *Structured (e.g., no GOTOs, one entrance, and one exit)*
- *Maintainability*

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For Systems Engineering

Examples of standards include the following:

[PA160.IG103.SP101.SubP102.AMP103]

- *Standard Parts Lists*
- *Standard drawing requirements*
- *International Organization for Standardization (ISO) T3303 standards for manufactured parts*

3. Conduct peer reviews of the selected product components.

[PA160.IG103.SP101.SubP103]

Refer to the Verification process area for more information about conducting peer reviews. [PA160.IG103.SP101.SubP103.R101]

4. Perform unit testing of the product component as appropriate.

[PA160.IG103.SP101.SubP104]

For Software Engineering

Examples of unit testing methods include the following:

[PA160.IG103.SP101.SubP104.AMP101]

- *Statement coverage testing*
- *Branch coverage testing*
- *Predicate coverage testing*
- *Path coverage testing*
- *Boundary value testing*
- *Special value testing*

5. Revise the product component as necessary. [PA160.IG103.SP101.SubP105]

An example of when the product component may need to be revised is when the design changes. [PA160.IG103.SP101.SubP105.N101]

SP 3.2-1 Establish Product Support Documentation

Establish and maintain the end-use documentation. [PA160.IG103.SP102]

This practice develops and maintains the documentation that will be used to install, operate, and maintain the product. [PA160.IG103.SP102.N101]

Typical Work Products

1. Training materials [PA160.IG103.SP102.W101]

- 14040 2. User's manual [PA160.IG103.SP102.W102]
- 14041 3. Operator's manual [PA160.IG103.SP102.W103]
- 14042 4. Maintenance manual [PA160.IG103.SP102.W104]
- 14043 5. On-line help [PA160.IG103.SP102.W105]
- 14044 **Subpractices**
- 14045 1. Review the requirements, the design, the product, and the test
- 14046 results to ensure that issues affecting the installation, operation,
- 14047 and maintenance documentation are identified and resolved.
- 14048 [PA160.IG103.SP102.SubP101]
- 14049 2. Use effective methods to develop the installation, operation, and
- 14050 maintenance documentation. [PA160.IG103.SP102.SubP102]
- 14051 Documentation methods are documented, either directly or by reference, in the
- 14052 project's defined process. [PA160.IG103.SP102.SubP102.N101]
- 14053 3. Adhere to the applicable documentation standards.
- 14054 [PA160.IG103.SP102.SubP103]
- 14055 Examples of documentation standards include the following:

14056 [PA160.IG103.SP102.SubP103.N101]

 - Compatibility with designated word processors
 - Acceptable fonts
 - Numbering of pages, sections, and paragraphs
 - Consistency with designated style manual
 - Use of abbreviations
 - Security classification markings
 - Internationalization requirements
- 14064
- 14065 4. Develop preliminary versions of the installation, operation, and
- 14066 maintenance documentation early in the life cycle for review by the
- 14067 relevant stakeholders. [PA160.IG103.SP102.SubP104]
- 14068 5. Conduct peer reviews of the installation, operation, and
- 14069 maintenance documentation. [PA160.IG103.SP102.SubP105]
- 14070 *Refer to the Verification process area for more information about*
- 14071 *conducting peer reviews.* [PA160.IG103.SP102.SubP105.R101]
- 14072 6. Revise the installation, operation, and maintenance documentation
- 14073 as necessary. [PA160.IG103.SP102.SubP106]

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Examples of when documentation may need to be revised:

[PA160.IG103.SP102.SubP106.N101]

- requirements change
- design changes
- product changes
- documentation errors
- work-around fixes

14082 **Generic Practices by Goal**

14083 **GG 1 Achieve Specific Goals**

14084 *The process supports and enables achievement of the specific goals of the*
14085 *process area by transforming identifiable input work products to produce*
14086 *identifiable output work products.*

14087 **GP 1.1 Identify Work Scope**

14088 *Identify the scope of the work to be performed and work products*
14089 *to be produced for technical solution, and communicate this*
14090 *information to those performing the work.* [GP101]

14091 **GP 1.2 Perform Base Practices**

14092 *Perform the base practices of the technical solution process to*
14093 *develop work products and provide services to achieve the*
14094 *specific goals of the process area.* [GP102]

14095 **GG 2 Institutionalize a Managed Process**

14096 *The process is institutionalized as a managed process.*

14097 **GP 2.1 Establish an Organizational Policy**

14098 *Establish and maintain an organizational policy for planning and*
14099 *performing the technical solution process.* [GP103]

14100 Elaboration:

14101 This policy establishes organizational expectations for addressing the
14102 iterative cycle in which product component solutions are selected,
14103 product and product component designs are developed, and the
14104 product component designs are implemented. [PA160.EL101]

14105 **GP 2.2 Plan the Process**

14106 ***Establish and maintain the requirements and objectives, and plans***
14107 ***for performing the technical solution process.*** [GP104]

14108 Elaboration:

14109 These requirements, objectives, and plans are typically described in the
14110 project plan as described in the Project Planning process area.
14111 [PA160.EL102]

14112 **GP 2.3 Provide Resources**

14113 ***Provide adequate resources for performing the technical solution***
14114 ***process, developing the work products and providing the services***
14115 ***of the process.*** [GP105]

14116 Elaboration:

14117 Special facilities may be required for developing, designing, and
14118 implementing solutions to requirements. When necessary, the facilities
14119 required for the activities in the Technical Solution process area are
14120 developed or purchased. [PA160.EL111]

14121 Examples of tools used to perform the activities of the Technical
14122 Solution process area include the following: [PA160.EL104]

- 14123 • Design specification tools
- 14124 • Simulators and modeling tools
- 14125 • Prototyping tools
- 14126 • Scenario definition and management tools
- 14127 • Requirements tracking tools
- 14128 • Interactive documentation tools

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14130 **GP 2.4 Assign Responsibility**

14131 ***Assign responsibility and authority for performing the process,***
14132 ***developing the work products, and providing the services of the***
14133 ***technical solution process.*** [GP106]

14134 **GP 2.5 Train People**

14135 ***Train the people performing or supporting the technical solution***
14136 ***process as needed.*** [GP107]

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Elaboration:

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Examples of training topics include the following: [PA160.EL105]

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- Application domain of the product and product components

14140

- Design methods

14141

- Interface design

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- Unit testing techniques

14143

- Standards (e.g., product, safety, human factors, environmental)

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GP 2.6 Manage Configurations

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

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Elaboration:

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Examples of work products placed under configuration management include the following: [PA160.EL106]

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- Product, product component, process, service and interface designs

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- Complete technical data package

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- Interface design documents

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- Criteria for design and component reuse

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- Implemented design (e.g., software code, fabricated product components)

14155

- User, installation, operation, and maintenance documentation

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GP 2.7 Identify and Involve Relevant Stakeholders

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Identify and involve the relevant stakeholders of the technical solution process as planned. [GP124]

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Elaboration:

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For engineering processes, consider stakeholders among customers, end users, developers, producers, testers, suppliers, marketers, maintainers, disposal personnel, and others who may be affected by, or may affect, the product as well as the process. [PA160.EL113]

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Examples of activities for stakeholder involvement include: [PA160.EL114]

- Developing alternative solutions and selection criteria
- Evolving operational concept and scenarios
- Obtaining approval on external interface specifications and design descriptions
- Developing the technical data package
- Assessing the make, buy, or reuse alternatives for product components
- Implementing the design

GP 2.8 Monitor and Control the Process

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Monitor and control the technical solution process against the plan and take appropriate corrective action. [GP110]

Elaboration:

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Examples of measures used in monitoring and controlling the activities of the Technical Solution process area include the following: [PA160.EL108]

- Cost, schedule, and effort expended for rework
- Percentage of requirements addressed in the product or product component design
- Size and complexity of the product, product components, interfaces, and documentation
- Defect density of technical solutions work products

GP 2.9 Objectively Evaluate Adherence

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Objectively evaluate adherence of the technical solution process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

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Elaboration:

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Examples of activities reviewed include the following: [PA160.EL110]

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- Selecting product component solutions

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- Developing product and product component designs

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- Implementing product component designs

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Examples of work products reviewed include the following: [PA160.EL112]

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- Technical data packages

14204

- Product, product component, and interface designs

14205

- Implemented design (e.g., software code, fabricated product components)

14206

14207

- User, installation, operation, and maintenance documentation

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GP 2.10 Review Status with Higher-Level Management

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Review the activities, status, and results of the technical solution process with higher-level management and resolve issues. [GP112]

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GG 3 Institutionalize a Defined Process

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The process is institutionalized as a defined process.

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GP 3.1 Establish a Defined Process

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Establish and maintain the description of a defined technical solution process. [GP114]

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GP 3.2 Collect Improvement Information

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

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[GP117]

14223

GG 4 Institutionalize a Quantitatively Managed Process

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The process is institutionalized as a quantitatively managed process.

14225 **GP 4.1 Establish Quality Objectives**

14226 *Establish and maintain quantitative objectives for the technical*
14227 *solution process about quality and process performance based on*
14228 *customer needs and business objectives.* [GP118]

14229 **GP 4.2 Stabilize Subprocess Performance**

14230 *Stabilize the performance of one or more subprocesses of the*
14231 *technical solution process to determine its ability to achieve the*
14232 *established quantitative quality and process performance*
14233 *objectives.* [GP119]

14234 **GG 5 Institutionalize an Optimizing Process**

14235 *The process is institutionalized as an optimizing process.*

14236 **GP 5.1 Ensure Continuous Process Improvement**

14237 *Ensure continuous improvement of the technical solution process*
14238 *in fulfilling the relevant business goals of the organization.* [GP125]

14239 **GP 5.2 Correct Common Cause of Problems**

14240 *Identify and correct the root causes of defects and other problems*
14241 *in the technical solution process.* [GP121]

14242 PRODUCT INTEGRATION

14243 Engineering

14244 Purpose

14245 The purpose of Product Integration is to assemble the product from the
14246 product components, ensure that the product, as integrated, functions
14247 properly, and deliver the product. [PA147]

14248 Introductory Notes

14249 This process area addresses the integration of product components into
14250 more complex product components or into complete products. The
14251 term "integration" is used in this sense throughout this process area and
14252 is not to be confused with integration of people or activities that may be
14253 described elsewhere in the model. [PA147.N101]

14254 The scope of this process area is to achieve complete product
14255 integration through progressive assembly of product components, in one
14256 stage or in incremental stages, according to a defined integration
14257 strategy. [PA147.N102]

14258 A critical aspect of product integration is the management of internal
14259 and external interfaces of the products and product components to
14260 ensure compatibility among the interfaces. Attention should be paid to
14261 interface management throughout the project. [PA147.N103]

14262 Product integration is more than just a one-time assembly of the
14263 product components at the conclusion of design and fabrication.
14264 Product integration can be conducted incrementally, using an iterative
14265 process of assembling product components, evaluating them, and then
14266 assembling more product components. This process may begin with
14267 analysis and simulations (e.g., threads, rapid prototypes, virtual
14268 prototypes, and physical prototypes) and steadily progress through
14269 increasingly more realistic incremental functionality until the final
14270 product is achieved. In each successive "build," prototypes (virtual,
14271 rapid, or physical) are constructed, evaluated, improved, and
14272 reconstructed based upon knowledge gained in the evaluation process.
14273 The degree of virtual vs. physical prototyping required depends on the
14274 functionality of the design tools, the complexity of the product, and its
14275 associated risk. There is a high probability that the product, integrated
14276 in this manner, will pass product verification and validation. For some
14277 products, the last integration phase will occur when the product is
14278 deployed at its intended operational site. [PA147.N104]

14279 **Related Process Areas**

- 14280 *Refer to the Requirements Development process area for more*
 14281 *information about identifying interface requirements. [PA147.R101]*
- 14282 *Refer to the Technical Solution process area for more information about*
 14283 *defining the interfaces and the integration environment (when the*
 14284 *integration environment needs to be developed). [PA147.R102]*
- 14285 *Refer to the Verification process area for more information about*
 14286 *verifying the interfaces, the integration environment, and the*
 14287 *progressively assembled product components. [PA147.R103]*
- 14288 *Refer to the Validation process area for more information about*
 14289 *performing validation of the product components and the integrated*
 14290 *product. [PA147.R104]*
- 14291 *Refer to the Risk Management process area for more information about*
 14292 *identifying risks and the use of prototypes in risk mitigation for both*
 14293 *interface compatibility and product component integration. [PA147.R105]*
- 14294 *Refer to the Decision Analysis and Resolution process area for more*
 14295 *information about using a structured approach for selecting the*
 14296 *appropriate integration strategy and for deciding whether the integration*
 14297 *environment should be acquired or developed. [PA147.R106]*
- 14298 *Refer to the Configuration Management process area for more*
 14299 *information about managing changes to interface definitions and on the*
 14300 *distribution of information. [PA147.R107]*
- 14301 *Refer to the Supplier Agreement Management process area for more*
 14302 *information about acquiring product components or parts of the*
 14303 *integration environment. [PA147.R108]*

14304 **Specific Goals**

14305 **SG 1 Prepare for Product Integration** [PA147.IG101]

14306 ***The strategy for conducting product integration is established and***
 14307 ***maintained.***

14308 **SG 2 Ensure Interface Compatibility** [PA147.IG102]

14309 ***The product component interfaces, both internal and external, are compatible.***

14310 **SG 3 Assemble Product Components and Deliver the Product** [PA147.IG103]

14311 *Verified product components are assembled and the integrated, verified, and*
14312 *validated product is delivered.*

14313 **Generic Goals**

14314 **GG 1 Achieve Specific Goals** [CL102.GL101]

14315 *The process supports and enables achievement of the specific goals of the*
14316 *process area by transforming identifiable input work products to produce*
14317 *identifiable output work products.*

14318 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

14319 *The process is institutionalized as a managed process.*

14320 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

14321 *The process is institutionalized as a defined process.*

14322 **GG 4 Institutionalize a Quantitatively Managed Process** [CL105.GL101]

14323 *The process is institutionalized as a quantitatively managed process.*

14324 **GG 5 Institutionalize an Optimizing Process** [CL106.GL101]

14325 *The process is institutionalized as an optimizing process.*

14326 Practice to Goal Relationship Table

- 14327 SG 1 Prepare for Product Integration [PA147.IG101]
- 14328 SP 1.1-1 Establish a Product Integration Strategy
- 14329 SP 1.2-2 Establish the Product Integration Environment
- 14330 SP 1.3-3 Define Detailed Product Integration Procedures

- 14331 SG 2 Ensure Interface Compatibility [PA147.IG102]
- 14332 SP 2.1-1 Review Interface Descriptions for Completeness
- 14333 SP 2.2-1 Manage Interfaces

- 14334 SG 3 Assemble Product Components and Deliver the Product [PA147.IG103]
- 14335 SP 3.1-1 Confirm Readiness of Product Components for Integration
- 14336 SP 3.2-1 Assemble Product Components
- 14337 SP 3.3-1 Checkout Assembled Product Components
- 14338 SP 3.4-1 Package and Deliver the Product or Product Component

- 14339 GG 1 Achieve Specific Goals [CL102.GL101]
- 14340 GP 1.1 Identify Work Scope
- 14341 GP 1.2 Perform Base Practices

- 14342 GG 2 Institutionalize a Managed Process [CL103.GL101]
- 14343 GP 2.1 Establish an Organizational Policy
- 14344 GP 2.2 Plan the Process
- 14345 GP 2.3 Provide Resources
- 14346 GP 2.4 Assign Responsibility
- 14347 GP 2.5 Train People
- 14348 GP 2.6 Manage Configurations
- 14349 GP 2.7 Identify and Involve Relevant Stakeholders
- 14350 GP 2.8 Monitor and Control the Process
- 14351 GP 2.9 Objectively Evaluate Adherence
- 14352 GP 2.10 Review Status with Higher-Level Management

- 14353 GG 3 Institutionalize a Defined Process [CL104.GL101]
- 14354 GP 3.1 Establish a Defined Process
- 14355 GP 3.2 Collect Improvement Information

- 14356 GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]
- 14357 GP 4.1 Establish Quality Objectives
- 14358 GP 4.2 Stabilize Subprocess Performance

- 14359 GG 5 Institutionalize an Optimizing Process [CL106.GL101]
- 14360 GP 5.1 Ensure Continuous Process Improvement
- 14361 GP 5.2 Correct Common Cause of Problems

14362 Specific Practices by Goal

14363 **SG 1 Prepare for Product Integration** [PA147.IG101]

14364 ***The strategy for conducting product integration is established and***

14365 ***maintained.***

14366 Preparing for integration of product components involves establishing
14367 and maintaining an integration strategy. An integration strategy is
14368 developed early in the project concurrently with the practices in the
14369 Technical Solution process area. The integration strategy and
14370 supporting documentation identify a sequence for receipt, assembly,
14371 and evaluation of the various product components that make up the
14372 product. [PA147.IG101.N101]

14373 **SP 1.1-1 Establish a Product Integration Strategy**

14374 ***Establish and maintain a strategy for integration of the product***
14375 ***components.*** [PA147.IG101.SP101]

14376 *Refer to the Define Interfaces specific practice in the Technical Solution*
14377 *process area for more information about defining interfaces for products*
14378 *and product components.* [PA147.IG101.SP101.R101]

14379 ***For Integrated Product and Process Development***

14380 *The integration strategy should be developed concurrently and*
14381 *iteratively with the product and product component designs.*
14382 [PA147.IG101.SP101.AMP101]

14383 The basis for effective product integration is an integration strategy. A
14384 successful integration strategy should use a combination of techniques,
14385 depending on the complexity of both the product components to be
14386 assembled and the complexity of interim and final assembled products.
14387 [PA147.IG101.SP101.N101]

14388 To develop an integration strategy, one must analyze alternative
14389 assembly sequences; select the best solution, and identify the
14390 environment and a minimum set of procedures for integration of the
14391 product components. Availability of the product components, test
14392 equipment, procedures, integration environment, and personnel skills
14393 are factors in developing the integration strategy. [PA147.IG101.SP101.N102]

14394 Integration strategies can provide for incremental assembly and
14395 evaluation of product components that provide a problem-free
14396 foundation for incorporation of other product components as they
14397 become available, or for prototypes of high-risk product components.
14398 For complex products, the integration strategy should be incremental
14399 and address the iterative process of build-evaluate-build.
14400 [PA147.IG101.SP101.N103]

14401 The integration strategy should be harmonized with the selection of
14402 solutions and the design of product and product components in the
14403 Technical Solution process area. [PA147.IG101.SP101.N104]

14404 *Refer to the Decision Analysis and Resolution process area for more*
14405 *information about using a structured approach to selecting the*
14406 *appropriate product integration strategy.* [PA147.IG101.SP101.N104.R101]

14407 *Refer to the Configuration Management process area for more*
14408 *information about protecting and distributing changes to the product*
14409 *integration strategy so that everyone can know the current state of the*
14410 *interfaces.* [PA147.IG101.SP101.N104.R102]

14411 *Refer to the Risk Management process area for more information about*
14412 *identifying and handling risks in the product integration strategy.*
14413 [PA147.IG101.SP101.N104.R103]

14414 **Typical Work Products**

- 14415 1. Product integration sequence and the rationale for selecting it
14416 [PA147.IG101.SP101.W101]
- 14417 2. Rationale for rejecting other assembly scenarios [PA147.IG101.SP101.W102]
- 14418 3. Product Integration environment definition [PA147.IG101.SP101.W103]
- 14419 4. Product integration procedures and criteria [PA147.IG101.SP101.W104]
- 14420 5. Evaluation strategy for assemblies of product components
14421 [PA147.IG101.SP101.W105]
- 14422 6. Product integration strategy documentation [PA147.IG101.SP101.W106]

14423 **Subpractices**

- 14424 1. Identify the product components to be assembled.
14425 [PA147.IG101.SP101.SubP101]
- 14426 2. Identify the product integration verifications to be performed using
14427 the definition of the interfaces between the product components.
14428 [PA147.IG101.SP101.SubP102]
- 14429 3. Identify the product integration environment required for integrating
14430 the product components. [PA147.IG101.SP101.SubP103]

14431 This can include defining the specific tools and test equipment to establish the
14432 product integration environment. [PA147.IG101.SP101.SubP103.N101]
- 14433 4. Identify the logical sequences for integrating the product
14434 components. [PA147.IG101.SP101.SubP104]
- 14435 5. Develop the product integration strategy. [PA147.IG101.SP101.SubP105]

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Example contents of the product integration strategy include the following:

[PA147.IG101.SP101.SubP105.N101]

- The product integration sequence
- The work to be done
- The responsibilities for each activity and the resources required
- The schedule to be met
- The procedures to be followed
- The tooling required

6. Periodically review the product integration strategy and revise as needed. [PA147.IG101.SP101.SubP106]

Assess the integration strategy to ensure that variations in production and delivery schedules have not had an adverse impact on the sequence or compromised the factors upon which earlier decisions were made. [PA147.IG101.SP101.SubP106.N101]

7. Capture the rationale for decisions taken and deferred.

[PA147.IG101.SP101.SubP107]

8. Take corrective action to improve the product integration strategy.

[PA147.IG101.SP101.SubP108]

9. Assess the product integration strategy on a continuing basis.

[PA147.IG101.SP101.SubP109]

10. Manage the changes and distribution of the information about the product integration strategy. [PA147.IG101.SP101.SubP110]

SP 1.2-2 Establish the Product Integration Environment

Establish and maintain the environment needed to support the integration of the product components. [PA147.IG101.SP102]

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Refer to the Technical Solution process area for more information about how to develop a product integration environment or how to buy or reuse one. [PA147.IG101.SP102.R101]

14464 The product integration strategy may identify needs for an environment
14465 that must be acquired or developed. This may yield requirements for the
14466 purchase or development of equipment, software, or other resources.
14467 These requirements are provided to the Requirements Development
14468 process area for development. The product integration environment
14469 may include the reuse of existing organizational resources. In this case,
14470 the strategy should outline the use of these resources and
14471 arrangements for their use must be made. The decision to acquire or
14472 develop the product integration environment is conducted in the
14473 Technical Solution process area. If the decision is to develop the
14474 product integration environment, the other practices in Technical
14475 Solution and all other process areas involved in conducting a
14476 development project are used. [PA147.IG101.SP102.N101]

14477 The environment required at each step of the product integration
14478 process may include test equipment, simulators (taking the place of
14479 non-available product components), pieces of real equipment, and
14480 recording devices. [PA147.IG101.SP102.N102]

14481 **Typical Work Products**

- 14482 1. Verified environment for product integration [PA147.IG101.SP102.W101]
- 14483 2. Support documentation for the product integration environment
14484 [PA147.IG101.SP102.W102]

14485 **Subpractices**

- 14486 1. Identify the requirements for the product integration environment.
14487 [PA147.IG101.SP102.SubP101]
- 14488 2. Identify verification criteria and procedures for the product
14489 integration environment. [PA147.IG101.SP102.SubP102]
- 14490 3. Decide whether to make or buy the needed product integration
14491 environment. [PA147.IG101.SP102.SubP103]
- 14492 4. Initiate a project to develop the integration environment if it cannot
14493 be acquired. [PA147.IG101.SP102.SubP104]

14494 For unprecedented, complex projects, the product integration environment can be
14495 a major development. As such, it would involve project planning, requirements
14496 development, technical solutions, verification, validation, and risk management.
14497 [PA147.IG101.SP102.SubP104.N101]

- 14498 5. Maintain the product integration environment throughout the
14499 project. [PA147.IG101.SP102.SubP105]
- 14500 6. Dispose of those portions of the environment that are no longer
14501 useful. [PA147.IG101.SP102.SubP106]

14502 **SP 1.3-3 Define Detailed Product Integration Procedures**

14503 ***Define detailed procedures and criteria for integration of the***
14504 ***product components.*** [PA147.IG101.SP103]

14505 As the product integration strategy matures, detailed procedures,
14506 inputs, outputs, expected results, and progress criteria are needed.
14507 [PA147.IG101.SP103.N101]

14508 Detailed procedures for the integration of the product components can
14509 include such things as the number of incremental iterations to be
14510 performed and details of the expected tests and other evaluations to be
14511 carried out at each stage. [PA147.IG101.SP103.N102]

14512 Detailed criteria can include criteria indicating the readiness of a
14513 product component for integration or its acceptability. [PA147.IG101.SP103.N103]

14514 For example, the probability of proper functioning, the delivery rate and
14515 its variation, the lead time from order to delivery, personnel availability,
14516 availability of the integration facility/line/environment. [PA147.IG101.SP103.N105]

14517
14518 Detailed criteria can be defined for how the product components are to
14519 be verified and the functions it is expected to have. Details can be
14520 defined for how the assembled product components and final integrated
14521 product are to be validated and delivered. [PA147.IG101.SP103.N106]

14522 Detailed criteria may also include the degree of simulation permitted for
14523 a product component to pass a test or the detailed criteria for the
14524 environment for the integration test. [PA147.IG101.SP103.N104]

14525 **Typical Work Products**

14526 1. Detailed product integration procedures [PA147.IG101.SP103.W101]

14527 2. Detailed product integration criteria [PA147.IG101.SP103.W102]

14528 **Subpractices**

14529 1. Establish and maintain detailed product integration procedures for
14530 the product components. [PA147.IG101.SP103.SubP101]

14531 2. Establish and maintain the detailed criteria for product component
14532 integration and evaluation. [PA147.IG101.SP103.SubP102]

14533 3. Establish and maintain the detailed criteria for validation and
14534 delivery of the integrated product. [PA147.IG101.SP103.SubP103]

14535 **SG 2 Ensure Interface Compatibility** [PA147.IG102]

14536 ***The product component interfaces, both internal and external, are compatible.***

14537 Many product integration problems arise from unknown or uncontrolled
14538 aspects of both internal and external interfaces. Effective management
14539 of product component interface requirements, specifications, and
14540 designs helps ensure that implemented interfaces will be complete and
14541 compatible. [PA147.IG102.N101]

14542 **SP 2.1-1 Review Interface Descriptions for Completeness**

14543 ***Review interface descriptions for coverage and completeness.***

14544 [PA147.IG102.SP101]

14545 The interfaces should include, in addition to product component
14546 interfaces, all the interfaces with the product integration environment.

14547 [PA147.IG102.SP101.N101]

14548 **Typical Work Products**

- 14549 1. Categories of interfaces [PA147.IG102.SP101.W101]
- 14550 2. List of interfaces per category [PA147.IG102.SP101.W102]
- 14551 3. Mapping of the interfaces to the product components and product
14552 integration environment [PA147.IG102.SP101.W103]

14553 **Subpractices**

- 14554 1. Review interface data for completeness and ensure complete
14555 coverage of all interfaces. [PA147.IG102.SP101.SubP101]

14556 ***For Software Engineering***

14557 *In the message category for software, interfaces would include*
14558 *the following:* [PA147.IG102.SP101.SubP101.AMP101]

- 14559 • *Origination*
- 14560 • *Destination*
- 14561 • *Stimulus*
- 14562 • *Protocols and data characteristics*

14563 ***For Systems Engineering***

14564 *For mechanical and electronic components, the interface data*
14565 *should include the following:* [PA147.IG102.SP101.SubP101.AMP102]

- 14566 • *Mechanical interfaces (e.g., weight and size, center of*
14567 *gravity, clearance of parts in operation, space required*
14568 *for maintenance, fixed links, mobile links, shocks and*
14569 *vibrations received from the bearing structure)*
- 14570 • *Noise interfaces (e.g., noise transmitted by the structure,*
14571 *noise transmitted in the air, acoustics)*

- 14572 • Climatic interfaces (e.g., temperature, humidity, pressure,
14573 salinity)
- 14574 • Thermal interfaces (e.g., heat dissipation, transmission of
14575 heat to the bearing structure, air conditioning
14576 characteristics)
- 14577 • Fluid interfaces (e.g., fresh water inlet/outlet, seawater
14578 inlet/outlet for a naval/coastal product, air conditioning,
14579 compressed air, nitrogen, fuel, lubricating oil, exhaust gas
14580 outlet)
- 14581 • Electrical interfaces (e.g., power supply consumption by
14582 network with transients and peak values; non-sensitive
14583 control signal for power supply, communications, etc.;
14584 sensitive signal [analog links];disturbing signal
14585 [microwave, etc.]; grounding signal to comply with the
14586 TEMPEST standard)
- 14587 • Electromagnetic interfaces (e.g., magnetic field, radio and
14588 radar links, optical band link wave guides, coaxial and
14589 optical fibers)
- 14590 • Man-machine interface (e.g., audio or voice synthesis, audio
14591 or voice recognition, display [analog dial, TV screen, or
14592 liquid crystal display, indicators' light emitting diodes],
14593 manual controls [pedal, joystick, ball, keys, push buttons,
14594 touch screen])

14595 Consider all the product components and prepare a relationship table mapping.
14596 Interfaces are usually classified in three main classes: environmental, physical,
14597 and functional. Typical categories for these classes include the following:
14598 mechanical, fluid, sound, electrical, climatic, electromagnetic, thermal, message,
14599 and the man-machine or human interface. [PA147.IG102.SP101.SubP101.N101]

14600 2. Ensure that product components and interfaces are marked to
14601 ensure easy and correct connection to the joining product
14602 component. [PA147.IG102.SP101.SubP102]

14603 3. Periodically review the adequacy of interface descriptions.
14604 [PA147.IG102.SP101.SubP103]

14605 Once established, the interface descriptions must be periodically reviewed to
14606 ensure there is no deviation between the existing descriptions and the products
14607 being developed, processed, produced, or bought. [PA147.IG102.SP101.SubP103.N101]

14608 SP 2.2-1 Manage Interfaces

14609 **Manage internal and external interface definitions, designs, and**
14610 **changes for products and product components.** [PA147.IG102.SP102]

14611 *Refer to the Requirements Development process area for more*
14612 *information about requirements for interfaces.* [PA147.IG102.SP102.R101]

14613 *Refer to the Technical Solution process area for more information about*
14614 *design of interfaces between product components.* [PA147.IG102.SP102.R102]

14615 *Refer to the Requirements Management process area for more*
14616 *information about managing the changes to the interface requirements.*
14617 [PA147.IG102.SP102.R103]

14618 *Refer to the Configuration Management process area for more*
14619 *information about distributing changes to the interface descriptions*
14620 *(specifications), so that everyone can know the current state of the*
14621 *interfaces.* [PA147.IG102.SP102.R104]

14622 Management of the interfaces includes the maintenance of the
14623 consistency of the interfaces throughout the development cycle and
14624 resolution of conflict, noncompliance, and change issues.
14625 [PA147.IG102.SP102.N101]

14626 The interfaces should include, in addition to product component
14627 interfaces, all the interfaces with the environment as well as other
14628 environments for verification, validation, operations and support.
14629 [PA147.IG102.SP102.N102]

14630 The interface changes are captured, maintained, and readily
14631 accessible. [PA147.IG102.SP102.N103]

14632 **Typical Work Products**

- 14633 1. Table of relationships between the product components and the
14634 external environment (e.g., main power supply, fastening product,
14635 computer bus system, etc.) [PA147.IG102.SP102.W101]
- 14636 2. Table of relationships between the different product components
14637 [PA147.IG102.SP102.W102]
- 14638 3. List of agreed-to interfaces defined for each pair of product
14639 components, when applicable [PA147.IG102.SP102.W103]
- 14640 4. Reports from the interface control working group meetings
14641 [PA147.IG102.SP102.W104]
- 14642 5. Action items for interface updating [PA147.IG102.SP102.W105]
- 14643 6. Application Program Interface [PA147.IG102.SP102.W106]
- 14644 7. Updated interface description or agreement [PA147.IG102.SP102.W107]

14645 **Subpractices**

- 14646 1. Ensure the compatibility of the interfaces throughout the
14647 development cycle. [PA147.IG102.SP102.SubP101]
- 14648 2. Resolve conflict, noncompliance, and change issues.
14649 [PA147.IG102.SP102.SubP102]

14650 3. Maintain a repository for interface data accessible to project
14651 participants. [PA147.IG102.SP102.SubP103]

14652 A common accessible repository for interface data provides a mechanism to
14653 ensure that everyone knows where the current interface data resides and can
14654 access it for use. [PA147.IG102.SP102.SubP103.N101]

14655 **SG 3 Assemble Product Components and Deliver the Product** [PA147.IG103]

14656 ***Verified product components are assembled and the integrated, verified, and***
14657 ***validated product is delivered.***

14658 Integration of product components proceeds according to the product
14659 integration strategy. Before integration, each product component should
14660 be confirmed to be compliant with its interface requirements. Product
14661 components are assembled into larger, more complex product
14662 components. These assembled product components are checked for
14663 correct inter-operation. This process continues until product integration
14664 is complete. If, during this process, problems are identified, the problem
14665 should be documented and a corrective action process initiated.

14666 [PA147.IG103.N101]

14667 Ensure that the assembly of the product components into larger and
14668 more complex product components is conducted according to the
14669 product integration strategy. The timely receipt of needed product
14670 components and the involvement of the right people contribute to the
14671 successful integration of the product components that comprise the
14672 product. [PA147.IG103.N102]

14673 **SP 3.1-1 Confirm Readiness of Product Components for Integration**

14674 ***Confirm, prior to assembly, that each product component required***
14675 ***to assemble the product has been properly identified, functions***
14676 ***according to its description, and that the product component***
14677 ***interfaces comply with the interface descriptions.*** [PA147.IG103.SP101]

14678 *Refer to the Verification process area for more information about*
14679 *verifying product components.* [PA147.IG103.SP101.R101]

14680 *Refer to the Technical Solution process area for more information about*
14681 *unit test of product components.* [PA147.IG103.SP101.R102]

14682 The purpose of this practice is to ensure that the properly identified
14683 product component that meets its description can actually be
14684 assembled according to the product integration strategy. The product
14685 components are checked for quantity, obvious damage, and
14686 consistency between the product component and interface descriptions.

14687 [PA147.IG103.SP101.N101]

14688 Although unit tests are conducted in Technical Solution, verifications
14689 are conducted in Verification, and other assurances are conducted in
14690 Process and Product Quality Assurance, the ultimate responsibility for
14691 checking to make sure everything is proper with the product
14692 components before assembly is the responsibility of Product
14693 Integration. [PA147.IG103.SP101.N102]

14694 **Typical Work Products**

- 14695 1. Acceptance documents for the received product components
14696 [PA147.IG103.SP101.W101]
- 14697 2. Delivery receipts [PA147.IG103.SP101.W102]
- 14698 3. Checked packing lists [PA147.IG103.SP101.W103]
- 14699 4. Exception reports [PA147.IG103.SP101.W104]
- 14700 5. Waivers [PA147.IG103.SP101.W105]

14701 **Subpractices**

- 14702 1. Track the status of all product components as soon as they
14703 become available for integration. [PA147.IG103.SP101.SubP101]
- 14704 2. Ensure that product components are delivered to the product
14705 integration environment in accordance with the product integration
14706 strategy. [PA147.IG103.SP101.SubP102]
- 14707 3. Confirm the receipt of each properly identified product component.
14708 [PA147.IG103.SP101.SubP103]
- 14709 4. Ensure that each received product component meets its
14710 description. [PA147.IG103.SP101.SubP104]
- 14711 5. Check the configuration status against the expected configuration.
14712 [PA147.IG103.SP101.SubP105]
- 14713 6. Perform pre-check (for example by a visual inspection and using
14714 basic metrics) of all the physical interfaces before connecting
14715 product components together. [PA147.IG103.SP101.SubP106]

14716 **SP 3.2-1 Assemble Product Components**

14717 ***Assemble product components according to the product***
14718 ***integration strategy.*** [PA147.IG103.SP102]

14719 *Refer to the Verification process area for more information about*
14720 *verifying assembled product components.* [PA147.IG103.SP102.R101]

14721 *Refer to the Validation process area for more information about*
14722 *validating assembled product components.* [PA147.IG103.SP102.R102]

14723 The assembly and checkout activities of the next practice are
14724 conducted iteratively, from the initial product components, through the
14725 interim assemblies of product components, to the product as a whole.
14726 [PA147.IG103.SP102.N101]

14727 **Typical Work Products**

- 14728 1. Assembled product or product components. [PA147.IG103.SP102.W101]

14729 **Subpractices**

- 14730 1. Ensure the readiness of the product integration environment.
14731 [PA147.IG103.SP102.SubP101]

- 14732 2. Ensure that the assembly sequence is properly performed.
14733 [PA147.IG103.SP102.SubP102]

14734 Record all appropriate information (e.g., configuration status, serial numbers of
14735 the product components, types, and calibration date of the meters).

14736 [PA147.IG103.SP102.SubP102.N101]

- 14737 3. Record all appropriate information (e.g., configuration status, serial
14738 numbers of the elements, types and calibration date of the meters).

14739 [PA147.IG103.SP102.SubP103]

- 14740 4. Revise the product integration strategy as appropriate.

14741 [PA147.IG103.SP102.SubP104]

14742 **SP 3.3-1 Checkout Assembled Product Components**

14743 ***Checkout an assembly of product components.*** [PA147.IG103.SP103]

14744 The activity of checkout is used here as the action of examining and
14745 evaluating something for performance, suitability, or readiness and is
14746 not to be confused with the activity used in configuration management
14747 processes. The checkout activity is performed as appropriate for the
14748 stages of assembly of product components as identified in the product
14749 integration strategy. The product integration strategy may define a
14750 more refined integration sequence than might be envisioned just by
14751 examining the product architecture. For example, if an assembly of
14752 product components were composed of four less complex product
14753 components, the integration sequence will not necessarily call for the
14754 simultaneous integration and checkout of the four units as one. Rather,
14755 the four less complex units may be integrated progressively, one at a
14756 time, with a checkout after each assembly operation prior to realizing
14757 the more complex product component that matched the specification in
14758 the product architecture. Alternately, the strategy could have
14759 determined that only a final check was the best one to perform.

14760 [PA147.IG103.SP103.N101]

14761 The adjustment required to fit components together in the factory could
14762 be different from the one required to fit components when installed on
14763 the operational site. In that case, the product's logbook for the customer
14764 should be used to record such specific parameters. [PA147.IG103.SP103.N102]

14765 **Typical Work Products**

- 14766 1. Checked out assembled product or product components
14767 [PA147.IG103.SP103.W101]
- 14768 2. Exception reports [PA147.IG103.SP103.W102]
- 14769 3. Interface checkout reports [PA147.IG103.SP103.W103]
- 14770 4. Product integration summary reports [PA147.IG103.SP103.W104]

14771 **Subpractices**

- 14772 1. Conduct the checkout of assembled product components following
14773 the product integration strategy. [PA147.IG103.SP103.SubP101]
- 14774 2. Record the checkout results. [PA147.IG103.SP103.SubP102]

14775 Example results include the following: [PA147.IG103.SP103.SubP102.N101]

- 14776 • Any adaptation required to the integration procedure
 - 14777 • Any change to the product configuration (spare parts, new release)
 - 14778 • Checkout procedure deviations
- 14779

14780 **SP 3.4-1 Package and Deliver the Product or Product Component**

14781 ***Package the assembled product or product component and deliver***
14782 ***it to the appropriate customer.*** [PA147.IG103.SP104]

14783 *Refer to the Verification process area for more information about*
14784 *verifying the product or an assembly of product components before*
14785 *packaging.* [PA147.IG103.SP104.R101]

14786 *Refer to the Validation process area for more information about*
14787 *validating the product or an assembly of product components before*
14788 *packaging.* [PA147.IG103.SP104.R102]

14789 The packaging requirements for some products may be addressed in
14790 their specifications and verification criteria. This is especially important
14791 when items are stored and transported by the customer. In such cases,
14792 there may be a spectrum of environmental and stress conditions
14793 specified for the package. In other circumstances, factors such as the
14794 following may become important: [PA147.IG103.SP104.N101]

- 14795 • Economy and ease of transportation (e.g., containerization)

- 14796 • Accountability (e.g., shrinkwrapping)
- 14797 • Ease and safety of unpacking (e.g., sharp edges, strength of
- 14798 binding methods, childproofing, environmental friendliness of
- 14799 packing material, weight)

14800 The adjustment required to fit product components together in the
14801 factory could be different from the one required to fit product
14802 components when installed on the operational site. In that case, the
14803 product's logbook for the customer should be used to record such
14804 specific parameters. [PA147.IG103.SP104.N102]

14805 **Typical Work Products**

- 14806 1. Packaged product or product components [PA147.IG103.SP104.W101]
- 14807 2. Delivery documentation [PA147.IG103.SP104.W102]

14808 **Subpractices**

- 14809 1. Review the requirements, design, product, verification results, and
14810 documentation to ensure that issues affecting the packaging and
14811 delivery of the product are identified and resolved.
14812 [PA147.IG103.SP104.SubP101]
- 14813 2. Use effective methods to package and deliver the assembled
14814 product. [PA147.IG103.SP104.SubP102]

14815 *For Software Engineering*

14816 *Examples of software packaging and delivery methods include*
14817 *the following:*
14818 *(Packaging and delivery methods are documented, either*
14819 *directly or by reference, in the project's defined process.)*
14820 *[PA147.IG103.SP104.SubP102.AMP101]*

- 14821 • *Magnetic tape*
- 14822 • *Diskettes*
- 14823 • *Hardcopy documents*
- 14824 • *Compact disks*
- 14825 • *Other electronic distribution such as the Internet*

- 14826
- 14827 3. Satisfy the applicable requirements and standards for packaging
14828 and delivering the product. [PA147.IG103.SP104.SubP103]

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For Software Engineering

Examples of requirements and standards for packaging and delivering the software include the following:

[PA147.IG103.SP104.SubP103.AMP101]

- *Type of storage and delivery media*
- *Custodians of the master and backup copies of the software*
- *Required documentation*
- *Copyrights*
- *License provisions*
- *Security of the software*

For Systems Engineering

Examples of requirements and standards include those for safety, the environment, security, and transportability.

[PA147.IG103.SP104.SubP103.AMP102]

4. Prepare the operational site for installation of the product.

[PA147.IG103.SP104.SubP104]

Preparing the operational site may be the responsibility of the customer or end-users. *[PA147.IG103.SP104.SubP104.N101]*

5. Deliver the product and related documentation and confirm receipt.

[PA147.IG103.SP104.SubP105]

6. Install the product at the operational site and confirm correct operation. *[PA147.IG103.SP104.SubP106]*

Installing the product may be the responsibility of the customer or end-users. In some circumstances, very little may need to be done to confirm correct operation (more like a checkout procedure). In other circumstances, final verification of the integrated product occurs at the operational site. *[PA147.IG103.SP104.SubP106.N101]*

Generic Practices by Goal

GG 1 Achieve Specific Goals

The process supports and enables achievement of the specific goals of the process area by transforming identifiable input work products to produce identifiable output work products.

14862 **GP 1.1 Identify Work Scope**

14863 *Identify the scope of the work to be performed and work products*
14864 *to be produced for product integration, and communicate this*
14865 *information to those performing the work.* [GP101]

14866 **GP 1.2 Perform Base Practices**

14867 *Perform the base practices of the product integration process to*
14868 *develop work products and provide services to achieve the*
14869 *specific goals of the process area.* [GP102]

14870 **GG 2 Institutionalize a Managed Process**

14871 *The process is institutionalized as a managed process.*

14872 **GP 2.1 Establish an Organizational Policy**

14873 *Establish and maintain an organizational policy for planning and*
14874 *performing the product integration process.* [GP103]

14875 Elaboration:

14876 This policy establishes organizational expectations for developing a
14877 product integration strategy and environment, ensuring interface
14878 compatibility among product components, assembling the product
14879 components, and delivering the product and product components.
14880 [PA147.EL101]

14881 **GP 2.2 Plan the Process**

14882 *Establish and maintain the requirements and objectives, and plans*
14883 *for performing the product integration process.* [GP104]

14884 Elaboration:

14885 These requirements, objectives, and plans are described in the plan for
14886 product integration. This plan for product integration differs from the
14887 product integration strategy described in the specific practices in this
14888 process area. The product integration strategy addresses individual
14889 product integration requirements (e.g., sequencing, environment,
14890 interfaces, procedures.), whereas the plan for product integration
14891 ensures that the planning needed to define those requirements occurs,
14892 as well as the planning for interface management, assembly, and the
14893 other activities of this process area [PA147.EL102]

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GP 2.3 Provide Resources

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

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Elaboration:

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14902

Product component interface coordination may be accomplished with an Interface Control Working Group consisting of people who represent external and internal interfaces. Such groups can be used to elicit needs for interface requirements development. [PA147.EL115]

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Special facilities may be required for assembling and delivering the product. When necessary, the facilities required for the activities in the Product Integration process area are developed or purchased. [PA147.EL116]

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Examples of tools used to perform the activities of the Product Integration process area include the following: [PA147.EL117]

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- Prototyping tools
- Analysis tools
- Simulation tools
- Interface management tools
- Assembly tools (e.g., compilers, make files, joining tools, jigs and fixtures)

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GP 2.4 Assign Responsibility

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

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GP 2.5 Train People

Train the people performing or supporting the product integration process as needed. [GP107]

14922

Elaboration:

14923

Examples of training topics include the following: [PA147.EL105]

14924

- Application domain

14925

- Product integration procedures and methods

14926

- Organization's facilities for integration and assembly

14927

- Assembly methods

14928

- Packaging standards

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GP 2.6 Manage Configurations

14931

Place designated work products of the product integration process under appropriate levels of configuration management.

14932

[GP109]

14933

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Elaboration:

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Examples of work products placed under configuration management include the following: [PA147.EL106]

14936

- Acceptance documents for the received product components

14937

- Checked out assembled product and product components

14938

- Product integration strategy

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- Updated interface description or agreement

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GP 2.7 Identify and Involve Relevant Stakeholders

14943

Identify and involve the relevant stakeholders of the product integration process as planned. [GP124]

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14945

Elaboration:

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For engineering-related processes, consider stakeholders among customers, end users, developers, producers, testers, suppliers, marketers, maintainers, disposal personnel, and others who may be affected by, or may affect, the product as well as the process. [PA147.EL120]

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Examples of activities for stakeholder involvement include: [PA147.EL121]

- Reviewing interface descriptions for completeness
- Establishing the product integration strategy
- Assembling and delivering the product and product components
- Communicating the results after checkout
- Communicating new, effective product integration practices to give affected people the opportunity to improve their performance.

GP 2.8 Monitor and Control the Process

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Monitor and control the product integration process against the plan and take appropriate corrective action. [GP110]

Elaboration:

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Examples of measures used in monitoring and controlling the activities of the Product Integration process area include the following: [PA147.EL112]

- Product component integration profile (e.g., product component assemblies planned, performed, and number of exceptions found)
- Integration checkout problem report trends (e.g., number written and number closed)
- Integration checkout problem report aging (i.e., how long each problem report has been open)

GP 2.9 Objectively Evaluate Adherence

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Objectively evaluate adherence of the product integration process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

Elaboration:

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Examples of activities reviewed include the following: [PA147.EL114]

- Establishing and maintaining a product integration strategy
- Ensuring interface compatibility
- Assembling product components and delivering the product.

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Examples of work products reviewed include the following: [PA147.EL119]

- Product integration strategy
- Acceptance documents for the received product components
- Assembled product and product components

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GP 2.10 Review Status with Higher-Level Management

Review the activities, status, and results of the product integration process with higher-level management and resolve issues. [GP112]

14990

GG 3 Institutionalize a Defined Process

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The process is institutionalized as a defined process.

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GP 3.1 Establish a Defined Process

Establish and maintain the description of a defined product integration process. [GP114]

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GP 3.2 Collect Improvement Information

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

[GP117]

15001

GG 4 Institutionalize a Quantitatively Managed Process

15002

The process is institutionalized as a quantitatively managed process.

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GP 4.1 Establish Quality Objectives

Establish and maintain quantitative objectives for the product integration process about quality and process performance based on customer needs and business objectives. [GP118]

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GP 4.2 Stabilize Subprocess Performance

Stabilize the performance of one or more subprocesses of the product integration process to determine its ability to achieve the established quantitative quality and process performance objectives. [GP119]

15012

GG 5 Institutionalize an Optimizing Process

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The process is institutionalized as an optimizing process.

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GP 5.1 Ensure Continuous Process Improvement

Ensure continuous improvement of the product integration process in fulfilling the relevant business goals of the organization. [GP125]

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GP 5.2 Correct Common Cause of Problems

Identify and correct the root causes of defects and other problems in the product integration process. [GP121]

15021 VERIFICATION

15022 Engineering

15023 Purpose

15024 The purpose of Verification is to assure that selected work products
15025 meet their specified requirements. [PA150]

15026 Introductory Notes

15027 Verification encompasses verification preparation, verification
15028 performance, and identification of corrective action. [PA150.N101]

15029 Verification includes verification of the product and intermediate work
15030 products against all selected requirements, including customer, product,
15031 and product component requirements. [PA150.N102]

15032 Verification is inherently an incremental process since it occurs
15033 throughout the development of the product and work products,
15034 beginning with verification of the requirements, progressing through the
15035 verification of the evolving work products, and culminating in the
15036 verification of the completed product. [PA150.N103]

15037 Verification of work products at each level of the product substantially
15038 increases the likelihood that the product will meet the customer,
15039 product, and product component requirements. [PA150.N104]

15040 The Verification and Validation process areas are similar, but they
15041 address different issues. Validation demonstrates that the product, as
15042 provided (or as it will be provided), will fulfill its intended use, whereas
15043 Verification addresses whether the work product properly reflects the
15044 specified requirements. In other words, verification assures "you built it
15045 right;" whereas, validation assures "you built the right thing." [PA150.N105]

15046 Peer reviews are an important part of verification and are a proven
15047 mechanism for effective defect removal. An important corollary is to
15048 develop a better understanding of the work products and the processes
15049 that produced them so defects can be prevented and process
15050 improvement opportunities can be identified. [PA150.N106]

15051 Peer reviews involve a methodical examination of work products by the
15052 producers' peers to identify defects and other changes that are needed.
15053 [PA150.N107]

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

- Inspections
- Structured walkthroughs

The specific work products that will undergo a peer review are identified in the project's defined process and planned as part of the project planning activities as described in the Integrated Project Management process area. [PA150.N108]

15062 **Related Process Areas**

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Refer to Integrated Project Management (IPPD) process area for more information about what work products will be selected for verification.

[PA150.R101]

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

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

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

15074 **Specific Goals**

15075 **SG 1 Prepare for Verification** [PA150.IG101]

Preparation for verification is conducted.

15077 **SG 2 Perform Peer Reviews** [PA150.IG102]

Peer reviews are performed on selected work products.

15079 **SG 3 Verify Selected Work Products** [PA150.IG103]

Selected work products are verified against their specified requirements.

15081 Generic Goals

15082 **GG 1** **Achieve Specific Goals** [CL102.GL101]

15083 *The process supports and enables achievement of the specific goals of the*
15084 *process area by transforming identifiable input work products to produce*
15085 *identifiable output work products.*

15086 **GG 2** **Institutionalize a Managed Process** [CL103.GL101]

15087 *The process is institutionalized as a managed process.*

15088 **GG 3** **Institutionalize a Defined Process** [CL104.GL101]

15089 *The process is institutionalized as a defined process.*

15090 **GG 4** **Institutionalize a Quantitatively Managed Process** [CL105.GL101]

15091 *The process is institutionalized as a quantitatively managed process.*

15092 **GG 5** **Institutionalize an Optimizing Process** [CL106.GL101]

15093 *The process is institutionalized as an optimizing process.*

15094 Practice to Goal Relationship Table

- 15095 SG 1 Prepare for Verification [PA150.IG101]
- 15096 SP 1.1-1 Establish a Verification Strategy
- 15097 SP 1.2-2 Establish the Verification Environment
- 15098 SP 1.3-3 Establish Detailed Verification Plans

- 15099 SG 2 Perform Peer Reviews [PA150.IG102]
- 15100 SP 2.1-1 Prepare for Peer Reviews
- 15101 SP 2.2-1 Conduct Peer Reviews
- 15102 SP 2.3-2 Analyze Peer Review Data

- 15103 SG 3 Verify Selected Work Products [PA150.IG103]
- 15104 SP 3.1-1 Perform Verification
- 15105 SP 3.2-2 Analyze Verification Results and Identify Corrective Action
- 15106 SP 3.3-1 Perform Re-Verification

- 15107 GG 1 Achieve Specific Goals [CL102.GL101]
- 15108 GP 1.1 Identify Work Scope
- 15109 GP 1.2 Perform Base Practices

- 15110 GG 2 Institutionalize a Managed Process [CL103.GL101]
- 15111 GP 2.1 Establish an Organizational Policy
- 15112 GP 2.2 Plan the Process
- 15113 GP 2.3 Provide Resources
- 15114 GP 2.4 Assign Responsibility
- 15115 GP 2.5 Train People
- 15116 GP 2.6 Manage Configurations
- 15117 GP 2.7 Identify and Involve Relevant Stakeholders
- 15118 GP 2.8 Monitor and Control the Process
- 15119 GP 2.9 Objectively Evaluate Adherence
- 15120 GP 2.10 Review Status with Higher-Level Management

- 15121 GG 3 Institutionalize a Defined Process [CL104.GL101]
- 15122 GP 3.1 Establish a Defined Process
- 15123 GP 3.2 Collect Improvement Information

- 15124 GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]
- 15125 GP 4.1 Establish Quality Objectives
- 15126 GP 4.2 Stabilize Subprocess Performance

- 15127 GG 5 Institutionalize an Optimizing Process [CL106.GL101]
- 15128 GP 5.1 Ensure Continuous Process Improvement
- 15129 GP 5.2 Correct Common Cause of Problems

15130 Specific Practices by Goal

- 15131 **SG 1 Prepare for Verification** [PA150.IG101]

15132 ***Preparation for verification is conducted.***

15133 For comprehensive verification, preparation is required to assure that all
15134 levels of verification are conducted. Verification includes inspection,
15135 testing, analyses, and demonstration. This up-front preparation is also
15136 necessary to ensure that verification provisions are embedded in
15137 product and product component requirements, designs, and
15138 developmental plans and schedules. [PA150.IG101.N101]

15139 Methods of verification include, but are not limited to, inspections, peer
15140 reviews, audits, walkthroughs, analyses, simulations, testing, and
15141 demonstrations. [PA150.IG101.N102]

15142 Preparation also entails the definition of support tools, test equipment
15143 and software, simulations, prototypes, and facilities. [PA150.IG101.N103]

15144 **SP 1.1-1 Establish a Verification Strategy**

15145 ***Establish and maintain a verification strategy for selected work***
15146 ***products.*** [PA150.IG101.SP101]

15147 *Refer to the Integrated Project Management (IPPD) process area for*
15148 *more information about identifying work products for peer review.*

15149 [PA150.IG101.SP101.R101]

15150 ***For Software Engineering***

15151 *Examples of verification methods include the following:*

15152 [PA150.IG101.SP101.AMP101]

- 15153 • *Path coverage testing*
- 15154 • *Load, stress, and performance testing*
- 15155 • *Decision table based testing*
- 15156 • *Functional decomposition based testing*
- 15157 • *Test case reuse*
- 15158 • *Alpha and Beta test*
- 15159 • *Operational scenario testing*
- 15160 • *Acceptance tests*

15161

15162 ***For Integrated Product and Process Development***

15163 *The verification strategy should be developed concurrently*
15164 *and iteratively with the product and product component*

15165 *designs.* [PA150.IG101.SP101.AMP102]

15166 The verification strategy is created to derive the specific activities
15167 related to verifying work products. These result in detailed strategies
15168 and procedures for the verification of the work products.

15169 [PA150.IG101.SP101.N101]

15170 The requirements and strategies for verification are typically
15171 documented in a verification strategy. The verification strategy
15172 addresses the specific actions, resources, and environments required
15173 for work product verification. This differs from the verification plans
15174 addressed by the Plan the Process generic practice. The generic
15175 practice addresses the process tasks, who is responsible for them, and
15176 resources generally needed. The verification strategy defines the
15177 technical approach to work product verification and the specific
15178 approaches that will be used to verify specific work products.

15179 [PA150.IG101.SP101.N102]

15180 The verification strategy typically begins with involvement in the
15181 definition of product and product component requirements to ensure
15182 that these requirements are verifiable. This strategy includes ensuring
15183 that an appropriate method of verification is assigned to each
15184 requirement when necessary, and verification criteria are developed. At
15185 a minimum, a method of verification is assigned to each selected work
15186 product. [PA150.IG101.SP101.N103]

15187 The verification strategy may address peer reviews. The specific work
15188 products that will undergo a peer review are typically identified in the
15189 project plan. [PA150.IG101.SP101.N104]

15190 **Typical Work Products**

- 15191 1. Verification strategy [PA150.IG101.SP101.W101]
- 15192 2. Commercial off-the-shelf (COTS) verification strategy
15193 [PA150.IG101.SP101.W102]
- 15194 3. Verification procedures [PA150.IG101.SP101.W103]
- 15195 4. Verification criteria [PA150.IG101.SP101.W104]

15196 **Subpractices**

- 15197 1. Define the requirements for a realistic verification environment.
15198 [PA150.IG101.SP101.SubP102]
- 15199 2. Identify the verification methods and processes that are available
15200 for use. [PA150.IG101.SP101.SubP103]

15201 **SP 1.2-2 Establish the Verification Environment**

15202 ***Establish and maintain the environment needed to support***
15203 ***verification.*** [PA150.IG101.SP102]

15204 An environment needs to be established to enable verification to take
15205 place. The verification environment may be acquired, developed,
15206 reused, modified, or a combination of these depending on the needs of
15207 the project. [PA150.IG101.SP102.N101]

15208 The type of environment required will depend on the verification criteria
15209 and the verification method used. A peer review may require little more
15210 than a package of materials, reviewers, and a room. A product test
15211 may require simulators, emulators, scenario generators, data reduction
15212 tools, environmental controls, and interfaces with other systems.

15213 [PA150.IG101.SP102.N102]

15214 **Typical Work Products**

15215 1. Verification support equipment [PA150.IG101.SP102.W101]

15216 2. Verification environment [PA150.IG101.SP102.W102]

15217 **Subpractices**

15218 1. Identify verification environment requirements. [PA150.IG101.SP102.SubP101]

15219 2. Identify verification resources that are available for reuse and
15220 modification. [PA150.IG101.SP102.SubP102]

15221 3. Identify verification equipment and tools. [PA150.IG101.SP102.SubP103]

15222 4. Acquire verification support equipment and an environment, such
15223 as test equipment and software. [PA150.IG101.SP102.SubP104]

15224 **SP 1.3-3 Establish Detailed Verification Plans**

15225 ***Establish and maintain detailed verification plans for selected***
15226 ***work products.*** [PA150.IG101.SP103]

15227 **Subpractices**

15228 1. Plan the set of comprehensive, integrated verification activities for
15229 work products and any COTS products, as necessary.

15230 [PA150.IG101.SP103.SubP101]

15231 2. Develop and refine the verification criteria when necessary.

15232 [PA150.IG101.SP103.SubP102]

15233 3. For verification of each work product, define which method and
15234 process will be used (globally or for each of their requirements).

15235 [PA150.IG101.SP103.SubP103]

15236 4. Identify the expected results and any tolerances allowed in the
15237 observation and other criteria for satisfying the requirements.

15238 [PA150.IG101.SP103.SubP104]

- 15239 5. Identify any equipment and environmental components needed to
15240 support verification. [PA150.IG101.SP103.SubP105]

15241 **SG 2 Perform Peer Reviews** [PA150.IG102]

15242 ***Peer reviews are performed on selected work products.***

15243 Peer reviews involve a methodical examination of work products by the
15244 producers' peers to identify defects for removal and to recommend
15245 other changes that are needed. [PA150.IG102.N101]

15246 The peer review is an important and effective engineering method
15247 implemented via inspections, structured walkthroughs, or a number of
15248 other collegial review methods. [PA150.IG102.N102]

15249 Peer reviews are primarily applied to work products developed by the
15250 projects, but they can also be applied to other work products such as
15251 documentation and training work products that are typically developed
15252 by support groups. [PA150.IG102.N103]

15253 **SP 2.1-1 Prepare for Peer Reviews**

15254 ***Prepare for peer reviews of selected work products.*** [PA150.IG102.SP101]

15255 Preparation activities for peer reviews typically include identifying the
15256 staff who will be invited to participate in the peer review of each work
15257 product, identifying the key reviewers who must participate in the peer
15258 review, preparing and updating any materials that will be used during
15259 the peer reviews such as checklists and review criteria, and scheduling
15260 peer reviews. [PA150.IG102.SP101.N101]

15261 **Typical Work Products**

- 15262 1. Peer review schedule [PA150.IG102.SP101.W101]
15263 2. Peer review checklist [PA150.IG102.SP101.W102]
15264 3. Entry and exit criteria for work products [PA150.IG102.SP101.W103]
15265 4. Re-review criteria [PA150.IG102.SP101.W104]
15266 5. Peer review training material [PA150.IG102.SP101.W105]
15267 6. Selected work products to be reviewed [PA150.IG102.SP101.W106]

15268 **Subpractices**

- 15269 1. Determine what type of peer review will be conducted.
15270 [PA150.IG102.SP101.SubP101]

15271

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

15272

- Inspections
- Structured walkthroughs
- Active reviews

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

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[PA150.IG102.SP101.SubP102]

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Refer to the Measurement and Analysis process area for practices on identifying and collecting data. [PA150.IG102.SP101.SubP102.R101]

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

15281

[PA150.IG102.SP101.SubP103]

15282

4. Establish and maintain criteria for requiring a re-review of the work product. [PA150.IG102.SP101.SubP104]

15283

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

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Examples of items addressed by the checklists include the following:

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[PA150.IG102.SP101.SubP105.N102]

15288

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

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

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

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

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

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Examples of related information include the following: [PA150.IG102.SP101.SubP108.N101]

- The plan for the peer review
- Objectives of the work product
- Applicable standards
- Relevant inputs to the work product (e.g., the relevant requirements for a design)
- Checklists

9. Assign roles for the peer review as appropriate. [PA150.IG102.SP101.SubP109]

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

- Leader
- Reader
- Recorder
- Author

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

SP 2.2-1 Conduct Peer Reviews

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

One of the purposes of conducting a peer review is to find and remove defects early in the life cycle. Peer reviews are performed incrementally, as work products are being developed, not at the end of the cycle. These reviews are structured and are not management reviews.

[PA150.IG102.SP102.N101]

Peer reviews are performed on key work products of specification, design, test, and implementation activities and/or specific planning work products (e.g., software development plan, risk management plan, or test plan). [PA150.IG102.SP102.N102]

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

When issues arise during the peer review, they are communicated to the primary developer of the work product for correction.

[PA150.IG102.SP102.N104]

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

[PA150.IG102.SP102.N104.R101]

15342 Peer reviews should address the following guidelines: there must be
15343 sufficient preparation, the conduct must be managed and controlled,
15344 consistent and sufficient data must be recorded (an example is
15345 conducting a formal inspection), and action items must be recorded.

15346 [PA150.IG102.SP102.N105]

15347 **Typical Work Products**

15348 1. Peer review results [PA150.IG102.SP102.W101]

15349 2. Peer review issues [PA150.IG102.SP102.W102]

15350 3. Peer review data [PA150.IG102.SP102.W103]

15351 **Subpractices**

15352 1. Perform the assigned roles in the peer review. [PA150.IG102.SP102.SubP101]

15353 2. Identify and document defects and other issues in the work
15354 product. [PA150.IG102.SP102.SubP102]

15355 3. Capture the results of the peer review and document the action
15356 items. [PA150.IG102.SP102.SubP103]

15357 4. Collect peer review data. [PA150.IG102.SP102.SubP104]

15358 *Refer to the Measurement and Analysis process area for data collection*
15359 *practices.* [PA150.IG102.SP102.SubP104.R101]

15360 5. Identify action items and communicate the issues to stakeholders.
15361 [PA150.IG102.SP102.SubP105]

15362 *Refer to the Requirements Development process area where*
15363 *appropriate to address the action items identified in the peer reviews.*

15364 [PA150.IG102.SP102.SubP105.R101]

15365 *Refer to the Technical Solution process area where appropriate to*
15366 *address the action items identified in the peer reviews.*

15367 [PA150.IG102.SP102.SubP105.R102]

15368 *Refer to the Product Integration process area where appropriate to*
15369 *address the action items identified in the peer reviews.*

15370 [PA150.IG102.SP102.SubP105.R103]

15371 6. Plan a re-review of the work product if the re-review criteria are
15372 satisfied. [PA150.IG102.SP102.SubP106]

15373 7. Ensure that the exit criteria for the peer review are satisfied.

15374 [PA150.IG102.SP102.SubP107]

15375 **SP 2.3-2 Analyze Peer Review Data**

15376 **Analyze data about preparation, conduct, and results of the peer**
15377 **reviews.** [PA150.IG102.SP103]

15378 *Refer to the Measurement and Analysis process area for information*
15379 *about analyzing peer review data.* [PA150.IG102.SP103.R101]

15380 **Typical Work Products**

- 15381 1. Peer review data [PA150.IG102.SP103.W101]
- 15382 2. Peer review action items [PA150.IG102.SP103.W102]

15383 **Subpractices**

- 15384 1. Record data related to the preparation, conduct, and results of the
15385 peer reviews. [PA150.IG102.SP103.SubP101]

15386 Typical data are product name, size of the product, composition of the peer review
15387 team, type of peer review, preparation time per reviewer, length of the review
15388 meeting, number of defects found, type and origin of defect, etc. Additional
15389 information on the work product being peer reviewed may be collected such as
15390 size, development stage, operating modes examined, and requirements being
15391 evaluated. [PA150.IG102.SP103.SubP101.N101]

- 15392 2. Store the data for future reference and analysis. [PA150.IG102.SP103.SubP102]
- 15393 3. Protect the data to ensure that peer review data are not used
15394 inappropriately. [PA150.IG102.SP103.SubP103]

15395 Examples of inappropriate use of peer review data include using data to evaluate
15396 the performance of people and using data for attribution. [PA150.IG102.SP103.SubP103.N101]

- 15397
- 15398 4. Analyze the peer review data. [PA150.IG102.SP103.SubP104]

15399 **SG 3 Verify Selected Work Products** [PA150.IG103]

15400 **Selected work products are verified against their specified requirements.**

15401 **SP 3.1-1 Perform Verification**

15402 **Perform verification according to the verification strategy.**
15403 [PA150.IG103.SP101]

15404 Verifying products and work products incrementally promotes early
15405 detection of problems and can remove defects early. These results of
15406 verification save considerable cost of fault isolation and rework
15407 associated with troubleshooting problems. [PA150.IG103.SP101.N101]

15408

Typical Work Products

15409

1. Verification results [PA150.IG103.SP101.W101]

15410

2. Verification reports [PA150.IG103.SP101.W102]

15411

3. Demonstrations [PA150.IG103.SP101.W103]

15412

4. "As Verified" procedures log [PA150.IG103.SP101.W104]

15413

Subpractices

15414

1. Verify COTS and reused components to verify that they meet the requirements. [PA150.IG103.SP101.SubP101]

15415

15416

2. Perform product verification against the requirements according to the verification strategy and procedures. [PA150.IG103.SP101.SubP102]

15417

15418

3. Capture the results of verification activities. [PA150.IG103.SP101.SubP103]

15419

4. Identify action items resulting from verification of work products.

15420

[PA150.IG103.SP101.SubP104]

15421

5. Document the "as-run" verification method and the deviations from the strategies and procedures made during its performance.

15422

15423

[PA150.IG103.SP101.SubP105]

15424

SP 3.2-2 Analyze Verification Results and Identify Corrective Action

15425

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

15426

15427

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

15428

15429

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

15430

15431

Analysis reports or "as-run" method documentation may also indicate that bad verification results are due to method problems, criteria problems, or an infrastructure problem. [PA150.IG103.SP102.N103]

15432

15433

15434

Refer to the corrective action practices of Project Monitoring and Control process area for implementing corrective action.

15435

15436

[PA150.IG103.SP102.N103.R101]

15437

Typical Work Products

15438

1. Analysis report (such as statistics on performances, causal analysis of non-conformances, comparison of the behavior between the real product and models, trends, etc.)

15439

15440

[PA150.IG103.SP102.W101]

15441

15442

2. Trouble reports [PA150.IG103.SP102.W102]

- 15443 3. Method, criteria, and infrastructure change requests
15444 [PA150.IG103.SP102.W103]
- 15445 4. Corrective actions to verification methods, criteria, and/or
15446 infrastructure [PA150.IG103.SP102.W104]

15447 **Subpractices**

- 15448 1. Compare actual results to expected results. [PA150.IG103.SP102.SubP101]
- 15449 2. Based on the established verification criteria, identify products that
15450 have not met their requirements or identify problems with the
15451 methods, criteria, and/or infrastructure. [PA150.IG103.SP102.SubP102]
- 15452 3. Analyze the verification data on defects. [PA150.IG103.SP102.SubP103]
- 15453 4. Capture all results of the analysis into a report. [PA150.IG103.SP102.SubP104]
- 15454 5. Use verification results to compare actual measurements and
15455 performance to technical performance parameters.
15456 [PA150.IG103.SP102.SubP105]
- 15457 6. Provide information on how defects may be resolved (including
15458 verification methods, criteria, and/or infrastructure) and formalize it
15459 in a plan. [PA150.IG103.SP102.SubP106]

15460 **SP 3.3-1 Perform Re-Verification**

15461 ***Perform re-verification of corrected work products and ensure that***
15462 ***work products have not been negatively impacted.*** [PA150.IG103.SP103]

15463 Re-verification is done to ensure that the defect has been corrected,
15464 and to ensure that the work product has not been corrupted as a result
15465 of defect-correction actions. [PA150.IG103.SP103.N101]

15466 Re-verification will typically focus in detail on the part of the work
15467 product where the defect was detected. However, the work product that
15468 was being verified when the defect was detected will need to be re-
15469 verified to the extent needed to ensure that no new defects have been
15470 introduced. [PA150.IG103.SP103.N103]

15471 Re-verification is also necessary when there are changes in the
15472 requirements and/or the designs. [PA150.IG103.SP103.N104]

15473 Re-verification may be necessary when problems have been detected
15474 on the verification method. (See the "Perform Verification" specific
15475 practice.) [PA150.IG103.SP103.N105]

15476 **Typical Work Products**

- 15477 1. Re-verification results [PA150.IG103.SP103.W101]
- 15478 2. Subsystem and component verification results [PA150.IG103.SP103.W102]

- 15479 3. System verification results [PA150.IG103.SP103.W103]
- 15480 **Subpractices**
- 15481 1. Identify where re-verification is necessary. [PA150.IG103.SP103.SubP101]
- 15482 2. Perform re-verification. [PA150.IG103.SP103.SubP102]
- 15483 3. Perform re-test, as appropriate, including regression testing.
- 15484 [PA150.IG103.SP103.SubP103]
- 15485 *For Software Engineering*
- 15486 *Perform regression testing, as appropriate, whenever the*
- 15487 *software that is being tested changes or the software*
- 15488 *environment changes. [PA150.IG103.SP103.SubP103.AMP101]*
- 15489 4. Supplement or correct the documentation describing the
- 15490 verification activities. [PA150.IG103.SP103.SubP104]

15491 **Generic Practices by Goal**

15492 **GG 1 Achieve Specific Goals**

15493 *The process supports and enables achievement of the specific goals of the*

15494 *process area by transforming identifiable input work products to produce*

15495 *identifiable output work products.*

15496 **GP 1.1 Identify Work Scope**

15497 *Identify the scope of the work to be performed and work products*

15498 *to be produced for verification, and communicate this information*

15499 *to those performing the work. [GP101]*

15500 **GP 1.2 Perform Base Practices**

15501 *Perform the base practices of the verification process to develop*

15502 *work products and provide services to achieve the specific goals*

15503 *of the process area. [GP102]*

15504 **GG 2 Institutionalize a Managed Process**

15505 *The process is institutionalized as a managed process.*

15506 **GP 2.1 Establish an Organizational Policy**

15507 *Establish and maintain an organizational policy for planning and*

15508 *performing the verification process. [GP103]*

15509 Elaboration:

15510 This policy establishes organizational expectations for establishing and
15511 maintaining a verification strategy and environment, and performing
15512 peer reviews and verifying selected work products. [PA150.EL101]

15513 **GP 2.2 Plan the Process**

15514 ***Establish and maintain the requirements and objectives, and plans***
15515 ***for performing the verification process.*** [GP104]

15516 Elaboration:

15517 These requirements, objectives, and plans are described in the plan for
15518 verification. This plan for verification differs from the verification strategy
15519 described in the specific practices in this process area. The verification
15520 strategy addresses specific actions, resources, and environments
15521 required for work product verification, whereas the plan for verification
15522 addresses high-level planning for all the verification. [PA150.EL102]

15523 **GP 2.3 Provide Resources**

15524 ***Provide adequate resources for performing the verification***
15525 ***process, developing the work products and providing the services***
15526 ***of the process.*** [GP105]

15527 Elaboration:

15528 Examples of tools used to perform the activities of the Verification
15529 process area include the following: [PA150.EL103]

- 15530
- Test management tools
 - Test case generators
 - Test coverage analyzers
 - Simulators
- 15531
15532
15533

15534

15535 Certain verification methods may require special tools, equipment,
15536 facilities, and training (e.g., peer reviews may require meeting rooms
15537 and trained moderators; certain verification tests may require special
15538 test equipment and those skilled in the use of the equipment).
15539 [PA150.EL104]

15540 Special facilities may be required for verifying selected work products.
15541 When necessary, the facilities required for the activities in the
15542 Verification process area are developed or purchased. [PA150.EL110]

15543
15544
15545
15546

GP 2.4 Assign Responsibility

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

15547
15548
15549

GP 2.5 Train People

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

15550

Elaboration:

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15552
15553
15554
15555
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15557
15558

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

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

15559
15560
15561

GP 2.6 Manage Configurations

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

15562

Elaboration:

15563
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15566
15567
15568
15569

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

- Verification strategy
- Peer review training material
- Peer review data
- Verification reports

15570
15571
15572

GP 2.7 Identify and Involve Relevant Stakeholders

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

15573 Elaboration:

15574 For engineering processes, consider stakeholders among customers,
15575 end users, developers, producers, testers, suppliers, marketers,
15576 maintainers, disposal personnel, and others who may be affected by, or
15577 may affect, the product as well as the process. [PA150.EL113]

15578 Examples of activities for stakeholder involvement include: [PA150.EL114]

- 15579 • Establishing a verification strategy
- 15580 • Conducting peer reviews
- 15581 • Assessing verification results and identify corrective action

15582

15583 **GP 2.8 Monitor and Control the Process**

15584 ***Monitor and control the verification process against the plan and***
15585 ***take appropriate corrective action.*** [GP110]

15586 Elaboration:

15587 Examples of measures used in monitoring and controlling the activities
15588 of the Verification process area include the following: [PA150.EL107]

- 15589 • Verification profile (e.g., the number of verifications planned,
15590 performed, and defects found; perhaps categorized by verification
15591 method or type)
- 15592 • Number of defects detected by defect category
- 15593 • Verification problem report trends (e.g., number written and
15594 number closed)
- 15595 • Verification problem report status (i.e., how long each problem
15596 report has been open)

15597

15598 **GP 2.9 Objectively Evaluate Adherence**

15599 ***Objectively evaluate adherence of the verification process and the***
15600 ***work products and services of the process to the applicable***
15601 ***requirements, objectives, and standards, and address***
15602 ***noncompliance.*** [GP113]

15603

Elaboration:

15604

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

15605

- Establishing and maintaining a verification strategy

15606

- Performing peer reviews

15607

- Verifying selected work products

15608

15609

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

15610

- Verification strategy

15611

- Peer review checklists

15612

- Verification reports

15613

15614

GP 2.10 Review Status with Higher-Level Management

15615

Review the activities, status, and results of the verification

15616

process with higher-level management and resolve issues. [GP112]

15617

GG 3 Institutionalize a Defined Process

15618

The process is institutionalized as a defined process.

15619

GP 3.1 Establish a Defined Process

15620

Establish and maintain the description of a defined verification

15621

process. [GP114]

15622

GP 3.2 Collect Improvement Information

15623

Collect work products, measures, measurement results, and

15624

improvement information derived from planning and performing

15625

the verification process to support the future use and

15626

improvement of the organization's processes and process assets.

15627

[GP117]

15628

GG 4 Institutionalize a Quantitatively Managed Process

15629

The process is institutionalized as a quantitatively managed process.

15630 **GP 4.1 Establish Quality Objectives**

15631 *Establish and maintain quantitative objectives for the verification*
15632 *process about quality and process performance based on*
15633 *customer needs and business objectives.* [GP118]

15634 **GP 4.2 Stabilize Subprocess Performance**

15635 *Stabilize the performance of one or more subprocesses of the*
15636 *verification process to determine its ability to achieve the*
15637 *established quantitative quality and process performance*
15638 *objectives.* [GP119]

15639 **GG 5 Institutionalize an Optimizing Process**

15640 *The process is institutionalized as an optimizing process.*

15641 **GP 5.1 Ensure Continuous Process Improvement**

15642 *Ensure continuous improvement of the verification process in*
15643 *fulfilling the relevant business goals of the organization.* [GP125]

15644 **GP 5.2 Correct Common Cause of Problems**

15645 *Identify and correct the root causes of defects and other problems*
15646 *in the verification process.* [GP121]

15647 VALIDATION

15648 Engineering

15649 Purpose

15650 The purpose of Validation is to demonstrate that a product or product
15651 component fulfills its intended use when placed in its intended
15652 environment. [PA149]

15653 Introductory Notes

15654 Validation demonstrates that the as-built product actually performs its
15655 intended function(s) in its intended environment. [PA149.N101]

15656 Validation activities use approaches similar to verification (e.g., test,
15657 analysis, simulation, etc.). Both validation and verification activities
15658 often run concurrently and may use portions of the same environment.
15659 The difference is that verification demonstrates compliance with
15660 requirements, while validation demonstrates satisfactory suitability for
15661 use in the intended operating environment. In other words, verification
15662 assures "you built it right;" whereas validation assures "you built the
15663 right thing." [PA149.N102]

15664 *Refer to the Verification process area for more information about*
15665 *verification activities.* [PA149.N102.R101]

15666 Product validation should be accomplished using the actual product
15667 operating in its intended environment where possible. The entire
15668 environment may be used or only part of it. Validation issues can be
15669 discovered early in the development life cycle through the use of early
15670 validation activities (such as validation of customer requirements
15671 against the operational needs of the customers and end-users).

15672 [PA149.N103]

15673 *Refer to the Requirements Development process area for more*
15674 *information about requirements validation. Requirements validation*
15675 *practices are included in Requirements Development to ensure early*
15676 *requirements validation activities are performed.* [PA149.N103.R101]

15677 Validation issues may include the identification of unsatisfactory product
15678 requirements or unanticipated or unintended functions or behavior.
15679 When issues are identified, they are referred to the Requirements
15680 Development, Technical Solution, or Project Monitoring and Control
15681 process area's practices for resolution. [PA149.N104]

15682 Related Process Areas

15683 *Refer to the Requirements Development process area for more*
 15684 *information about requirements generation based on the customer*
 15685 *needs and for corrective action when validation issues are identified*
 15686 *that affect the product or product component requirements.* [PA149.R101]

15687 *Refer to the Technical Solution process area for more information about*
 15688 *transforming requirements into product specifications and for corrective*
 15689 *action when validation issues are identified that affect the product or*
 15690 *product component design.* [PA149.R102]

15691 *Refer to the Verification process area for more information about*
 15692 *verifying that the product and product components meet their*
 15693 *requirements.* [PA149.R103]

15694 *Refer to the Decision Analysis and Resolution process area for more*
 15695 *information about structured decision making related to deciding on the*
 15696 *optimum validation strategy.* [PA149.R104]

15697 Specific Goals

15698 **SG 1 Prepare for Validation** [PA149.IG101]

15699 ***Preparation for validation is conducted.***

15700 **SG 2 Validate Product or Product Components** [PA149.IG102]

15701 ***The product or product components are validated to ensure that they are***
 15702 ***suitable for use in their intended operating environment.***

15703 Generic Goals

15704 **GG 1 Achieve Specific Goals** [CL102.GL101]

15705 ***The process supports and enables achievement of the specific goals of the***
 15706 ***process area by transforming identifiable input work products to produce***
 15707 ***identifiable output work products.***

15708 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

15709 ***The process is institutionalized as a managed process.***

15710 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

15711 ***The process is institutionalized as a defined process.***

15712 **GG 4 Institutionalize a Quantitatively Managed Process** [CL105.GL101]

15713 *The process is institutionalized as a quantitatively managed process.*

15714 **GG 5 Institutionalize an Optimizing Process** [CL106.GL101]

15715 *The process is institutionalized as an optimizing process.*

15716 Practice to Goal Relationship Table

15717 **SG 1 Prepare for Validation** [PA149.IG101]

- 15718 SP 1.1-1 Establish a Validation Strategy
- 15719 SP 1.2-2 Establish the Validation Environment
- 15720 SP 1.3-3 Define Detailed Validation Procedures

15721 **SG 2 Validate Product or Product Components** [PA149.IG102]

- 15722 SP 2.1-1 Perform Validation
- 15723 SP 2.2-1 Capture and Analyze Validation Results

15724 **GG 1 Achieve Specific Goals** [CL102.GL101]

- 15725 GP 1.1 Identify Work Scope
- 15726 GP 1.2 Perform Base Practices

15727 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

- 15728 GP 2.1 Establish an Organizational Policy
- 15729 GP 2.2 Plan the Process
- 15730 GP 2.3 Provide Resources
- 15731 GP 2.4 Assign Responsibility
- 15732 GP 2.5 Train People
- 15733 GP 2.6 Manage Configurations
- 15734 GP 2.7 Identify and Involve Relevant Stakeholders
- 15735 GP 2.8 Monitor and Control the Process
- 15736 GP 2.9 Objectively Evaluate Adherence
- 15737 GP 2.10 Review Status with Higher-Level Management

15738 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

- 15739 GP 3.1 Establish a Defined Process
- 15740 GP 3.2 Collect Improvement Information

15741 **GG 4 Institutionalize a Quantitatively Managed Process** [CL105.GL101]

- 15742 GP 4.1 Establish Quality Objectives
- 15743 GP 4.2 Stabilize Subprocess Performance

15744 **GG 5 Institutionalize an Optimizing Process** [CL106.GL101]

- 15745 GP 5.1 Ensure Continuous Process Improvement
- 15746 GP 5.2 Correct Common Cause of Problems

15747 Specific Practices by Goal

15748 **SG 1 Prepare for Validation** [PA149.IG101]

15749 *Preparation for validation is conducted.*

15750 Preparation activities for validation allow for flexibility to the technical
 15751 approach in the product development effort. Preparation activities
 15752 include establishing and maintaining a validation strategy, environment,
 15753 and detailed procedures. The validation strategy may include the
 15754 validation of only the end product or it may include appropriate levels of
 15755 the product components that are used to build the product. Any product
 15756 may be subject to validation including replacement, maintenance, and
 15757 training products to name just a few. [PA149.IG101.N101]

15758 The environment required to validate the product or product
 15759 components is prepared according to the strategy. The environment
 15760 may be purchased or specified, designed, and built. Reuse of all or part
 15761 of the environment is also described in the validation strategy. The
 15762 environments used for product integration and verification should be
 15763 considered in a collaborative effort in the validation strategy to reduce
 15764 cost and improve efficiency or productivity. [PA149.IG101.N102]

15765 **SP 1.1-1 Establish a Validation Strategy**

15766 ***Establish and maintain a validation strategy.*** [PA149.IG101.SP101]

15767 *For Integrated Product and Process Development*

15768 *The validation strategy should be developed concurrently and*
 15769 *iteratively with the product and product component designs.*

15770 [PA149.IG101.SP101.AMP101]

15771 The requirements and strategies for validation are documented in a
 15772 validation strategy. The validation strategy addresses the specific
 15773 actions, resources, and environments required for product validation.
 15774 When planning the validation process (see Project Planning and the
 15775 Planning generic practice), specific tasks should be included to address
 15776 the detailed validation strategies and activities needed. The validation
 15777 strategy not only defines the technical approach to product validation,
 15778 but also detailed activities and resources. These activities and
 15779 resources may include facilities, validation equipment, environments,
 15780 time phasing, resource sharing among validation activities within the
 15781 project and by other projects within the same organization, etc. This
 15782 may result in the generation of lower-level product component
 15783 requirements that are handled by the Requirements Development
 15784 process area. Derived requirements, such as interface requirements to
 15785 test sets and test equipment, may be generated. These requirements
 15786 are also passed to the Requirements Development processes to ensure
 15787 that the product or product components can be validated in the
 15788 environment defined by the strategy. [PA149.IG101.SP101.N101]

15789 A validation strategy should be available early in the development
 15790 process so that the validation mechanisms are clearly understood and
 15791 agreed to by the relevant stakeholders. [PA149.IG101.SP101.N102]

15792 The validation strategy and procedures address the development,
15793 maintenance, support, and training for the product and product
15794 components as appropriate. [PA149.IG101.SP101.N103]

15795 **Typical Work Products**

15796 1. Validation strategy [PA149.IG101.SP101.W101]

15797 **Subpractices**

15798 1. Identify the key principles, features, and phases for product or
15799 product component validation throughout the development life
15800 cycle. [PA149.IG101.SP101.SubP101]

15801 2. Define requirements for a realistic validation environment that
15802 covers operation, maintenance, training, and support.

15803 [PA149.IG101.SP101.SubP102]

15804 The product must be maintainable and supportable in its intended operational
15805 environment. This practice addresses the actual maintenance, training, and
15806 support services that may be delivered along with the product. In some cases, this
15807 practice may be performed by organizations other than the development
15808 organization. [PA149.IG101.SP101.SubP102.N101]

15809 An example of evaluation of maintenance concepts in the operational environment
15810 is a demonstration that maintenance tools are operating in the actual product.

15811 [PA149.IG101.SP101.SubP102.N102]

15812 3. Define the evaluation criteria for validation. [PA149.IG101.SP101.SubP103]

15813 4. Review the validation strategy with relevant stakeholders.

15814 [PA149.IG101.SP101.SubP104]

15816 **SP 1.2-2 Establish the Validation Environment**

15817 ***Establish and maintain the environment needed to support***
15818 ***validation.*** [PA149.IG101.SP102]

15819 The validation strategy may identify needs for an environment that must
15820 be acquired or developed. This may yield requirements for the purchase
15821 or development of equipment, software, or other resources. These
15822 requirements are provided to the Requirements Development process
15823 areas for development. The validation environment may include the
15824 reuse of existing resources. In this case, the strategy should outline the
15825 use of these resources and arrangements for their use must be made.
15826 Examples of the type of elements in a validation environment include
15827 the following: [PA149.IG101.SP102.N101]

- 15828 • Test tools interfaced with the product being validated (e.g., scope,
15829 electronic devices, probes)

- 15830 • Temporary embedded test software
- 15831 • Recording tools for dump or further analysis and replay
- 15832 • Simulated subsystems or components (by software or by
- 15833 electronics or by mechanics)
- 15834 • Simulated interfaced systems (e.g., a dummy warship for testing a
- 15835 naval radar)
- 15836 • Real interfaced systems (e.g., aircraft for testing a radar with
- 15837 trajectory tracking facilities)
- 15838 • Facilities and Customer-Supplied Products
- 15839 • The skilled people to operate or use all the above elements
- 15840 • Dedicated computing or network test environment (e.g., pseudo
- 15841 operational telecommunications network test bed or facility with
- 15842 actual trunks, switches and systems established for realistic
- 15843 integration and validation trials)

15844 Early development of the validation strategy is needed to ensure that
15845 the validation environment will be available when necessary.

15846 [PA149.IG101.SP102.N102]

15847 The validation environment should be carefully controlled to provide for
15848 replication, analysis of results, and re-validation of problem areas.

15849 [PA149.IG101.SP102.N103]

15850 **Typical Work Products**

- 15851 1. Validation environment [PA149.IG101.SP102.W101]

15852 **Subpractices**

- 15853 1. Identify validation environment requirements. [PA149.IG101.SP102.SubP101]
- 15854 2. Identify customer-supplied products. [PA149.IG101.SP102.SubP102]
- 15855 3. Identify reuse items. [PA149.IG101.SP102.SubP103]
- 15856 4. Identify test equipment and tools. [PA149.IG101.SP102.SubP104]
- 15857 5. Identify validation resources that are available for re-use and
- 15858 modification. [PA149.IG101.SP102.SubP105]
- 15859 6. Plan the availability of resources in detail. [PA149.IG101.SP102.SubP106]

15860 **SP 1.3-3 Define Detailed Validation Procedures**

15861 ***Define detailed procedures and criteria for validation.*** [PA149.IG101.SP103]

15862 Validation procedures are defined to ensure that the product or product
15863 component will fulfill its intended use when placed in its intended
15864 environment. Acceptance test cases and procedures may meet the
15865 need for validation procedures. [PA149.IG101.SP103.N101]

15866 The detailed validation procedures include test and evaluation of
15867 maintenance, training and support services. [PA149.IG101.SP103.N102]

15868 **Typical Work Products**

- 15869 1. Validation procedures [PA149.IG101.SP103.W101]
- 15870 2. Validation criteria [PA149.IG101.SP103.W102]
- 15871 3. Test and evaluation procedures for maintenance, training, and
15872 support [PA149.IG101.SP103.W103]

15873 **Subpractices**

- 15874 1. Review the product requirements to ensure that issues affecting
15875 validation of the product are identified and resolved.
15876 [PA149.IG101.SP103.SubP101]
- 15877 2. Document the environment, operational scenario, procedures,
15878 inputs, outputs, and expected results for the validation strategy.
15879 [PA149.IG101.SP103.SubP102]
- 15880 3. Assess the design as it matures in the context of the validation
15881 environment to identify validation issues. [PA149.IG101.SP103.SubP103]

15882 **SG 2 Validate Product or Product Components** [PA149.IG102]

15883 ***The product or product components are validated to ensure that they are***
15884 ***suitable for use in their intended operating environment.***

15885 Validation activities should start early in the project and are performed
15886 according to the validation strategy. [PA149.IG102.N101]

15887 The validation strategy and procedures are used to validate the product
15888 and or product components and any associated maintenance, training
15889 and support services using the appropriate validation environment. In
15890 some cases, this practice may be performed by organizations other
15891 than the development organization. [PA149.IG102.N102]

15892 **SP 2.1-1 Perform Validation**

15893 ***Perform validation according to the validation strategy.***

15894 [PA149.IG102.SP101]

15895 To be acceptable to users, the product and product components must
15896 perform as expected in their intended operational environment.

15897 [PA149.IG102.SP101.N101]

15898 Validation activities are performed and the resulting data is collected
15899 according to established plans and procedures. [PA149.IG102.SP101.N102]

15900 The as-run validation procedures should be documented and the
15901 deviations occurring during the execution should be noted, as
15902 appropriate. [PA149.IG102.SP101.N103]

15903 **Typical Work Products**

- 15904 1. Validation reports [PA149.IG102.SP101.W101]
- 15905 2. Validation results [PA149.IG102.SP101.W102]
- 15906 3. Validation cross-reference matrix [PA149.IG102.SP101.W103]
- 15907 4. As-run procedures log [PA149.IG102.SP101.W104]
- 15908 5. Operational demonstrations [PA149.IG102.SP101.W105]

15909 **SP 2.2-1 Capture and Analyze Validation Results**

15910 ***Capture and analyze the results of the validation activities and***
15911 ***identify issues.*** [PA149.IG102.SP102]

15912 The data resulting from validation tests, inspections, demonstrations, or
15913 evaluations are analyzed against the defined validation criteria. Analysis
15914 reports indicate whether or not the needs were met; and in the case of
15915 deficiencies, these reports document the degree of success or failure
15916 and categorize probable cause of failure. The collected test, inspection,
15917 or review results are compared with established evaluation criteria to
15918 determine whether to proceed or to address requirements or design
15919 issues in the Requirements Development or Technical Solution process
15920 areas. [PA149.IG102.SP102.N101]

15921 Analysis reports or as-run validation documentation may also indicate
15922 that bad test results are due to a validation procedure problem or a
15923 validation environment problem. [PA149.IG102.SP102.N102]

15924 **Typical Work Products**

- 15925 1. Validation deficiency reports [PA149.IG102.SP102.W101]
- 15926 2. Validation issues [PA149.IG102.SP102.W102]
- 15927 3. Procedure change request [PA149.IG102.SP102.W103]

15928 **Subpractices**

- 15929 1. Compare actual results to expected results. [PA149.IG102.SP102.SubP101]

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2. Based on the established validation criteria, identify products or product components that do not perform suitably in their intended operating environments or identify problems with the methods, criteria, and/or environment. [PA149.IG102.SP102.SubP102]
 3. Analyze the validation data for defects. [PA149.IG102.SP102.SubP103]
 4. Capture the results of the analysis and identify issues. [PA149.IG102.SP102.SubP104]
 5. Use validation results to compare actual measurements and performance to intended use or operational need. [PA149.IG102.SP102.SubP105]

15940 Generic Practices by Goal

15941 **GG 1 Achieve Specific Goals**

15942 *The process supports and enables achievement of the specific goals of the*
15943 *process area by transforming identifiable input work products to produce*
15944 *identifiable output work products.*

15945 **GP 1.1 Identify Work Scope**

15946 *Identify the scope of the work to be performed and work products*
15947 *to be produced for validation, and communicate this information*
15948 *to those performing the work. [GP101]*

15949 **GP 1.2 Perform Base Practices**

15950 *Perform the base practices of the validation process to develop*
15951 *work products and provide services to achieve the specific goals*
15952 *of the process area. [GP102]*

15953 **GG 2 Institutionalize a Managed Process**

15954 *The process is institutionalized as a managed process.*

15955 **GP 2.1 Establish an Organizational Policy**

15956 *Establish and maintain an organizational policy for planning and*
15957 *performing the validation process. [GP103]*

15958 Elaboration:

15959 This policy establishes organizational expectations for establishing and
15960 maintaining a validation strategy and environment, and for ensuring that
15961 the product and product components are suitable for use in their
15962 intended operating environment. [PA149.EL101]

15963 **GP 2.2 Plan the Process**

15964 ***Establish and maintain the requirements and objectives, and plans***
15965 ***for performing the validation process.*** [GP104]

15966 Elaboration:

15967 These requirements, objectives, and plans are described in the plan for
15968 validation. This plan for validation differs from the validation strategy
15969 described in the specific practices in this process area. The validation
15970 strategy addresses the specific actions, resources, and environments
15971 required for validation, whereas the plan for validation addresses high
15972 level planning for all the validation activities. [PA149.EL102]

15973 **GP 2.3 Provide Resources**

15974 ***Provide adequate resources for performing the validation process,***
15975 ***developing the work products and providing the services of the***
15976 ***process.*** [GP105]

15977 Elaboration:

15978 Special facilities may be required for validating the product and product
15979 components. When necessary, the facilities required for the activities in
15980 the Validation process area are developed or purchased. [PA149.EL111]

15981 Examples of tools used to perform the activities of the Validation
15982 process area include the following: [PA149.EL103]

- 15983 • Test management tools
- 15984 • Test case generators
- 15985 • Test coverage analyzers
- 15986 • Simulators
- 15987 • Load, stress and performance tools

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GP 2.4 Assign Responsibility

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

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GP 2.5 Train People

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

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Elaboration:

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Examples of training topics include the following: [PA149.EL104]

- Application domain
- Validation principles, standards, and methods
- Intended use environment

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GP 2.6 Manage Configurations

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

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Elaboration:

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Examples of work products placed under configuration management include the following: [PA149.EL105]

- Validation strategy
- Validation procedures
- Validation reports

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GP 2.7 Identify and Involve Relevant Stakeholders

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

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Elaboration:

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For engineering processes, consider stakeholders among customers, end users, developers, producers, testers, suppliers, marketers, maintainers, disposal personnel, and others who may be affected by, or may affect, the product as well as the process. [PA149.EL113]

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Examples of activities for stakeholder involvement include: [PA149.EL114]

- Establishing the validation strategy
- Reviewing product and product component validation results and resolving issues
- Resolving issues with the customers or end users

Issues with the customers or end users are resolved particularly when there are significant deviations from their baselined needs for the following: [PA149.EL115]

- Waivers on the contract or agreement (what, when, and for which products, services, or manufactured products)
- Additional in-depth studies or trials or test and evaluation
- Possible changes in the contracts or agreements

GP 2.8 Monitor and Control the Process

Monitor and control the validation process against the plan and take appropriate corrective action. [GP110]

Elaboration:

Examples of measures used in monitoring and controlling the activities of the Validation process area include the following: [PA149.EL109]

- Number of validation activities completed (planned versus actual)
- Validation problem report trends (e.g., number written and number closed)
- Validation problem report aging (i.e., how long each problem report has been open)

GP 2.9 Objectively Evaluate Adherence

Objectively evaluate adherence of the validation process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

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Elaboration:

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Examples of activities reviewed include the following: [PA149.EL110]

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- Establishing and maintaining a validation strategy

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- Validating product or product components

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Examples of work products reviewed include the following: [PA149.EL112]

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- Validation strategy

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- Validation procedures

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GP 2.10 Review Status with Higher-Level Management

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

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GG 3 Institutionalize a Defined Process

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The process is institutionalized as a defined process.

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GP 3.1 Establish a Defined Process

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

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GP 3.2 Collect Improvement Information

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Collect work products, measures, measurement results, and improvement information derived from planning and performing the validation process to support the future use and improvement of the organization's processes and process assets. [GP117]

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GG 4 Institutionalize a Quantitatively Managed Process

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The process is institutionalized as a quantitatively managed process.

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GP 4.1 Establish Quality Objectives

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Establish and maintain quantitative objectives for the validation process about quality and process performance based on customer needs and business objectives. [GP118]

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16078 **GP 4.2 Stabilize Subprocess Performance**

16079 ***Stabilize the performance of one or more subprocesses of the***
16080 ***validation process to determine its ability to achieve the***
16081 ***established quantitative quality and process performance***
16082 ***objectives.*** [GP119]

16083 **GG 5 Institutionalize an Optimizing Process**

16084 ***The process is institutionalized as an optimizing process.***

16085 **GP 5.1 Ensure Continuous Process Improvement**

16086 ***Ensure continuous improvement of the validation process in***
16087 ***fulfilling the relevant business goals of the organization.*** [GP125]

16088 **GP 5.2 Correct Common Cause of Problems**

16089 ***Identify and correct the root causes of defects and other problems***
16090 ***in the validation process.*** [GP121]

16091 SUPPORT

16092 The following section contains all of the process areas that belong to
16093 the Support process area category. The Support process areas of
16094 CMMI are as follows: [FM107.T101]

- 16095 • Configuration Management
- 16096 • Process and Product Quality Assurance
- 16097 • Measurement and Analysis
- 16098 • Decision Analysis and Resolution
- 16099 • Causal Analysis and Resolution
- 16100 • Organizational Environment for Integration

16101 *Refer to the Understanding the Model chapter of the Overview section*
16102 *for more information about the Support process areas and how they*
16103 *interact.* [FM107.T101.R101]

16104 CONFIGURATION MANAGEMENT

16105 Support

16106 Purpose

16107 The purpose of Configuration Management is to establish and maintain
16108 the integrity of work products using configuration identification,
16109 configuration control, configuration status accounting, and configuration
16110 audits. [PA159]

16111 Introductory Notes

16112 Configuration Management involves the following: [PA159.N101]

- 16113 • Identifying the configuration of selected work products that
16114 compose the baselines at given points in time
- 16115 • Controlling changes to configuration items
- 16116 • Building or providing specifications to build work products from the
16117 configuration management system
- 16118 • Maintaining the integrity of baselines
- 16119 • Providing accurate status and current configuration data to
16120 developers, end users, and customers

16121 The work products placed under configuration management include the
16122 products that are delivered to the customer, designated internal work
16123 products, acquired products, tools, and other items that are used in
16124 creating and describing these work products. [PA159.N102]

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Examples of work products that may be placed under configuration management include: [PA159.N109]

- Plans
- Process descriptions
- Requirements
- Design data
- Drawings
- Product specifications
- Code
- Compilers
- Product data files
- Product technical publications.

Configuration management of work products may be performed at several levels of granularity. A "configuration item" is an entity designated for configuration management, which may consist of multiple related work products. Configuration items can be decomposed into configuration components and configuration units. Only the term "configuration item" is used in this process area. Therefore, in these practices, "configuration item" may be interpreted as "configuration component" or "configuration unit" as appropriate. [PA159.N103]

A "baseline" describes one or more configuration items and the associated entities of which it is composed. Baselines provide a stable basis for continuing evolution of configuration items. [PA159.N104]

An example of a baseline is an approved description of a product that includes internally consistent versions of requirements, requirement traceability matrices, design, discipline-specific items, and end-user documentation. [PA159.N110]

A configuration management system is established containing the baselines as they are developed. Changes to baselines and the release of work products built from the configuration management system are systematically controlled and monitored via the configuration control, change management and configuration auditing functions of configuration management. [PA159.N105]

This process area applies not only to configuration management on projects, but also to configuration management on organization work products such as standards, procedures, and reuse libraries. [PA159.N106]

16163 Configuration Management includes control of content, versions,
16164 changes, and distribution of data. It is focused on the rigorous control
16165 of the managerial and technical aspects of the work products including
16166 the delivered system. [PA159.N107]

16167 This process area covers the practices for performing the configuration
16168 management function and is applicable to all work products that are
16169 placed under configuration management. [PA159.N108]

16170 Related Process Areas

16171 *Refer to the Project Planning process area for information on*
16172 *developing plans and work breakdown structures - a method of dividing*
16173 *project work that may be useful for determining configuration items.*
16174 [PA159.R101]

16175 *Refer to the Causal Analysis and Resolution process area for more*
16176 *information about both the method to use for analyzing the impact of*
16177 *change requests and the method to use when evaluating changes.*
16178 [PA159.R102]

16179 *Refer to the Project Monitoring and Control process area for more*
16180 *information about performance analyses and corrective actions.*
16181 [PA159.R103]

16182 Specific Goals

16183 **SG 1 Establish Baselines** [PA159.IG101]

16184 ***Baselines of identified work products are established and maintained.***

16185 **SG 2 Track and Control Changes** [PA159.IG102]

16186 ***Changes to the work products under configuration management are tracked***
16187 ***and controlled.***

16188 **SG 3 Establish Integrity** [PA159.IG103]

16189 ***Integrity of baselines is established and maintained.***

16190 Generic Goals

16191 **GG 1** **Achieve Specific Goals** [CL102.GL101]

16192 *The process supports and enables achievement of the specific goals of the*
16193 *process area by transforming identifiable input work products to produce*
16194 *identifiable output work products.*

16195 **GG 2** **Institutionalize a Managed Process** [CL103.GL101]

16196 *The process is institutionalized as a managed process.*

16197 **GG 3** **Institutionalize a Defined Process** [CL104.GL101]

16198 *The process is institutionalized as a defined process.*

16199 **GG 4** **Institutionalize a Quantitatively Managed Process** [CL105.GL101]

16200 *The process is institutionalized as a quantitatively managed process.*

16201 **GG 5** **Institutionalize an Optimizing Process** [CL106.GL101]

16202 *The process is institutionalized as an optimizing process.*

16203 Practice to Goal Relationship Table

- 16204 SG 1 Establish Baselines [PA159.IG101]
- 16205 SP 1.1-1 Identify Configuration Items
- 16206 SP 1.2-1 Establish a Configuration Management System
- 16207 SP 1.3-1 Create or Release Baselines

- 16208 SG 2 Track and Control Changes [PA159.IG102]
- 16209 SP 2.1-1 Track Changes
- 16210 SP 2.2-1 Control Changes

- 16211 SG 3 Establish Integrity [PA159.IG103]
- 16212 SP 3.1-1 Establish Configuration Management Records
- 16213 SP 3.2-1 Perform Configuration Audits

- 16214 GG 1 Achieve Specific Goals [CL102.GL101]
- 16215 GP 1.1 Identify Work Scope
- 16216 GP 1.2 Perform Base Practices

- 16217 GG 2 Institutionalize a Managed Process [CL103.GL101]
- 16218 GP 2.1 Establish an Organizational Policy
- 16219 GP 2.2 Plan the Process
- 16220 GP 2.3 Provide Resources
- 16221 GP 2.4 Assign Responsibility
- 16222 GP 2.5 Train People
- 16223 GP 2.6 Manage Configurations
- 16224 GP 2.7 Identify and Involve Relevant Stakeholders
- 16225 GP 2.8 Monitor and Control the Process
- 16226 GP 2.9 Objectively Evaluate Adherence
- 16227 GP 2.10 Review Status with Higher-Level Management

- 16228 GG 3 Institutionalize a Defined Process [CL104.GL101]
- 16229 GP 3.1 Establish a Defined Process
- 16230 GP 3.2 Collect Improvement Information

- 16231 GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]
- 16232 GP 4.1 Establish Quality Objectives
- 16233 GP 4.2 Stabilize Subprocess Performance

- 16234 GG 5 Institutionalize an Optimizing Process [CL106.GL101]
- 16235 GP 5.1 Ensure Continuous Process Improvement
- 16236 GP 5.2 Correct Common Cause of Problems

16237 Specific Practices by Goal

16238 **SG 1 Establish Baselines** [PA159.IG101]

16239 ***Baselines of identified work products are established and maintained.***

SP 1.1-1 Identify Configuration Items

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Identify the configuration items, components, and related work products that will be placed under configuration management.

[PA159.IG101.SP101]

Configuration identification is the selection, creation, and specification of the products that are delivered to the customer, designated internal work products, acquired products, tools, and other items that are used in creating and describing these work products. Items under configuration management will include specifications and interface documents that define the requirements for the product. Other documents, such as test results, may also be included depending on their criticality to defining the product. [PA159.IG101.SP101.N101]

A "configuration item" is an entity designated for configuration management, which may consist of multiple related work products that form a baseline. This logical grouping provides ease of identification and controlled access. The selection of work products for configuration management should be based on criteria established during planning.

[PA159.IG101.SP101.N102]

For Systems Engineering

In a system that includes both hardware and software, where software represents a small part of the system, all of the software may be designated as a single configuration item. In other cases, the software may be decomposed into multiple configuration items. [PA159.IG101.SP101.N102.AMP101]

Configuration items can be decomposed into configuration components and configuration units. Only the term "configuration item" is used in this process area. In these practices, "configuration item" may be interpreted as "configuration component" or "configuration unit" as appropriate. For example, configuration items in the area of requirements management could vary from each individual requirement to a set of requirements. [PA159.IG101.SP101.N103]

Typical Work Products

1. Identified configuration items [PA159.IG101.SP101.W101]

Subpractices

1. Select the configuration items and work products that compose them based on documented criteria. [PA159.IG101.SP101.SubP101]

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Example criteria for selecting configuration items at the appropriate work product level include the following: [PA159.IG101.SP101.SubP101.N102]

- Work products that may be used by two or more groups
- Work products that are expected to change over time either because of errors or change of requirements
- Work products that are dependent on each other and a change in one mandates a change in others
- Work products that are critical for the project

Examples of work products that may be part of a configuration item include the following: [PA159.IG101.SP101.SubP101.N101]

- Process descriptions
- Requirements
- Design
- Test plans and procedures
- Test results
- Interface descriptions

For Software Engineering

Examples of software work products that may be part of a configuration item include the following:
[PA159.IG101.SP101.SubP101.N101.AMP101]

- *Code/module*
- *Tools (e.g., Compilers)*

2. Assign unique identifiers to configuration items. [PA159.IG101.SP101.SubP102]
3. Specify the important characteristics of each configuration item.
[PA159.IG101.SP101.SubP103]

Example characteristics of configuration items include author, document or file type, and programming language for software code files. [PA159.IG101.SP101.SubP103.N101]

4. Specify the point in its development that each configuration item is placed under configuration management. [PA159.IG101.SP101.SubP104]

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Example criteria for determining when to place work products under configuration management include the following: [PA159.IG101.SP101.SubP104.N101]

- Stage of the development life cycle
- When the work product is ready for test
- Degree of control desired on the work product
- Cost and schedule limitations
- Customer requirements

5. Identify the owner responsible for each configuration item.

[PA159.IG101.SP101.SubP105]

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SP 1.2-1 Establish a Configuration Management System

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Establish and maintain a configuration management and change management system for controlling work products. [PA159.IG101.SP102]

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A configuration management system includes the storage media, the procedures, and the tools for accessing the configuration system.

[PA159.IG101.SP102.N101]

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A change management system includes the storage media, the procedures, and tools for recording and accessing change requests.

[PA159.IG101.SP102.N102]

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Typical Work Products

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1. Configuration management system with controlled work products

[PA159.IG101.SP102.W101]

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2. Configuration management system access control procedures

[PA159.IG101.SP102.W102]

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3. Change request database [PA159.IG101.SP102.W103]

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Subpractices

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1. Establish a mechanism to manage multiple control levels of configuration management. [PA159.IG101.SP102.SubP101]

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Examples of situations leading to multiple levels of control include the following:
[PA159.IG101.SP102.SubP101.N101]

- Differences in the levels of control needed at different times in the life cycle (e.g., tighter control as product matures)
- Differences in the levels of control needed for different types of systems (e.g., software-only systems versus systems that include hardware and software)
- Differences in the levels of control to satisfy necessary privacy and security requirements for the configuration items

Three examples of configuration management systems are as follows:
[PA159.IG101.SP102.SubP101.N102]

- Dynamic (or developer's) systems contain components currently being created or revised. They are the developer's workspace and are controlled by the developer. Configuration items in a dynamic system are under version control.
- Master (or controlled) systems contain current baselines and changes to them. Configuration items in a master system are under full configuration management as described in this process area.
- Static systems contain archives of various baselines released for use. Static systems are under full configuration management as described in this process area.

2. Store and retrieve configuration items in the configuration management system. [PA159.IG101.SP102.SubP102]
3. Share and transfer configuration items between control levels within the configuration management system. [PA159.IG101.SP102.SubP103]
4. Store and recover archived versions of configuration items.
[PA159.IG101.SP102.SubP104]
5. Store, update, and retrieve configuration management records.
[PA159.IG101.SP102.SubP105]
6. Create configuration management reports from the configuration management system. [PA159.IG101.SP102.SubP106]
7. Preserve the contents of the configuration management system.
[PA159.IG101.SP102.SubP107]

Examples of preservation functions of the configuration management system include the following: [PA159.IG101.SP102.SubP107.N101]

- Backups and restoration of configuration management files
- Archiving of configuration management files
- Recovery from configuration management errors

- 16376 8. Revise the configuration management structure as necessary.
16377 [PA159.IG101.SP102.SubP108]

16378 **SP 1.3-1 Create or Release Baselines**

16379 **Create or release baselines for internal use and for delivery to the**
16380 **customer.** [PA159.IG101.SP103]

16381 A baseline is a set of specifications or work products that has been
16382 formally reviewed and agreed upon, that thereafter serves as the basis
16383 for further development, and that can be changed only through change
16384 control procedures. A baseline represents the assignment of an
16385 identifier to a configuration item and its associated entities.

16386 [PA159.IG101.SP103.N101]

16387 **For Systems Engineering**

16388 *Release of a baseline constitutes approval of a set of*
16389 *configuration data for the agreed upon set of configuration*
16390 *items from the configuration management system and*
16391 *releasing it for further development. Multiple baselines may*
16392 *be used to define an evolving product during its development*
16393 *cycle. One common set includes the system level*
16394 *requirements, system element level design requirements, and*
16395 *the product definition at the end of development/beginning of*
16396 *production. These are referred to as the functional, allocated,*
16397 *and product baselines.* [PA159.IG101.SP103.N101.AMP101]

16398 **For Software Engineering**

16399 *A set of requirements, design, source code files and the*
16400 *associated executable code, build files, and user*
16401 *documentation (associated entities) that have been assigned*
16402 *a unique identifier can be considered to be a baseline.*
16403 *Release of a baseline constitutes retrieval of source code files*
16404 *(configuration items) from the configuration management*
16405 *system and generating the executable files. A baseline that is*
16406 *delivered to an external customer is typically called a "release"*
16407 *whereas a baseline for an internal use is typically called a*
16408 *"build."* [PA159.IG101.SP103.N101.AMP102]

16409 **Typical Work Products**

- 16410 1. Baselines [PA159.IG101.SP103.W101]
16411 2. Description of baselines [PA159.IG101.SP103.W102]

16412 **Subpractices**

- 16413 1. Obtain authorization from the configuration control board (CCB)
16414 before creating or releasing baselines of configuration items.

16415 [PA159.IG101.SP103.SubP101]

- 16416 2. Create or release baselines only from configuration items in the
16417 configuration management system. [PA159.IG101.SP103.SubP102]

16418 *For Systems Engineering*

16419 *Assure that the configuration items are built to the correct*
16420 *drawing.* [PA159.IG101.SP103.SubP102.AMP101]

- 16421 3. Document the set of configuration items that are contained in a
16422 baseline. [PA159.IG101.SP103.SubP103]

- 16423 4. Make the current set of baselines readily available.
16424 [PA159.IG101.SP103.SubP104]

16425 **SG 2 Track and Control Changes** [PA159.IG102]

16426 ***Changes to the work products under configuration management are tracked***
16427 ***and controlled.***

16428 **SP 2.1-1 Track Changes**

16429 ***Track change requests for the configuration items.*** [PA159.IG102.SP101]

16430 Change requests address not only new or changed requirements, but
16431 also failures and defects in the work products. [PA159.IG102.SP101.N101]

16432 Changes are analyzed to determine the impact that the change will
16433 have on the work product, related work products, and schedule and
16434 COST. [PA159.IG102.SP101.N102]

16435 **Typical Work Products**

- 16436 1. Change requests [PA159.IG102.SP101.W101]

16437 **Subpractices**

- 16438 1. Initiate and record change requests in the change request system.
16439 [PA159.IG102.SP101.SubP101]

- 16440 2. Analyze the impact of proposed changes and fixes.
16441 [PA159.IG102.SP101.SubP102]

16442 Changes are evaluated through a process that ensures they are consistent with
16443 all the technical and project requirements. [PA159.IG102.SP101.SubP102.N101]

16444 Changes are evaluated for their impact beyond the immediate project or contract
16445 requirements. Changes to an item used in multiple products can resolve an
16446 immediate issue while causing a problem in other applications.

16447 [PA159.IG102.SP101.SubP102.N102]

- 16448 3. Review and get agreement with those affected by change requests
16449 that will be addressed in the next baseline. [PA159.IG102.SP101.SubP103]
- 16450 Schedule and conduct the change-request review by appropriate participants in
16451 the decision. Record the disposition and rationale, including success criteria, a
16452 brief action plan if appropriate, and needs met or unmet by the change. Perform
16453 the actions required in the disposition, and report the results to affected parties.
16454 [PA159.IG102.SP101.SubP103.N101]
- 16455 4. Track the status of change requests to closure. [PA159.IG102.SP101.SubP104]
- 16456 Changes brought into the system need to be handled in a proficient and timely
16457 manner. Once a change request has been processed, it is critical to close the
16458 request with the appropriate approved action as soon as it is practical. Actions left
16459 open result in larger than necessary status lists, which in turn result in added
16460 costs and confusion. [PA159.IG102.SP101.SubP104.N101]

16461 **SP 2.2-1 Control Changes**

16462 ***Control changes to the content of configuration items.*** [PA159.IG102.SP102]

16463 Control is maintained over the configuration of the work product
16464 baseline. This control includes tracking the configuration of each of the
16465 configuration items, approving a new configuration if necessary, and
16466 updating the baseline. [PA159.IG102.SP102.N101]

16467 **Typical Work Products**

- 16468 1. Revision history of configuration items [PA159.IG102.SP102.W101]
- 16469 2. Archives baseline [PA159.IG102.SP102.W102]

16470 **Subpractices**

- 16471 1. Control changes to configuration items throughout the life cycle.
16472 [PA159.IG102.SP102.SubP101]
- 16473 2. Obtain appropriate authorization before changed configuration
16474 items are entered into the configuration management system.
16475 [PA159.IG102.SP102.SubP102]

16476 For example, an authorization may come from CCB, project manager, or the
16477 customer. [PA159.IG102.SP102.SubP102.N101]

- 16478
- 16479 3. Check-in and check-out configuration items from the configuration
16480 management system for incorporation of changes in a manner that
16481 maintains the correctness and integrity of the configuration items.
16482 [PA159.IG102.SP102.SubP103]

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Examples of check-in and check-out steps include the following:
[PA159.IG102.SP102.SubP103.N101]

- Verifying that the revisions are authorized
- Updating the configuration items
- Archiving the replaced baseline and retrieving the new baseline

4. Perform reviews to ensure that changes have not caused unintended effects on the baselines, e.g., ensure that the changes have not compromised safety and/or security of the system.

[PA159.IG102.SP102.SubP104]

5. Record changes and the reasons for the changes as appropriate.

[PA159.IG102.SP102.SubP105]

If a proposed change to the work product is accepted, a schedule is identified for incorporating the change into the work product and other affected areas.

[PA159.IG102.SP102.SubP105.N101]

Configuration control mechanisms can be tailored to categories of changes. For example, the approval process could be shorter for component changes that do not affect other components. [PA159.IG102.SP102.SubP105.N102]

Changed configuration items are released after review and approval of configuration changes. Changes are not official until they are released.

[PA159.IG102.SP102.SubP105.N103]

SG 3 Establish Integrity [PA159.IG103]

Integrity of baselines is established and maintained.

SP 3.1-1 Establish Configuration Management Records

Establish and maintain records describing configuration items.

[PA159.IG103.SP101]

Typical Work Products

1. Revision history of configuration items [PA159.IG103.SP101.W101]
2. Change log [PA159.IG103.SP101.W102]
3. Copy of the changes [PA159.IG103.SP101.W103]
4. Status of configuration items [PA159.IG103.SP101.W104]
5. Differences between baselines [PA159.IG103.SP101.W105]

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Subpractices

1. Record configuration management actions in sufficient detail so the content and status of each configuration item is known and previous versions can be recovered. [PA159.IG103.SP101.SubP101]
2. Ensure affected individuals and groups have access to and knowledge of the configuration status of the configuration items.
[PA159.IG103.SP101.SubP102]

Examples of activities for communicating configuration status include the following: [PA159.IG103.SP101.SubP102.N101]

 - Providing access permissions to authorized end users
 - Making baseline copies readily available to authorized end users
3. Specify the latest version of the baselines. [PA159.IG103.SP101.SubP103]
4. Identify the version of configuration items that constitute a particular baseline. [PA159.IG103.SP101.SubP104]
5. Describe the differences between successive baselines.
[PA159.IG103.SP101.SubP105]
6. Revise the status and history (i.e., changes and other actions) of each configuration item as necessary. [PA159.IG103.SP101.SubP106]

SP 3.2-1 Perform Configuration Audits

Perform configuration audits to maintain integrity of the configuration baselines. [PA159.IG103.SP102]

Audit configuration management activities and processes to confirm that the resulting baselines and documentation are accurate and record the audit results as appropriate. [PA159.IG103.SP102.N101]

Typical Work Products

1. Configuration audit results [PA159.IG103.SP102.W101]
2. Action items [PA159.IG103.SP102.W102]

Subpractices

1. Assess the integrity of the baselines. [PA159.IG103.SP102.SubP101]
2. Verify that the configuration records correctly identify the configuration of the configuration items. [PA159.IG103.SP102.SubP102]
3. Review the structure and integrity of the items in the configuration management system. [PA159.IG103.SP102.SubP103]

- 16549 4. Verify the completeness and correctness of the items in the
16550 configuration management system. [PA159.IG103.SP102.SubP104]
- 16551 Completeness and correctness of the content is based on the requirements as
16552 stated in the plan and the disposition of approved change requests.
16553 [PA159.IG103.SP102.SubP104.N101]
- 16554 5. Verify compliance with applicable configuration management
16555 standards and procedures. [PA159.IG103.SP102.SubP105]
- 16556 6. Track action items from the audit to closure. [PA159.IG103.SP102.SubP106]

16557 **Generic Practices by Goal**

16558 **GG 1 Achieve Specific Goals**

16559 *The process supports and enables achievement of the specific goals of the*
16560 *process area by transforming identifiable input work products to produce*
16561 *identifiable output work products.*

16562 **GP 1.1 Identify Work Scope**

16563 *Identify the scope of the work to be performed and work products*
16564 *to be produced for configuration management, and communicate*
16565 *this information to those performing the work.* [GP101]

16566 **GP 1.2 Perform Base Practices**

16567 *Perform the base practices of the configuration management*
16568 *process to develop work products and provide services to achieve*
16569 *the specific goals of the process area.* [GP102]

16570 **GG 2 Institutionalize a Managed Process**

16571 *The process is institutionalized as a managed process.*

16572 **GP 2.1 Establish an Organizational Policy**

16573 *Establish and maintain an organizational policy for planning and*
16574 *performing the configuration management process.* [GP103]

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Elaboration:

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This policy establishes organizational expectations for establishing and maintaining baselines of identified work products, tracking and controlling changes to the work products (under configuration management), and establishing and maintaining integrity of the baselines. [PA159.EL101]

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GP 2.2 Plan the Process

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Establish and maintain the requirements and objectives, and plans for performing the configuration management process. [GP104]

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GP 2.3 Provide Resources

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

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Elaboration:

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Examples of tools used in performing the activities of the Configuration Management process area include the following: [PA159.EL104]

- Configuration management tools
- Data management tools
- Archiving and reproduction tools
- Database programs

16596

GP 2.4 Assign Responsibility

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

16600

GP 2.5 Train People

16601

16602

Train the people performing or supporting the configuration management process as needed. [GP107]

16603 Elaboration:

16604 Examples of training topics include the following: [PA159.EL105]
16605

- Roles, responsibilities, and authority of the configuration

16606 management staff

- Configuration management standards, procedures, and methods

16607

- Configuration library system

16608

16609

16610 **GP 2.6 Manage Configurations**

16611 ***Place designated work products of the configuration management***
16612 ***process under appropriate levels of configuration management.***
16613 [GP109]

16614 Elaboration:

16615 Examples of work products placed under configuration management
16616 include the following: [PA159.EL106]
16617

- Access lists

16618

- Change status reports

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- Change request database

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- Configuration Control Board meeting minutes

16621

- Archived baseline

16622

16623 **GP 2.7 Identify and Involve Relevant Stakeholders**

16624 ***Identify and involve the relevant stakeholders of the configuration***
16625 ***management process as planned.*** [GP124]

16626 Elaboration:

16627 Examples of activities for stakeholder involvement include: [PA159.EL111]
16628

- Establishing baselines

16629

- Reviewing configuration management system reports and resolving

16630 issues

- Assessing the impact of changes for the configuration items

16631

- Performing configuration audits

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- Reviewing the results of configuration management audits

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GP 2.8 Monitor and Control the Process

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Monitor and control the configuration management process against the plan and take appropriate corrective action. [GP110]

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Elaboration:

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Examples of measures used in monitoring and controlling the activities of the Configuration Management process area include the following:

16640

[PA159.EL108]

16641

16642

- Number of changes to configuration items

16643

- Number of configuration audits conducted

16644

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GP 2.9 Objectively Evaluate Adherence

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Objectively evaluate adherence of the configuration management process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

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Elaboration:

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Examples of activities reviewed include the following: [PA159.EL109]

16652

- Establishing and maintaining baselines

16653

- Tracking and controlling changes

16654

- Establishing and maintaining integrity of baselines

16655

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Examples of work products reviewed include the following: [PA159.EL110]

16657

- Archives baselines

16658

- Change request database

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GP 2.10 Review Status with Higher-Level Management

16661

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

16662

16663

16664

GG 3 Institutionalize a Defined Process

16665

The process is institutionalized as a defined process.

16666 **GP 3.1 Establish a Defined Process**

16667 *Establish and maintain the description of a defined configuration*
16668 *management process. [GP114]*

16669 **GP 3.2 Collect Improvement Information**

16670 *Collect work products, measures, measurement results, and*
16671 *improvement information derived from planning and performing*
16672 *the configuration management process to support the future use*
16673 *and improvement of the organization's processes and process*
16674 *assets. [GP117]*

16675 **GG 4 Institutionalize a Quantitatively Managed Process**

16676 *The process is institutionalized as a quantitatively managed process.*

16677 **GP 4.1 Establish Quality Objectives**

16678 *Establish and maintain quantitative objectives for the*
16679 *configuration management process about quality and process*
16680 *performance based on customer needs and business objectives.*
16681 *[GP118]*

16682 **GP 4.2 Stabilize Subprocess Performance**

16683 *Stabilize the performance of one or more subprocesses of the*
16684 *configuration management process to determine its ability to*
16685 *achieve the established quantitative quality and process*
16686 *performance objectives. [GP119]*

16687 **GG 5 Institutionalize an Optimizing Process**

16688 *The process is institutionalized as an optimizing process.*

16689 **GP 5.1 Ensure Continuous Process Improvement**

16690 *Ensure continuous improvement of the configuration management*
16691 *process in fulfilling the relevant business goals of the*
16692 *organization. [GP125]*

16693 **GP 5.2 Correct Common Cause of Problems**

16694 *Identify and correct the root causes of defects and other problems*
16695 *in the configuration management process. [GP121]*

16696 PROCESS AND PRODUCT QUALITY ASSURANCE

16697 Support

16698 Purpose

16699 The purpose of Process and Product Quality Assurance is to provide
16700 staff and management with objective insight into the processes and
16701 associated work products. [PA145]

16702 Introductory Notes

16703 Process and Product Quality Assurance involves the following:

16704 [PA145.N101]

- 16705 • Objectively evaluating performed process, work products, and
16706 services against the applicable process descriptions, standards,
16707 and procedures
- 16708 • Identifying and documenting noncompliance issues
- 16709 • Providing feedback to project staff and managers on the results of
16710 the quality assurance activities
- 16711 • Ensuring that noncompliance issues are addressed

16712 Process and Product Quality Assurance supports the delivery of high-
16713 quality products and services by providing the project staff and all levels
16714 of managers with appropriate visibility into, and feedback on, the
16715 processes and associated work products throughout the life cycle.

16716 [PA145.N102]

16717 Process and Product Quality Assurance ensures planned processes
16718 are implemented while Verification ensures that the specified
16719 requirements are satisfied. Process and Product Quality Assurance and
16720 Verification may on occasion look at the same product but from different
16721 perspectives. Projects should take care to minimize duplication of effort.

16722 [PA145.N103]

16723 Objectivity in process and product quality assurance evaluations is
16724 critical to the success of the project. Traditionally, a quality assurance
16725 group that is independent of the project provides this objectivity. It may
16726 be appropriate in some organizations, however, to implement the
16727 process and product quality assurance role without that independence.
16728 For example, in an organization with an open, quality-oriented culture,
16729 the process and product quality assurance role may be performed,
16730 partially or completely, by peers, and the quality assurance function
16731 may be embedded in the process. [PA145.N104]

16732 If the Process and Product Quality Assurance function is embedded in
16733 the process, a number of issues need to be addressed to ensure
16734 objectivity. Everyone performing quality assurance activities should be
16735 trained in quality assurance. Those performing quality assurance
16736 activities for a work product should be separate from those directly
16737 involved in developing or maintaining the work products. An
16738 independent reporting channel to the appropriate level of organizational
16739 management allows noncompliance issues to be escalated as
16740 necessary. [PA145.N105]

16741 Process and Product Quality Assurance should begin in the early
16742 stages of a project to establish plans, processes, standards, and
16743 procedures that will add value to the project and satisfy the
16744 requirements of the project and the organizational policies. Those
16745 performing the quality assurance function participate in establishing the
16746 plans, processes, standards and procedures to ensure they fit the
16747 project's needs and that they will be useable for performing quality
16748 assurance evaluations. In addition, the specific processes and
16749 associated work products that will be evaluated during the life cycle are
16750 designated. This designation may be based on sampling or on objective
16751 criteria that are consistent with organizational policies and project
16752 requirements and needs. [PA145.N106]

16753 When noncompliance issues are identified, they are first addressed
16754 within the project and resolved there if possible. Any noncompliance
16755 issues that can not be resolved within the project are escalated to an
16756 appropriate level of management for resolution. [PA145.N107]

16757 This process area primarily applies to evaluations of projects and
16758 services, but it also applies to evaluations of non-project activities and
16759 work products such as training activities. For these activities and work
16760 products, the term "project" should be appropriately interpreted.
16761 [PA145.N108]

16762 Related Process Areas

16763 *Refer to the Project Planning process area for more information about*
16764 *identifying processes and associated work products that the quality*
16765 *assurance function will objectively evaluate. [PA145.R101]*

16766 *Refer to the Verification process area for more information about*
16767 *satisfying specified requirements. [PA145.R102]*

16768 Specific Goals

16769 **SG 1 Objectively Evaluate Processes and Work Products** [PA145.IG101]

16770 *Adherence of the performed process and associated work products and*
16771 *services to applicable process descriptions, standards and procedures is*
16772 *objectively evaluated.*

16773 **SG 2 Provide Objective Insight** [PA145.IG102]

16774 *Noncompliance issues are objectively tracked and communicated, and*
16775 *resolution is ensured.*

16776 Generic Goals

16777 **GG 1 Achieve Specific Goals** [CL102.GL101]

16778 *The process supports and enables achievement of the specific goals of the*
16779 *process area by transforming identifiable input work products to produce*
16780 *identifiable output work products.*

16781 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

16782 *The process is institutionalized as a managed process.*

16783 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

16784 *The process is institutionalized as a defined process.*

16785 **GG 4 Institutionalize a Quantitatively Managed Process** [CL105.GL101]

16786 *The process is institutionalized as a quantitatively managed process.*

16787 **GG 5 Institutionalize an Optimizing Process** [CL106.GL101]

16788 *The process is institutionalized as an optimizing process.*

16789	Practice to Goal Relationship Table	
16790	SG 1 Objectively Evaluate Processes and Work Products [PA145.IG101]	
16791	SP 1.1-1	Objectively Evaluate Processes
16792	SP 1.2-1	Objectively Evaluate Work Products and Services
16793	SG 2 Provide Objective Insight [PA145.IG102]	
16794	SP 2.1-1	Communicate and Ensure Resolution of Noncompliance Issues
16795	SP 2.2-1	Establish Records
16796	GG 1 Achieve Specific Goals [CL102.GL101]	
16797	GP 1.1	Identify Work Scope
16798	GP 1.2	Perform Base Practices
16799	GG 2 Institutionalize a Managed Process [CL103.GL101]	
16800	GP 2.1	Establish an Organizational Policy
16801	GP 2.2	Plan the Process
16802	GP 2.3	Provide Resources
16803	GP 2.4	Assign Responsibility
16804	GP 2.5	Train People
16805	GP 2.6	Manage Configurations
16806	GP 2.7	Identify and Involve Relevant Stakeholders
16807	GP 2.8	Monitor and Control the Process
16808	GP 2.9	Objectively Evaluate Adherence
16809	GP 2.10	Review Status with Higher-Level Management
16810	GG 3 Institutionalize a Defined Process [CL104.GL101]	
16811	GP 3.1	Establish a Defined Process
16812	GP 3.2	Collect Improvement Information
16813	GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]	
16814	GP 4.1	Establish Quality Objectives
16815	GP 4.2	Stabilize Subprocess Performance
16816	GG 5 Institutionalize an Optimizing Process [CL106.GL101]	
16817	GP 5.1	Ensure Continuous Process Improvement
16818	GP 5.2	Correct Common Cause of Problems
16819	Specific Practices by Goal	

16820	SG 1	Objectively Evaluate Processes and Work Products [PA145.IG101]
16821	<i>Adherence of the performed process and associated work products and services to applicable process descriptions, standards and procedures is objectively evaluated.</i>	
16822		
16823		
16824	SP 1.1-1	Objectively Evaluate Processes
16825	<i>Objectively evaluate the designated performed processes against the applicable process descriptions, standards and procedures.</i>	
16826		
16827	<small>[PA145.IG101.SP101]</small>	

16828 Objectivity in Process and Product Quality Assurance evaluations is
16829 critical to the success of the project. A description of the quality
16830 assurance reporting chain and how it ensures objectivity of the process
16831 and product quality assurance function needs to be defined to ensure
16832 objectivity. [PA145.IG101.SP101.N101]

16833 **Typical Work Products**

- 16834 1. Audit reports [PA145.IG101.SP101.W101]
16835 2. Noncompliance reports [PA145.IG101.SP101.W102]
16836 3. Corrective actions [PA145.IG101.SP101.W103]

16837 **Subpractices**

- 16838 1. Advance use of an environment (created as part of project
16839 management) that encourages employee participation in identifying
16840 and reporting quality issues. [PA145.IG101.SP101.SubP101]
16841 2. Establish and maintain clearly stated criteria for the evaluations.
16842 [PA145.IG101.SP101.SubP102]

16843 The intent of this subpractice is to provide criteria, based on business needs, such
16844 as the following: [PA145.IG101.SP101.SubP102.N101]

- 16845 • What will be evaluated during the evaluation process
16846 • When or how often a process will be evaluated
16847 • How the evaluation will be conducted
16848 • Who must be involved in the evaluation
16849 3. Use the stated criteria to evaluate performed processes for
16850 adherence to process descriptions, standards, and procedures.
16851 [PA145.IG101.SP101.SubP103]
16852 4. Identify each noncompliance found during the evaluation.
16853 [PA145.IG101.SP101.SubP104]

16854 **SP 1.2-1 Objectively Evaluate Work Products and Services**

16855 ***Objectively evaluate the designated work products and services***
16856 ***against the applicable process descriptions, standards, and***
16857 ***procedures.*** [PA145.IG101.SP102]

16858 **Typical Work Products**

- 16859 1. Audit reports [PA145.IG101.SP102.W101]
16860 2. Noncompliance reports [PA145.IG101.SP102.W102]
16861 3. Corrective actions [PA145.IG101.SP102.W103]

- 16862 **Subpractices**
- 16863 1. Select work products to be evaluated, based on documented
- 16864 sampling criteria if sampling is used. [PA145.IG101.SP102.SubP101]
- 16865 2. Establish and maintain clearly stated criteria for the evaluation of
- 16866 work products. [PA145.IG101.SP102.SubP102]
- 16867 The intent of this subpractice is to provide criteria, based on business needs, such
- 16868 as the following: [PA145.IG101.SP102.SubP102.N101]
- 16869 • What will be evaluated during the evaluation of a work product
 - 16870 • When or how often a work product will be evaluated
 - 16871 • How the evaluation will be conducted
 - 16872 • Who must be involved in the evaluation
- 16873 3. Use the stated criteria during the evaluations of work products.
- 16874 [PA145.IG101.SP102.SubP103]
- 16875 4. Evaluate work products before delivery to the customer.
- 16876 [PA145.IG101.SP102.SubP104]
- 16877 5. Evaluate work products at selected milestones in their
- 16878 development. [PA145.IG101.SP102.SubP105]
- 16879 6. Perform in-progress or incremental evaluations of work products
- 16880 and services against process descriptions, standards, and
- 16881 procedures. [PA145.IG101.SP102.SubP106]
- 16882 7. Identify each noncompliance found during the evaluations.
- 16883 [PA145.IG101.SP102.SubP107]
- 16884 8. Identify lessons learned that improve processes for future products
- 16885 and services. [PA145.IG101.SP102.SubP108]

16886 **SG 2 Provide Objective Insight** [PA145.IG102]

16887 ***Noncompliance issues are objectively tracked and communicated, and***

16888 ***resolution is ensured.***

16889 **SP 2.1-1 Communicate and Ensure Resolution of Noncompliance Issues**

16890 ***Communicate quality issues and ensure resolution of***

16891 ***noncompliance issues with the staff and managers.*** [PA145.IG102.SP101]

16892 Noncompliance issues are problems identified in evaluations that reflect

16893 a lack of adherence to applicable standards, process descriptions, or

16894 procedures. The status of noncompliance issues provides an indication

16895 of quality trends. Quality issues include noncompliance issues and

16896 results of trend analysis. [PA145.IG102.SP101.N101]

16897 When local resolution of noncompliance issues cannot be obtained, use
16898 established escalation mechanisms to ensure that the appropriate level
16899 of management can resolve the issue. Track noncompliance issues to
16900 resolution. [PA145.IG102.SP101.N102]

16901 **Typical Work Products**

- 16902 1. Corrective action reports [PA145.IG102.SP101.W101]
- 16903 2. Audit reports [PA145.IG102.SP101.W102]
- 16904 3. Quality trends [PA145.IG102.SP101.W103]

16905 **Subpractices**

- 16906 1. Resolve each noncompliance with the appropriate members of the
16907 staff where possible. [PA145.IG102.SP101.SubP101]
- 16908 2. Document noncompliance issues when they cannot be resolved
16909 within the project. [PA145.IG102.SP101.SubP102]

16910 Examples of ways to resolve noncompliance within the project include the
16911 following: [PA145.IG102.SP101.SubP102.N101]

- 16912 • Fixing the noncompliance
- 16913 • Changing the process descriptions, standards, or procedures that were violated
- 16914 • Obtaining a waiver to cover the noncompliance issue

- 16915
- 16916 3. Escalate noncompliance issues that are not able to be resolved
16917 within the project to the appropriate level of management
16918 designated to receive and act on noncompliance issues.

16919 [PA145.IG102.SP101.SubP103]

- 16920 4. Analyze the noncompliance issues to see if there are any quality
16921 trends that can be identified and addressed. [PA145.IG102.SP101.SubP104]

- 16922 5. Ensure that relevant stakeholders are aware of the results of
16923 evaluations and the quality trends in a timely manner.

16924 [PA145.IG102.SP101.SubP105]

- 16925 6. Periodically review open noncompliance issues and trends with the
16926 manager designated to receive and act on noncompliance issues.

16927 [PA145.IG102.SP101.SubP106]

- 16928 7. Track noncompliance issues to resolution. [PA145.IG102.SP101.SubP107]

16929 **SP 2.2-1 Establish Records**

16930 ***Establish and maintain records of the quality assurance activities.***

16931 [PA145.IG102.SP102]

- 16932 **Typical Work Products**
- 16933 1. Audit logs [PA145.IG102.SP102.W101]
- 16934 2. Quality assurance reports [PA145.IG102.SP102.W102]
- 16935 3. Status of corrective actions [PA145.IG102.SP102.W103]
- 16936 4. Quality trends [PA145.IG102.SP102.W104]

- 16937 **Subpractices**
- 16938 1. Record process and product quality assurance activities in
- 16939 sufficient detail such that status and results are known.
- 16940 [PA145.IG102.SP102.SubP101]
- 16941 2. Revise the status and history of the quality assurance activities as
- 16942 necessary. [PA145.IG102.SP102.SubP102]

16943 **Generic Practices by Goal**

16944 **GG 1 Achieve Specific Goals**

16945 *The process supports and enables achievement of the specific goals of the*

16946 *process area by transforming identifiable input work products to produce*

16947 *identifiable output work products.*

16948 **GP 1.1 Identify Work Scope**

16949 *Identify the scope of the work to be performed and work products*

16950 *to be produced for process and product quality assurance, and*

16951 *communicate this information to those performing the work. [GP101]*

16952 **GP 1.2 Perform Base Practices**

16953 *Perform the base practices of the process and product quality*

16954 *assurance process to develop work products and provide services*

16955 *to achieve the specific goals of the process area. [GP102]*

16956 **GG 2 Institutionalize a Managed Process**

16957 *The process is institutionalized as a managed process.*

16958 **GP 2.1 Establish an Organizational Policy**

16959 *Establish and maintain an organizational policy for planning and*

16960 *performing the process and product quality assurance process.*

16961 [GP103]

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Elaboration:

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This policy establishes organizational expectations for objectively evaluating that processes and associated work products adhere to the applicable process descriptions, standards, and procedures, and ensuring that noncompliance are addressed. [PA145.EL101]

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This policy also establishes the expectation that the process and product quality assurance function is in place for all projects and possesses sufficient independence from project management to provide objectivity in identifying and reporting noncompliance issues. [PA145.EL102]

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GP 2.2 Plan the Process

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Establish and maintain the requirements and objectives, and plans for performing the process and product quality assurance process. [GP104]

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GP 2.3 Provide Resources

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Provide adequate resources for performing the process and product quality assurance process, developing the work products and providing the services of the process. [GP105]

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Elaboration:

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Examples of tools used in performing the activities of the Process and Product Quality Assurance process area include the following:

[PA145.EL105]

- Auditing tools

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GP 2.4 Assign Responsibility

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Assign responsibility and authority for performing the process, developing the work products, and providing the services of the process and product quality assurance process. [GP106]

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GP 2.5 Train People

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Train the people performing or supporting the process and product quality assurance process as needed. [GP107]

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Elaboration:

Examples of training topics include the following: [PA145.EL106]

- Application domain
- Customer relations
- Process descriptions, standards, procedures, and methods for the project
- Quality assurance objectives, process descriptions, standards, procedures, methods, and tools

GP 2.6 Manage Configurations

Place designated work products of the process and product quality assurance process under appropriate levels of configuration management. [GP109]

Elaboration:

Examples of work products placed under configuration management include the following: [PA145.EL111]

- Noncompliance reports
- Audit logs and reports

GP 2.7 Identify and Involve Relevant Stakeholders

Identify and involve the relevant stakeholders of the process and product quality assurance process as planned. [GP124]

Elaboration:

Examples of activities for stakeholder involvement include: [PA145.EL113]

- Establishing criteria for the objective evaluations of processes and work products
- Evaluating processes and work products
- Resolving issues on noncompliances
- Tracking noncompliance issues to closure

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GP 2.8 Monitor and Control the Process

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Monitor and control the process and product quality assurance process against the plan and take appropriate corrective action.

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17025

[GP110]

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Elaboration:

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Examples of measures used in monitoring and controlling the activities of the Process and Product Quality Assurance process area include the following: [PA145.EL108]

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- Variance of objective process evaluations planned and performed

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- Variance of objective product evaluations planned and performed

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GP 2.9 Objectively Evaluate Adherence

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Objectively evaluate adherence of the process and product quality assurance process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

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Elaboration:

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Examples of activities reviewed include the following: [PA145.EL109]

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- Objectively evaluating processes and work products

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- Tracking and communicating noncompliance issues

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Examples of work products reviewed include the following: [PA145.EL112]

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- Noncompliance reports

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- Audit logs and reports

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GP 2.10 Review Status with Higher-Level Management

17048

Review the activities, status, and results of the process and product quality assurance process with higher-level management and resolve issues. [GP112]

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17051

GG 3 Institutionalize a Defined Process

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The process is institutionalized as a defined process.

17053 **GP 3.1 Establish a Defined Process**

17054 *Establish and maintain the description of a defined process and*
17055 *product quality assurance process. [GP114]*

17056 **GP 3.2 Collect Improvement Information**

17057 *Collect work products, measures, measurement results, and*
17058 *improvement information derived from planning and performing*
17059 *the process and product quality assurance process to support the*
17060 *future use and improvement of the organization's processes and*
17061 *process assets. [GP117]*

17062 **GG 4 Institutionalize a Quantitatively Managed Process**

17063 *The process is institutionalized as a quantitatively managed process.*

17064 **GP 4.1 Establish Quality Objectives**

17065 *Establish and maintain quantitative objectives for the process and*
17066 *product quality assurance process about quality and process*
17067 *performance based on customer needs and business objectives.*
17068 *[GP118]*

17069 **GP 4.2 Stabilize Subprocess Performance**

17070 *Stabilize the performance of one or more subprocesses of the*
17071 *process and product quality assurance process to determine its*
17072 *ability to achieve the established quantitative quality and process*
17073 *performance objectives. [GP119]*

17074 **GG 5 Institutionalize an Optimizing Process**

17075 *The process is institutionalized as an optimizing process.*

17076 **GP 5.1 Ensure Continuous Process Improvement**

17077 *Ensure continuous improvement of the process and product*
17078 *quality assurance process in fulfilling the relevant business goals*
17079 *of the organization. [GP125]*

17080 **GP 5.2 Correct Common Cause of Problems**

17081 *Identify and correct the root causes of defects and other problems*
17082 *in the process and product quality assurance process. [GP121]*

17083 MEASUREMENT AND ANALYSIS

17084 Support

17085 Purpose

17086 The purpose of Measurement and Analysis is to develop and sustain a
17087 measurement capability that is used to support management
17088 information needs. [PA154]

17089 Introductory Notes

17090 Measurement involves the following: [PA154.N101]

- 17091 • Specifying the objectives of measurement and analysis such that
17092 they are aligned with identified information needs and objectives
- 17093 • Specifying the measures, data collection and storage mechanisms,
17094 analysis techniques, reporting and feedback mechanisms
- 17095 • Implementing the collection, storage, analysis, and reporting of the
17096 data
- 17097 • Providing objective results that can be used in making informed
17098 decisions, and taking appropriate corrective actions

17099 The integration of measurement and analysis activities into project
17100 processes supports the following: [PA154.N102]

- 17101 • Objective planning and estimating
- 17102 • Tracking actual performance against established plans and
17103 objectives
- 17104 • Identifying and resolving process-related issues
- 17105 • Providing a basis for incorporating measurement into additional
17106 processes in the future

17107 The people required to implement a measurement capability may or
17108 may not be employed in a separate organization wide program.
17109 Measurement capability may be integrated into individual projects or
17110 other organizational functions (e.g., Quality Assurance). [PA154.N103]

17111 The initial focus for measurement activities is at the project level.
17112 However, a measurement capability may prove useful for addressing
17113 organizational and/or enterprise wide information needs. [PA154.N104]

17114 Related Process Areas

17115 *Refer to the Project Planning process area for more information about*
17116 *estimating project attributes and other planning information needs.*

17117 [PA154.R101]

17118 *Refer to the Project Monitoring & Control process area for more*
17119 *information about monitoring project performance information needs.*

17120 [PA154.R102]

17121 *Refer to the Configuration Management process area for more*
17122 *information about managing measurement work products.* [PA154.R103]

17123 *Refer to the Requirements Development process area for more*
17124 *information about meeting customer requirements and related*
17125 *information needs.* [PA154.R104]

17126 *Refer to the Requirements Management process area for more*
17127 *information about maintaining requirements traceability and related*
17128 *information needs.* [PA154.R105]

17129 *Refer to the Organizational Process Definition process area for more*
17130 *information about establishing an Organizational Measurement*
17131 *Repository.* [PA154.R106]

17132 *Refer to the Quantitative Project Management process area for more*
17133 *information about understanding variation and the appropriate use of*
17134 *statistical analysis techniques.* [PA154.R107]

17135 Specific Goals

17136 **SG 1** **Align Measurement and Analysis Activities** [PA154.IG101]

17137 *Measurement objectives and practices are aligned with identified information*
17138 *needs and objectives.*

17139 **SG 2** **Provide Measurement Results** [PA154.IG102]

17140 *Measurement results that address identified information needs and objectives*
17141 *are provided.*

17142 Generic Goals

17143 **GG 1** **Achieve Specific Goals** [CL102.GL101]

17144 *The process supports and enables achievement of the specific goals of the*
17145 *process area by transforming identifiable input work products to produce*
17146 *identifiable output work products.*

17147 **GG 2** **Institutionalize a Managed Process** [CL103.GL101]

17148 *The process is institutionalized as a managed process.*

17149 **GG 3** **Institutionalize a Defined Process** [CL104.GL101]

17150 *The process is institutionalized as a defined process.*

17151 **GG 4** **Institutionalize a Quantitatively Managed Process** [CL105.GL101]

17152 *The process is institutionalized as a quantitatively managed process.*

17153 **GG 5** **Institutionalize an Optimizing Process** [CL106.GL101]

17154 *The process is institutionalized as an optimizing process.*

17155 Practice to Goal Relationship Table

17156	SG 1 Align Measurement and Analysis Activities [PA154.IG101]	
17157	SP 1.1-1	Establish Measurement Objectives
17158	SP 1.2-1	Specify Measures
17159	SP 1.3-1	Specify Data Collection and Storage Procedures
17160	SP 1.4-1	Specify Analysis Procedures
17161	SG 2 Provide Measurement Results [PA154.IG102]	
17162	SP 2.1-1	Collect Measurement Data
17163	SP 2.2-1	Analyze Measurement Data
17164	SP 2.3-1	Store Data and Results
17165	SP 2.4-1	Communicate Results
17166	GG 1 Achieve Specific Goals [CL102.GL101]	
17167	GP 1.1	Identify Work Scope
17168	GP 1.2	Perform Base Practices
17169	GG 2 Institutionalize a Managed Process [CL103.GL101]	
17170	GP 2.1	Establish an Organizational Policy
17171	GP 2.2	Plan the Process
17172	GP 2.3	Provide Resources
17173	GP 2.4	Assign Responsibility
17174	GP 2.5	Train People
17175	GP 2.6	Manage Configurations
17176	GP 2.7	Identify and Involve Relevant Stakeholders
17177	GP 2.8	Monitor and Control the Process
17178	GP 2.9	Objectively Evaluate Adherence
17179	GP 2.10	Review Status with Higher-Level Management
17180	GG 3 Institutionalize a Defined Process [CL104.GL101]	
17181	GP 3.1	Establish a Defined Process
17182	GP 3.2	Collect Improvement Information
17183	GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]	
17184	GP 4.1	Establish Quality Objectives
17185	GP 4.2	Stabilize Subprocess Performance
17186	GG 5 Institutionalize an Optimizing Process [CL106.GL101]	
17187	GP 5.1	Ensure Continuous Process Improvement
17188	GP 5.2	Correct Common Cause of Problems

17189 Specific Practices by Goal

17190 **SG 1 Align Measurement and Analysis Activities** [PA154.IG101]

17191 ***Measurement objectives and practices are aligned with identified information***
 17192 ***needs and objectives.***

17193 The specific practices covered under this specific goal may be
 17194 addressed concurrently or in differing order: [PA154.IG101.N101]

- 17195 • When establishing measurement objectives, experts often think
 17196 ahead about necessary criteria for specifying measures and

17197 analysis procedures. They also think concurrently about the
17198 constraints imposed by data collection and storage procedures.

- 17199 • It often is important to specify the essential analyses that will be
17200 conducted, before attending prematurely to details of measurement
17201 specification, data collection, or storage.

17202 **SP 1.1-1 Establish Measurement Objectives**

17203 ***Establish and maintain measurement objectives that are derived***
17204 ***from identified information needs and objectives.*** [PA154.IG101.SP101]

17205 Measurement objectives document the purposes for which
17206 measurement and analysis are done, and specify the kinds of actions
17207 that may be taken based on the results of data analyses.

17208 [PA154.IG101.SP101.N101]

17209 The sources for measurement objectives may be management,
17210 technical, project, or process implementation needs. [PA154.IG101.SP101.N102]

17211 The measurement objectives may also be constrained by existing
17212 developmental processes, available resources, or other measurement
17213 considerations. Judgments may need to be made about whether the
17214 value of the results will be commensurate with the resources devoted to
17215 doing the work. [PA154.IG101.SP101.N103]

17216 Modifications to identified information needs and objectives may, in
17217 turn, be indicated as a consequence of the process and results of
17218 measurement and analysis. [PA154.IG101.SP101.N104]

17219 Sources of information needs and objectives may include the following:

17220 [PA154.IG101.SP101.N105]

- 17221 • Project plans
- 17222 • Monitoring of project performance
- 17223 • Interviews with managers and others who have information needs
- 17224 • Established management objectives
- 17225 • Strategic plans
- 17226 • Formal requirements or contractual obligations
- 17227 • Recurring or other troublesome management or technical problems
- 17228 • Experiences of other projects or organizational entities
- 17229 • External Industry Benchmarks
- 17230 • Process Improvement Plans

17231 *Refer to the Project Planning process area for more information about*
17232 *estimating project attributes and other planning information needs.*

17233 [PA154.IG101.SP101.N105.R101]

17234 *Refer to the Project Monitoring and Control process area for more*
17235 *information about project performance information needs.*

17236 [PA154.IG101.SP101.N105.R102]

17237 *Refer to the Requirements Development process area for more*
17238 *information about meeting customer requirements and related*
17239 *information needs.* [PA154.IG101.SP101.N105.R103]

17240 *Refer to the Requirements Management process area for more*
17241 *information about maintaining requirements traceability and related*
17242 *information needs.* [PA154.IG101.SP101.N105.R104]

17243 **Typical Work Products**

17244 1. Documented measurement objectives [PA154.IG101.SP101.W101]

17245 **Subpractices**

17246 1. Document information needs and objectives. [PA154.IG101.SP101.SubP101]

17247 Information needs and objectives are documented to allow traceability to
17248 subsequent measurement and analysis activities. [PA154.IG101.SP101.SubP101.N101]

17249 2. Prioritize information needs and objectives. [PA154.IG101.SP101.SubP102]

17250 It may be neither possible nor desirable to subject all initially identified information
17251 needs to measurement and analysis. Priorities may also need to be set within the
17252 limits of available resources. [PA154.IG101.SP101.SubP102.N101]

17253 3. Document, review, and revise measurement objectives.

17254 [PA154.IG101.SP101.SubP103]

17255 It is important to carefully consider the purposes and intended uses of
17256 measurement and analysis. [PA154.IG101.SP101.SubP103.N101]

17257 The measurement objectives are documented, reviewed by management and
17258 other affected stakeholder groups, and revised as necessary. Doing so enables
17259 traceability to subsequent measurement and analysis activities, and helps ensure
17260 that the analyses will properly address identified information needs and
17261 objectives. [PA154.IG101.SP101.SubP103.N102]

17262 It is important that users of measurement and analysis results be involved in
17263 setting measurement objectives and deciding on plans of action. It may also be
17264 appropriate to involve those who provide the measurement data.

17265 [PA154.IG101.SP101.SubP103.N103]

17266 4. Provide feedback for refining and clarifying information needs and
17267 objectives as necessary. [PA154.IG101.SP101.SubP104]

17268 Identified information needs and objectives may need to be refined and clarified
17269 as a result of setting measurement objectives. Initial descriptions of information
17270 needs may be unclear or ambiguous. Conflicts may arise between existing needs
17271 and objectives. Precise targets on an already existing measure may be
17272 unrealistic. [PA154.IG101.SP101.SubP104.N101]

17273 5. Maintain traceability of the measurement objectives to the identified
17274 information needs and objectives. [PA154.IG101.SP101.SubP105]

17275 There must always be a good answer to the question, "Why are we measuring
17276 this?" [PA154.IG101.SP101.SubP105.N101]

17277 Of course, the measurement objectives may also change to reflect evolving
17278 information needs and objectives. [PA154.IG101.SP101.SubP105.N102]

17279 SP 1.2-1 Specify Measures

17280 ***Specify measures to address the measurement objectives.***

17281 [PA154.IG101.SP102]

17282 Measurement objectives are refined into precise, quantifiable
17283 measures. [PA154.IG101.SP102.N101]

17284 Measures may be either 'base' or 'derived'. Data for 'Base Measures'
17285 are obtained by direct measurement. Data for 'Derived Measures'
17286 come from other data, typically by combining two or more base
17287 measures. [PA154.IG101.SP102.N102]

17288 Examples of commonly used Base Measures include the following:

17289 [PA154.IG101.SP102.N103]

- 17290 • Estimates and actual measures of work product size (e.g., pages)
- 17291 • Estimates and actual measures of effort and cost (e.g., person
17292 hours)
- 17293 • Quality measures (e.g., number of defects, severity of defects)

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Examples of commonly used derived measures include the following:

[PA154.IG101.SP102.N104]

- Earned Value (e.g. Actual Cost of Work Performed / Budgeted Cost of Work Performed)
- Schedule Performance Index
- Defect Density
- Peer review coverage
- Test or verification coverage
- Reliability measures (e.g., mean time to failure)

Derived measures typically are expressed as ratios, composite indices, or other aggregate summary measures. They are often more quantitatively reliable and meaningfully interpretable than the base measures used to generate them. [PA154.IG101.SP102.N105]

Typical Work Products

1. Documented specifications of base and derived measures

[PA154.IG101.SP102.W101]

Subpractices

1. Identify candidate measures based on documented measurement objectives. [PA154.IG101.SP102.SubP101]

The measurement objectives are refined into specific measures. The identified candidate measures are categorized and specified by name and unit of measure.

[PA154.IG101.SP102.SubP101.N101]

2. Identify existing measures that already address the measurement objectives. [PA154.IG101.SP102.SubP102]

Specifications for measures may already exist, perhaps established for other purposes earlier or elsewhere in the organization. [PA154.IG101.SP102.SubP102.N101]

3. Specify operational definitions for the measures. [PA154.IG101.SP102.SubP103]

Operational definitions are stated in precise and unambiguous term. They address two important criteria as follows: [PA154.IG101.SP102.SubP103.N101]

- Communication: What has been measured, how was it measured, what are the units of measure, and what has been included or excluded?
- Repeatability: Can the measurement be repeated, given the same definition, to get the same results?

4. Prioritize, review, and revise measures. [PA154.IG101.SP102.SubP104]

17330 Proposed specifications of the measures are reviewed for their appropriateness
17331 with potential end users and other stakeholders. Priorities are set or changed,
17332 and specifications of the measures are revised as necessary.
17333 [PA154.IG101.SP102.SubP104.N101]

17334 **SP 1.3-1 Specify Data Collection and Storage Procedures**

17335 ***Specify how measurement data will be obtained and stored.***

17336 [PA154.IG101.SP103]

17337 Explicit specification of collection methods helps ensure that the right
17338 data are collected properly. It may also aid in further clarifying
17339 information needs and measurement objectives. [PA154.IG101.SP103.N101]

17340 Proper attention to storage and retrieval procedures helps ensure that
17341 data are available and accessible for future use. [PA154.IG101.SP103.N102]

17342 **Typical Work Products**

17343 1. Documented data collection and storage procedures

17344 [PA154.IG101.SP103.W101]

17345 2. Data collection tools [PA154.IG101.SP103.W102]

17346 **Subpractices**

17347 1. Identify existing sources of data that are generated from current
17348 work products, processes, or transactions. [PA154.IG101.SP103.SubP101]

17349 Existing sources of data may already have been identified when specifying the
17350 measures. Appropriate collection mechanisms may exist whether or not pertinent
17351 data have already been collected. [PA154.IG101.SP103.SubP101.N101]

17352 2. Identify measures for which data are needed, but are not currently
17353 available. [PA154.IG101.SP103.SubP102]

17354 3. Specify how to collect and store the data for each required
17355 measure. [PA154.IG101.SP103.SubP103]

17356 Explicit specifications are made of how, where, and when the data will be
17357 collected. Procedures for collecting valid data are specified. The data are stored
17358 in an accessible manner for analysis, and it is determined whether they will be
17359 saved for possible reanalysis or documentation purposes. [PA154.IG101.SP103.SubP103.N101]

17360 Questions to be considered typically include the following: [PA154.IG101.SP103.SubP103.N102]

- 17361 • Have the frequency of collection and the points in the process where
17362 measurements will be made been determined?
- 17363 • Has the time line that is required to move measurement results from the points of
17364 collection to repositories, other databases, or end users been established?
- 17365 • Who is responsible for obtaining the data?

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- Who is responsible for data storage, retrieval, and security?
- Have necessary supporting tools been developed or acquired?

4. Create data collection mechanisms and process guidance.

[PA154.IG101.SP103.SubP104]

Data collection and storage mechanisms are well integrated with other normal work processes. Data collection mechanisms may include manual or automated forms and templates. Clear, concise guidance on correct procedures is available to those responsible for doing the work. Training is provided as necessary to clarify the processes necessary for collection of complete and accurate data, and minimize the burden on those who must provide and record the data.

[PA154.IG101.SP103.SubP104.N101]

5. Support automatic collection of the data where appropriate and feasible. [PA154.IG101.SP103.SubP105]

Automated support can aid in collecting more complete and accurate data.

[PA154.IG101.SP103.SubP105.N101]

Examples of such automated support include: [PA154.IG101.SP103.SubP105.N102]

- Time stamped activity logs
- Static or dynamic analyses of artifacts

However, some data cannot be collected without human intervention (e.g., customer satisfaction or other human judgments), and setting up the necessary infrastructure for other automation may be costly. [PA154.IG101.SP103.SubP105.N103]

6. Prioritize, review, and revise data collection and storage procedures. [PA154.IG101.SP103.SubP106]

Proposed procedures are reviewed for their appropriateness and feasibility with those who are responsible for providing, collecting, and storing the data. They also may have useful insights about how to improve existing processes, or suggest other useful measures or analyses. [PA154.IG101.SP103.SubP106.N101]

7. Revise measures and measurement objectives as necessary.

[PA154.IG101.SP103.SubP107]

Priorities may need to be reset based on the following: [PA154.IG101.SP103.SubP107.N101]

- The importance of the measures
- The amount of effort required to obtain the data.

Considerations include whether new forms, tools, or training would be required to obtain the data. [PA154.IG101.SP103.SubP107.N102]

SP 1.4-1 Specify Analysis Procedures

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Specify how measurement data will be analyzed and reported.
[PA154.IG101.SP104]

Specifying the analysis procedures in advance ensures that appropriate analyses will be conducted and reported to address the documented measurement objectives (and thereby the information needs and objectives on which they are based). This approach also provides a check that the necessary data will in fact be collected. [PA154.IG101.SP104.N101]

Typical Work Products

1. Documented analysis specification and procedures
[PA154.IG101.SP104.W101]
2. Data analysis tools [PA154.IG101.SP104.W102]

Subpractices

1. Specify and prioritize the analyses that will be conducted and the reports that will be prepared. [PA154.IG101.SP104.SubP101]

Early attention is paid to the analyses that will be conducted and to the manner in which the results will be reported as follows. [PA154.IG101.SP104.SubP101.N101]

- The analyses explicitly address the documented measurement objectives.
- Presentation of the results is clearly understandable by the audiences to whom the results are addressed.

Priorities may have to be set within available resources. [PA154.IG101.SP104.SubP101.N102]

2. Select appropriate data analysis methods and tools.
[PA154.IG101.SP104.SubP102]

Issues to be considered typically include the following: [PA154.IG101.SP104.SubP102.N101]

- Choice of visual display and other presentation techniques (e.g., pie charts, bar charts, histograms, radar charts, line graphs, scatter plots, or tables)
- Choice of appropriate descriptive statistics (e.g., Arithmetic mean, Median, or Mode)
- Decisions about statistical sampling criteria when it is impossible or unnecessary to examine every data element
- Decisions about how to handle analysis in the presence of missing data elements

Descriptive statistics should typically do the following: [PA154.IG101.SP104.SubP102.N102]

- Examine distributions on the specified measures (e.g., central tendency, extent of variation, presence of atypical outliers)
- Examine the interrelationships among those measures (e.g., comparisons of defects by life-cycle status or product component)
- Display changes over time

17438 *Refer to the Quantitative Project Management process area, Specific*
17439 *Practices 4 & 5 for more information about understanding variation and*
17440 *the appropriate use of statistical analysis techniques.*

17441 [PA154.IG101.SP104.SubP102.R101]

17442 **3. Specify administrative procedures for analyzing the data and**
17443 **communicating the results.** [PA154.IG101.SP104.SubP103]

17444 Issues to be considered typically include the following: [PA154.IG101.SP104.SubP103.N101]

- 17445 • Identifying the persons and groups responsible for analyzing the data and
- 17446 presenting the results
- 17447 • Determining the time line to analyze the data and present the results,
- 17448 • Determining the venues for communicating the results (e.g., progress reports,
- 17449 transmittal memos, written reports, or staff meetings)

17450 **4. Review and revise the content and format of the proposed**
17451 **analyses and reports.** [PA154.IG101.SP104.SubP104]

17452 All of the proposed content and format are subject to review and revision,
17453 including analytic methods and tools, administrative procedures, and priorities.
17454 The stakeholders consulted should include intended end users, sponsors, data
17455 analyst, and data providers. [PA154.IG101.SP104.SubP104.N101]

17456 **5. Revise measures and measurement objectives as necessary.**

17457 [PA154.IG101.SP104.SubP105]

17458 Just as measurement needs drive data analysis, clarification of analysis criteria
17459 can affect measurement. Specifications for some measures may be refined
17460 further based on the specifications established for data analysis procedures.
17461 Other measures may prove to be unnecessary, or a need for additional measures
17462 may be recognized. [PA154.IG101.SP104.SubP105.N101]

17463 The exercise of specifying how measures will be analyzed and reported may also
17464 suggest the need for refining the measurement objectives themselves.

17465 [PA154.IG101.SP104.SubP105.N102]

17466 **6. Specify criteria for evaluating the utility of the analysis results, and**
17467 **of the conduct of the measurement and analysis activities.**

17468 [PA154.IG101.SP104.SubP106]

17469 Criteria for evaluating the utility of the analysis might include the extent to which
17470 the following apply: [PA154.IG101.SP104.SubP106.N101]

- 17471 • The results are (1) provided on a timely basis, (2) understandable, and (3) used
- 17472 for decision making.
- 17473 • The work does not cost more to perform than is justified by the benefits that it
- 17474 provides.

17475 Criteria for evaluating the conduct of the measurement and analysis might include
17476 the extent to which the following apply: [PA154.IG101.SP104.SubP106.N102]

- 17477 • The amount of missing data or the number of flagged inconsistencies are beyond specified thresholds.
- 17478
- 17479 • There is selection bias in sampling (e.g., only satisfied end users are surveyed to evaluate end-user satisfaction, or only unsuccessful projects are evaluated to determine overall productivity).
- 17480
- 17481
- 17482 • The measurement data are repeatable (e.g., statistically reliable).
- 17483 • Statistical assumptions have been satisfied (e.g., about the distribution of data or about appropriate measurement scales).
- 17484

17485 **SG 2 Provide Measurement Results** [PA154.IG102]

17486 ***Measurement results that address identified information needs and objectives are provided.***

17487

17488 The primary reason for doing measurement and analysis is to address identified information needs and objectives. Measurement results based on objective evidence can help to monitor performance, fulfill contractual obligations, make informed management and technical decisions, and enable corrective actions to be taken. [PA154.IG102.N101]

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17493 **SP 2.1-1 Collect Measurement Data**

17494 ***Obtain specified measurement data.*** [PA154.IG102.SP101]

17495 The data necessary for analysis are obtained and checked for completeness and integrity. [PA154.IG102.SP101.N101]

17496

17497 **Typical Work Products**

- 17498 1. Base and derived measurement data sets [PA154.IG102.SP101.W101]
- 17499 2. Results of data integrity tests [PA154.IG102.SP101.W102]

17500 **Subpractices**

- 17501 1. Obtain the data for base measures. [PA154.IG102.SP101.SubP101]

17502 Data are collected as necessary for previously used as well as for newly specified base measures. Existing data are gathered from project records or from elsewhere in the organization. [PA154.IG102.SP101.SubP101.N101]

17503

17504

17505 Note that data that were collected earlier may no longer be available for reuse in existing databases, paper records, or formal repositories. [PA154.IG102.SP101.SubP101.N102]

17506

- 17507 2. Generate the data for derived measures. [PA154.IG102.SP101.SubP102]

17508 Values are newly calculated for all derived measures. [PA154.IG102.SP101.SubP102.N101]

- 17509 3. Perform data integrity checks as close to the source of the data as possible. [PA154.IG102.SP101.SubP103]
- 17510

17511 All measurements are subject to error in specifying or recording data. It is always
17512 better to identify such errors and to identify sources of missing data early in the
17513 measurement and analysis cycle. [PA154.IG102.SP101.SubP103.N101]

17514 Checks can include scans for missing data, out-of-bounds data values, and
17515 unusual patterns and correlation across measures. [PA154.IG102.SP101.SubP103.N102]

17516 It is particularly important to do the following: [PA154.IG102.SP101.SubP103.N103]

- 17517 • Test and correct for inconsistency of classifications made by human judgement
- 17518 (i.e., to determine how frequently people make differing classification decisions
- 17519 based on the same information, otherwise known as "inter coder reliability").

- 17520 • Empirically examine the relationships among the measures that are used to
- 17521 calculate additional derived measures. Doing so can ensure that important
- 17522 distinctions are not overlooked and that the derived measures convey their
- 17523 intended meanings (otherwise known as "criterion validity").

17524 **SP 2.2-1 Analyze Measurement Data**

17525 **Analyze and interpret measurement data.** [PA154.IG102.SP102]

17526 The measurement data are analyzed as planned, additional analyses
17527 are conducted as necessary, results are reviewed with affected parties,
17528 and necessary revisions for future analyses are noted.

17529 [PA154.IG102.SP102.N101]

17530 **Typical Work Products**

- 17531 1. Analysis results and draft reports [PA154.IG102.SP102.W101]

17532 **Subpractices**

- 17533 1. Conduct initial analyses, interpret the results, and draw preliminary
17534 conclusions. [PA154.IG102.SP102.SubP101]

17535 The results of data analyses rarely "speak for themselves." Criteria for
17536 interpreting the results and drawing conclusions should be stated explicitly.

17537 [PA154.IG102.SP102.SubP101.N101]

- 17538 2. Conduct additional measurement and analysis as necessary, and
17539 prepare results for presentation. [PA154.IG102.SP102.SubP102]

17540 The results of planned analyses may suggest (or require) additional, unanticipated
17541 analyses. In addition, they may identify needs to refine existing measures, to
17542 calculate additional derived measures, or even to collect data for additional
17543 primitive measures to properly complete the planned analysis. Similarly, preparing
17544 the initial results for presentation may identify the need for additional,
17545 unanticipated analyses. [PA154.IG102.SP102.SubP102.N101]

- 17546 3. Review the initial results with affected stakeholders.

17547 [PA154.IG102.SP102.SubP103]

17548 It may be appropriate to review initial interpretations of the results and the way in
17549 which they are presented before disseminating and communicating them more
17550 widely. [PA154.IG102.SP102.SubP103.N101]

17551 Reviewing the initial results before their release may prevent needless
17552 misunderstandings, and lead to improvements in the data analysis and
17553 presentation. [PA154.IG102.SP102.SubP103.N102]

17554 Affected stakeholders with whom reviews may be conducted include intended end
17555 users and sponsors, as well as data analysts and data providers.
17556 [PA154.IG102.SP102.SubP103.N103]

17557 **4. Refine criteria for future analyses.** [PA154.IG102.SP102.SubP104]

17558 Valuable lessons that can improve future efforts are often learned from conducting
17559 data analyses and preparing results. Similarly, ways to improve measurement
17560 specifications and data collection procedures may become apparent, as may
17561 ideas for refining identified information needs and objectives.
17562 [PA154.IG102.SP102.SubP104.N101]

SP 2.3-1 Store Data and Results

Manage and store measurement data, measurement specifications, and analysis results. [PA154.IG102.SP103]

17566 Storing measurement-related information enables the timely and cost-
17567 effective future use of historical data and results. The information also is
17568 needed to provide sufficient context for interpretation of the data,
17569 measurement criteria, and analysis results. [PA154.IG102.SP103.N101]

17570 Information typically stored includes the following: [PA154.IG102.SP103.N102]

- 17571 • Measurement plans
- 17572 • Specifications of measures
- 17573 • Sets of data that have been collected
- 17574 • Analysis reports and presentations

17575 The stored information contains or references the information needed to
17576 understand and interpret the measures and assess them for
17577 reasonableness and applicability (e.g., measurement specifications
17578 used on different projects when comparing across projects).
17579 [PA154.IG102.SP103.N103]

17580 Data sets for derived measures typically can be recalculated and need
17581 not be stored. However, it may be appropriate to store summaries
17582 based on derived measures (e.g., charts, tables of results, or report
17583 prose). [PA154.IG102.SP103.N104]

17584 Interim analysis results need not be stored separately if they can be
17585 efficiently reconstructed. [PA154.IG102.SP103.N105]

17586 When data are shared more widely across projects, the data may reside
17587 in an organizational measurement repository. [PA154.IG102.SP103.N106]

17588 *Refer to the Organizational Process Definition process area, Specific*
17589 *Goal 2, Specific Practice 2 for more information about establishing an*
17590 *Organizational Measurement Repository.* [PA154.IG102.SP103.N106.R101]

17591 *Refer to the Configuration Management process area for information on*
17592 *managing measurement work products.* [PA154.IG102.SP103.N106.R102]

17593 **Typical Work Products**

17594 1. Stored data inventory [PA154.IG102.SP103.W101]

17595 **Subpractices**

17596 1. Review the data to ensure their completeness, integrity, accuracy,
17597 and currency. [PA154.IG102.SP103.SubP101]

17598 2. Make the stored contents available for use only by appropriate
17599 groups and personnel. [PA154.IG102.SP103.SubP102]

17600 3. Prevent the stored information from being used inappropriately.
17601 [PA154.IG102.SP103.SubP103]

17602 Examples of ways to prevent inappropriate use of the data and related information
17603 include controlling access to data, and educating people on the appropriate use of
17604 data. [PA154.IG102.SP103.SubP103.N101]

17605
17606 Examples of inappropriate use may include the following: [PA154.IG102.SP103.SubP103.N102]

- 17607
- Disclosure of information that was provided in confidence
 - Faulty interpretations based on incomplete, out-of-context, or otherwise misleading information
 - Measures used to improperly evaluate the performance of people or rank projects
 - Impugning the integrity of specific individuals.
- 17608
17609
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17613 **SP 2.4-1 Communicate Results**

17614 ***Report results of measurement and analysis activities to all***
17615 ***affected stakeholders.*** [PA154.IG102.SP104]

17616 The results of the measurement and analysis process are
17617 communicated to stakeholders in a timely and usable fashion to support
17618 decision making and assist in taking corrective action. [PA154.IG102.SP104.N101]

17619 Affected stakeholders include intended users, sponsors, data analysts,
17620 and data providers. [PA154.IG102.SP104.N102]

17621 **Typical Work Products**

17622 1. Delivered reports and related analysis results [PA154.IG102.SP104.W101]

17623 2. Transmittal and guidance documents [PA154.IG102.SP104.W102]

17624 **Subpractices**

17625 1. Keep stakeholders apprised of measurement results on a timely
17626 basis. [PA154.IG102.SP104.SubP101]

17627 Measurement results are communicated in time to be used for their intended
17628 purposes. Reports are unlikely to be used if they are distributed with little effort to
17629 follow up with those who need to know the results. [PA154.IG102.SP104.SubP101.N101]

17630 To the extent possible and as part of the normal way they do business, users of
17631 measurement results are kept personally involved in setting objectives and
17632 deciding on plans of action for measurement and analysis. The users are regularly
17633 kept apprised of progress and interim results. [PA154.IG102.SP104.SubP101.N102]

17634 2. Assist measurement stakeholders in understanding the results.
17635 [PA154.IG102.SP104.SubP102]

17636 Results are reported in a clear and concise manner appropriate to the
17637 methodological sophistication of the stakeholders. They are understandable,
17638 easily interpretable, and clearly tied to identified information needs and objectives.
17639 [PA154.IG102.SP104.SubP102.N101]

17640 The data often do not "speak for themselves" to practitioners who are not
17641 measurement experts. Measurement choices should be explicitly clear about the
17642 following: [PA154.IG102.SP104.SubP102.N102]

- 17643 • How and why the base and derived measures were specified
- 17644 • How the data were obtained
- 17645 • How to interpret the results based on the data analysis methods that were used
- 17646 • How the results address their information needs

17647 Examples of actions to assist in understanding of results include the following:

17648 [PA154.IG102.SP104.SubP102.N103]

- 17649 • Discussing the results with the stakeholders
- 17650 • Providing a transmittal memo that provides background and explanation
- 17651 • Briefing users on the results
- 17652 • Providing training on the appropriate use and understanding of measurement
17653 results.

17654

17655 Generic Practices by Goal

17656 **GG 1 Achieve Specific Goals**

17657 *The process supports and enables achievement of the specific goals of the*
17658 *process area by transforming identifiable input work products to produce*
17659 *identifiable output work products.*

17660 **GP 1.1 Identify Work Scope**

17661 *Identify the scope of the work to be performed and work products*
17662 *to be produced for measurement and analysis, and communicate*
17663 *this information to those performing the work.* [GP101]

17664 **GP 1.2 Perform Base Practices**

17665 *Perform the base practices of the measurement and analysis*
17666 *process to develop work products and provide services to achieve*
17667 *the specific goals of the process area.* [GP102]

17668 **GG 2 Institutionalize a Managed Process**

17669 *The process is institutionalized as a managed process.*

17670 **GP 2.1 Establish an Organizational Policy**

17671 *Establish and maintain an organizational policy for planning and*
17672 *performing the measurement and analysis process.* [GP103]

17673 Elaboration:

17674 This policy establishes organizational expectations for aligning
17675 measurement objectives and practices with identified information needs
17676 and objectives and for providing measurement results. [PA154.EL101]

17677 **GP 2.2 Plan the Process**

17678 *Establish and maintain the requirements and objectives, and plans*
17679 *for performing the measurement and analysis process.* [GP104]

17680 **GP 2.3 Provide Resources**

17681 *Provide adequate resources for performing the measurement and*
17682 *analysis process, developing the work products and providing the*
17683 *services of the process.* [GP105]

17684

Elaboration:

17685

Measurement personnel may be employed full-or part-time. A measurement group may or may not exist to support measurement activities across multiple projects. [PA154.EL104]

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Examples of tools used in performing the activities of the Measurement and Analysis process area include the following: [PA154.EL105]

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17690

- Statistical packages

17691

- Packages that support data collection over networks

17692

17693

GP 2.4 Assign Responsibility

17694

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

17695

17696

17697

GP 2.5 Train People

17698

Train the people performing or supporting the measurement and analysis process as needed. [GP107]

17699

17700

Elaboration:

17701

Examples of training topics include the following: [PA154.EL107]

17702

- Statistical techniques

17703

- Data collection, analysis, and reporting processes

17704

- Development of goal-related measurements (e.g., GQM)

17705

17706

GP 2.6 Manage Configurations

17707

Place designated work products of the measurement and analysis process under appropriate levels of configuration management.

17708

17709

[GP109]

17710

Elaboration:

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Examples of work products placed under configuration management include the following: [PA154.EL108]

- Specifications of base and derived measures
- Data collection and storage procedures
- Base and derived measurement data sets
- Analysis results and draft reports

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GP 2.7 Identify and Involve Relevant Stakeholders

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Identify and involve the relevant stakeholders of the measurement and analysis process as planned. [GP124]

17721

Elaboration:

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Examples of activities for stakeholder involvement include: [PA154.EL114]

- Establishing measurement objectives and procedures
- Assessing measurement data
- Providing meaningful feedback to those responsible for providing the raw data on which the analysis and results depend

17728

GP 2.8 Monitor and Control the Process

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Monitor and control the measurement and analysis process against the plan and take appropriate corrective action. [GP110]

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Elaboration:

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Examples of measures used in monitoring and controlling the activities of the Measurement and Analysis process area include the following:

[PA154.EL111]

- Percentage of project using progress and performance measures
- Percentage of measurement objectives addressed

17738

GP 2.9 Objectively Evaluate Adherence

17739

17740

17741

17742

Objectively evaluate adherence of the measurement and analysis process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

17743

Elaboration:

17744

Examples of activities reviewed include the following: [PA154.EL112]

17745

- Aligning measurement and analysis activities

17746

- Providing measurement results

17747

17748

Examples of work products reviewed include the following: [PA154.EL113]

17749

- Specifications of base and derived measures

17750

- Data collection and storage procedures

17751

- Analysis results and draft reports

17752

17753

GP 2.10 Review Status with Higher-Level Management

17754

17755

17756

Review the activities, status, and results of the measurement and analysis process with higher-level management and resolve issues. [GP112]

17757

GG 3 Institutionalize a Defined Process

17758

The process is institutionalized as a defined process.

17759

GP 3.1 Establish a Defined Process

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17761

Establish and maintain the description of a defined measurement and analysis process. [GP114]

17762

GP 3.2 Collect Improvement Information

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17765

17766

17767

Collect work products, measures, measurement results, and improvement information derived from planning and performing the measurement and analysis process to support the future use and improvement of the organization's processes and process assets. [GP117]

17768 **GG 4 Institutionalize a Quantitatively Managed Process**

17769 *The process is institutionalized as a quantitatively managed process.*

17770 **GP 4.1 Establish Quality Objectives**

17771 *Establish and maintain quantitative objectives for the*
17772 *measurement and analysis process about quality and process*
17773 *performance based on customer needs and business objectives.*

17774 [GP118]

17775 **GP 4.2 Stabilize Subprocess Performance**

17776 *Stabilize the performance of one or more subprocesses of the*
17777 *measurement and analysis process to determine its ability to*
17778 *achieve the established quantitative quality and process*
17779 *performance objectives.* [GP119]

17780 **GG 5 Institutionalize an Optimizing Process**

17781 *The process is institutionalized as an optimizing process.*

17782 **GP 5.1 Ensure Continuous Process Improvement**

17783 *Ensure continuous improvement of the measurement and analysis*
17784 *process in fulfilling the relevant business goals of the*
17785 *organization.* [GP125]

17786 **GP 5.2 Correct Common Cause of Problems**

17787 *Identify and correct the root causes of defects and other problems*
17788 *in the measurement and analysis process.* [GP121]

17789 DECISION ANALYSIS AND RESOLUTION

17790 Support

17791 Purpose

17792 The purpose of Decision Analysis and Resolution is to make decisions
17793 using a structured approach that evaluates identified alternatives
17794 against established criteria. [PA156]

17795 Introductory Notes

17796 Decision Analysis and Resolution involves making good decisions by
17797 (1) selecting a decision-making technique and level of structure, (2)
17798 identifying criteria that will be the basis of the decision, (3) identifying
17799 alternatives, and (4) evaluating the alternatives against the criteria.
17800 [PA156.N101]

17801 A structured decision-making process reduces the subjective nature of
17802 the decision and has a higher probability of selecting a solution that
17803 meets the multiple demands of the stakeholder community. [PA156.N102]

17804 While the primary application of a structured decision-making process is
17805 technical concerns, the decision analysis and resolution processes also
17806 applicable to many non-technical issues. Issues that have multiple
17807 alternative solutions and evaluation criteria lend themselves to
17808 structured decision-making. Binary decisions are not as appropriate.
17809 [PA156.N103]

17810 Trade studies of equipment or software are typical examples of
17811 structured decision-making. [PA156.N111]

17812

17813 During project planning, project staff identify which specific issues will
17814 require a structured decision-making process. Typical issues include
17815 selection among architectural or design alternatives, use of reusable or
17816 commercial off-the-shelf (COTS) components, supplier selection,
17817 engineering support environments or associated tools, test
17818 environments, and logistics and production issues. In production,
17819 project staff can use the Decision Analysis and Resolution process area
17820 to address a make-or-buy decision, the development of manufacturing
17821 processes, the selection of distribution locations, and other decisions.
17822 [PA156.N104]

17823 Project planning activities also frequently involve non-technical issues
17824 that would benefit from structured decision analysis. [PA156.N105]

17825 During project planning, guidelines are also created for deciding when
17826 to use a structured decision-making process to address unplanned
17827 issues. Guidelines often suggest using a structured decision-making
17828 process when issues are associated with medium to high risks or when
17829 issues affect the ability to achieve project objectives. [PA156.N106]

17830 A structured decision-making process can vary in its formality, type of
17831 criteria, and technique. Less formal decisions can be performed in a
17832 few hours, use only a few criteria (e.g., effectiveness and cost to
17833 implement), and result in a one or two page report. More formal
17834 decisions may require separate plans, months of person-hours,
17835 meetings to develop and approve criteria, simulations, prototypes,
17836 piloting, and extensive documentation. [PA156.N107]

17837 Both numeric and non-numeric criteria can be used in a structured
17838 decision-making process. Numeric criteria use weights to reflect the
17839 relative importance of the criteria. Non-numeric criteria use a more
17840 subjective ranking scale (e.g., high, medium, low). More formal
17841 decisions may require a full trade study. [PA156.N108]

17842 A structured decision-making process identifies and evaluates
17843 alternative solutions. The eventual selection of a final solution may
17844 involve iterative activities of identification and evaluation. Portions of
17845 identified alternatives may be combined, emerging technologies may
17846 change alternatives, and the business situation for vendors may change
17847 during the evaluation period. [PA156.N109]

17848 A final selection of an alternative is accompanied by documentation of
17849 the selected technique, criteria, and alternatives; and the rationale for
17850 the selection of the final solution. The documentation is distributed to
17851 the stakeholders; it provides a record of the decision and rationale that
17852 is useful to other projects that encounter a similar issue. [PA156.N110]

17853 Related Process Areas

17854 *Refer to the Project Planning process area for more information about*
17855 *general planning for projects. The Project Planning process area*
17856 *determines the issues that undergo a structured decision-making*
17857 *process and develops guidelines for deciding when to apply a structure*
17858 *decision-making process to unforeseen issues. [PA156.R101]*

17859 *Refer to the Integrated Project Management (IPPD) process area for*
17860 *more information about establishing the project's defined process. The*
17861 *project's defined process includes a structured decision-making process*
17862 *for each selected issue and incorporates the use of guidelines for*
17863 *applying a structured decision-making process to unforeseen issues.*
17864 [PA156.R102]

17865 Refer to the Risk Management process area for more information about
17866 identifying and mitigating risks. A structured decision-making process
17867 often addresses issues with identified risks. Selected solutions typically
17868 impact risk mitigation strategies. [PA156.R103]

17869 Specific Goals

17870 **SG 1 Evaluate Alternatives** [PA156.IG101]

17871 *Decisions are based on an evaluation of alternatives using established*
17872 *criteria.*

17873 Generic Goals

17874 **GG 1 Achieve Specific Goals** [CL102.GL101]

17875 *The process supports and enables achievement of the specific goals of the*
17876 *process area by transforming identifiable input work products to produce*
17877 *identifiable output work products.*

17878 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

17879 *The process is institutionalized as a managed process.*

17880 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

17881 *The process is institutionalized as a defined process.*

17882 **GG 4 Institutionalize a Quantitatively Managed Process** [CL105.GL101]

17883 *The process is institutionalized as a quantitatively managed process.*

17884 **GG 5 Institutionalize an Optimizing Process** [CL106.GL101]

17885 *The process is institutionalized as an optimizing process.*

17886 Practice to Goal Relationship Table

17887	SG 1 Evaluate Alternatives [PA156.IG101]	
17888	SP 1.1-1	Establish and Use Guidelines for Decision Analysis
17889	SP 1.2-1	Select Decision-Making Techniques
17890	SP 1.3-1	Establish Evaluation Criteria
17891	SP 1.4-1	Identify Alternative Solutions
17892	SP 1.5-1	Evaluate Alternatives
17893	SP 1.6-1	Select Solutions
17894	GG 1 Achieve Specific Goals [CL102.GL101]	
17895	GP 1.1	Identify Work Scope
17896	GP 1.2	Perform Base Practices
17897	GG 2 Institutionalize a Managed Process [CL103.GL101]	
17898	GP 2.1	Establish an Organizational Policy
17899	GP 2.2	Plan the Process
17900	GP 2.3	Provide Resources
17901	GP 2.4	Assign Responsibility
17902	GP 2.5	Train People
17903	GP 2.6	Manage Configurations
17904	GP 2.7	Identify and Involve Relevant Stakeholders
17905	GP 2.8	Monitor and Control the Process
17906	GP 2.9	Objectively Evaluate Adherence
17907	GP 2.10	Review Status with Higher-Level Management
17908	GG 3 Institutionalize a Defined Process [CL104.GL101]	
17909	GP 3.1	Establish a Defined Process
17910	GP 3.2	Collect Improvement Information
17911	GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]	
17912	GP 4.1	Establish Quality Objectives
17913	GP 4.2	Stabilize Subprocess Performance
17914	GG 5 Institutionalize an Optimizing Process [CL106.GL101]	
17915	GP 5.1	Ensure Continuous Process Improvement
17916	GP 5.2	Correct Common Cause of Problems

17917 Specific Practices by Goal

17918 **SG 1 Evaluate Alternatives** [PA156.IG101]

17919 ***Decisions are based on an evaluation of alternatives using established***
 17920 ***criteria.***

17921 Issues requiring a decision-making process may be identified during
 17922 any phase of a product or project life cycle. The objective should be to
 17923 identify issues as early as possible to maximize the time available to
 17924 resolve the issue. [PA156.IG101.N101]

SP 1.1-1 Establish and Use Guidelines for Decision Analysis

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Establish and use guidelines to determine which issues are subject to a structured decision analysis and resolution process.

[PA156.IG101.SP101]

Refer to the Project Planning process area for more information about planning which issues will undergo a structured decision-making process. [PA156.IG101.SP101.R101]

Refer to the Risk Management process area for more information about determining which topics are medium or high risk. [PA156.IG101.SP101.R102]

Most decisions do not require structured decision making, but somewhere between the trivial and the clearly important, the choice may be unclear without explicit criteria. Whether an issue is significant or not is dependent on the project and circumstances, and is determined by the established guidelines. [PA156.IG101.SP101.N101]

Typical guidelines for determining when to require structured decision-making include the following: [PA156.IG101.SP101.N102]

- When a decision is directly related to topics assessed as being of medium or high risk
- When a decision is related to changing work products under configuration management
- When a decision would cause schedule delays over a certain percent or specific amount of time
- When a decision affects the ability to achieve project objectives
- When the costs of the decision process are reasonable when compared to the decision's impact

Examples of when to use structured decision-making include the following: [PA156.IG101.SP101.N103]

- On material procurement when 20 percent of the material parts constitute 80 percent of the total material costs
- On design implementation decisions when technical performance failure may cause a catastrophic failure (e.g., safety of flight item)
- On decisions with the potential to significantly reduce design risk, engineering changes, cycle time, and production costs (e.g., to use lithography models to assess form and fit capability before releasing engineering drawings and production builds)

Typical Work Products

1. Guidelines for when to apply structured decision-making

[PA156.IG101.SP101.W101]

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Subpractices

1. Establish guidelines. [PA156.IG101.SP101.SubP101]
2. Incorporate the use of the guidelines into the defined process where appropriate. [PA156.IG101.SP101.SubP102]

Refer to the Integrated Project Management (IPPD) process area for more information about establishing the project's defined process.

[PA156.IG101.SP101.SubP102.R101]

SP 1.2-1 Select Decision-Making Techniques

Select the decision-making techniques. [PA156.IG101.SP102]

Decision-making techniques, ranging from consensus-based decisions to the use of probabilistic models and decision theory, should be considered and selected appropriately. The level of detail of a study should be commensurate with cost, schedule, performance, and risk impacts. [PA156.IG101.SP102.N101]

While many problems may need only one decision-making technique, some problems may require multiple techniques. For instance, simulations may augment a trade study to determine which design alternative best meets a given criterion. [PA156.IG101.SP102.N102]

Typical Work Products

1. Selected decision-making techniques [PA156.IG101.SP102.W101]

Subpractices

1. Select the techniques based on the purpose for making a decision and on the availability of the information used to support the technique. [PA156.IG101.SP102.SubP101]

For example, the appropriate technique for selecting a preferred approach when requirements are weakly defined may be different than the technique used when the requirements are well defined. [PA156.IG101.SP102.SubP101.N101]

Typical decision-making techniques include: [PA156.IG101.SP102.SubP101.N102]

- Trade studies
- Probabilistic models
- Delphi method
- Quality function deployment
- Group techniques

- 17998
17999
18000
2. Select techniques based on their ability to focus on the issues at hand without being overly influenced by side issues.
[PA156.IG101.SP102.SubP102]
- 18001
18002
- Results of simulations can be skewed by random activities in the solution that are not directly related to the issues at hand. [PA156.IG101.SP102.SubP102.N101]
- 18003
18004
3. Determine the level of structure of the decision-making process.
[PA156.IG101.SP102.SubP103]
- 18005
18006
- Consider the impact on cost, schedule, performance, and existing risk strategies.
[PA156.IG101.SP102.SubP103.N101]

18007 **SP 1.3-1 Establish Evaluation Criteria**

18008 ***Establish the evaluation criteria and their relative ranking.***

18009 [PA156.IG101.SP103]

18010 The evaluation criteria provide the basis for the rest of the decision-
18011 making process. These criteria must reflect the various stakeholder
18012 needs and objectives. The criteria are ranked so that the highest
18013 ranked criteria exert the most influence on the decision.

18014 [PA156.IG101.SP103.N101]

18015 Document evaluation criteria to alleviate the possibility of second-
18016 guessing decisions, or simply forgetting why decisions were made.
18017 Decisions based on criteria that are explicitly defined and established
18018 remove barriers to stakeholder buy-in. [PA156.IG101.SP103.N102]

18019 **Typical Work Products**

- 18020 1. Documented evaluation criteria [PA156.IG101.SP103.W101]
- 18021 2. Rankings of criteria importance [PA156.IG101.SP103.W102]

18022 **Subpractices**

- 18023 1. Develop evaluation criteria and their validity. [PA156.IG101.SP103.SubP101]

18024 Criteria should be traceable to requirements, scenarios, business case
18025 assumptions, business objectives, or other documented sources.

18026 [PA156.IG101.SP103.SubP101.N101]

18027 Types of criteria to consider include: [PA156.IG101.SP103.SubP101.N102]

- 18028 • Technology limitations
- 18029 • Environmental impact
- 18030 • Risks
- 18031 • Total ownership and life-cycle costs

- 18032 2. Define the range and scale for ranking the evaluation criteria.
18033 [PA156.IG101.SP103.SubP102]
- 18034 Scales of relative importance for evaluation criteria can be established with non-
18035 numeric values or with formulas that relate the evaluation parameter to a
18036 numerical weight. [PA156.IG101.SP103.SubP102.N101]
- 18037 3. Rank the criteria. [PA156.IG101.SP103.SubP103]
- 18038 The criteria are ranked according to the defined range and scale to reflect the
18039 needs, objectives, and priorities of the stakeholders. [PA156.IG101.SP103.SubP103.N101]
- 18040 4. Document the rationale for the selection and rejection of evaluation
18041 criteria. [PA156.IG101.SP103.SubP104]
- 18042 Documentation of selection criteria and rationale may be needed to justify
18043 solutions or for future reference and use. [PA156.IG101.SP103.SubP104.N101]
- 18044 5. Test the criteria and their relative importance. [PA156.IG101.SP103.SubP105]
- 18045 Untested criteria, their relative importance, and supporting data or functions may
18046 cause the validity of solutions to be questioned. Criteria and their relative priorities
18047 and scales can be tested with trial runs against a set of alternatives. This test
18048 allows the cumulative impact of a set of criteria on the solution to be evaluated. In
18049 such cases, the alternatives may be different than the proposed alternatives, to
18050 avoid biases. [PA156.IG101.SP103.SubP105.N101]

18051 **SP 1.4-1 Identify Alternative Solutions**

18052 ***Identify alternative solutions to issues.*** [PA156.IG101.SP104]

18053 A wider range of alternatives can surface by soliciting as many
18054 stakeholders as practical for input. Inputs from stakeholders with
18055 diverse skills and backgrounds can help identify and address
18056 assumptions, constraints, and biases. Brainstorming sessions may
18057 stimulate innovative alternatives through rapid interaction and feedback.
18058 Sufficient candidate solutions may not be furnished for analysis. As the
18059 analysis proceeds, other alternatives should be added to the list of
18060 potential candidate solutions. The generation and consideration of
18061 multiple alternatives early in a decision-making process increases the
18062 likelihood that an acceptable decision will be made, and that
18063 consequences of the decision will be understood. [PA156.IG101.SP104.N101]

18064 **Typical Work Products**

- 18065 1. Identified alternatives [PA156.IG101.SP104.W101]

18066 **Subpractices**

- 18067 1. Perform a literature search. [PA156.IG101.SP104.SubP101]

- 18068 A literature search can uncover what others have done both inside and outside
18069 the organization. It may provide a deeper understanding of the problem,
18070 alternatives to consider, barriers to implementation, existing trade studies, and
18071 lessons learned from similar decisions. [PA156.IG101.SP104.SubP101.N101]
- 18072 2. Identify alternatives for consideration in addition to those that may
18073 be provided with the issue. [PA156.IG101.SP104.SubP102]
- 18074 Evaluation criteria are an effective starting point for identifying alternatives. The
18075 evaluation criteria identify the priorities of the stakeholders and the importance of
18076 technical challenges. [PA156.IG101.SP104.SubP102.N101]
- 18077 Combining key attributes of existing alternatives can generate additional and
18078 sometimes stronger alternatives. [PA156.IG101.SP104.SubP102.N102]
- 18079 Solicit alternatives from stakeholders and staff. Brainstorming sessions,
18080 interviews, and working groups can be used effectively to uncover alternatives.
18081 [PA156.IG101.SP104.SubP102.N103]
- 18082 3. Document the proposed alternatives. [PA156.IG101.SP104.SubP103]

SP 1.5-1 Evaluate Alternatives

Evaluate alternative solutions using the documented criteria.

[PA156.IG101.SP105]

18086 Evaluating alternative solutions involves synthesizing analysis,
18087 discussion, and review. Iterative cycles of analysis are sometimes
18088 necessary. Supporting analyses, experimentation, prototyping or
18089 simulations may be needed to substantiate scoring and conclusions.
18090 [PA156.IG101.SP105.N101]

18091 Often the relative importance of criteria is imprecise and the total effect
18092 on a solution is not apparent until after the analysis is performed. In
18093 these cases, the best selection among alternative solutions may not be
18094 clear-cut when the resulting scores differ by relatively small amounts.
18095 Challenges to criteria and assumptions should be encouraged.
18096 [PA156.IG101.SP105.N102]

Typical Work Products

- 18097 1. Evaluation results [PA156.IG101.SP105.W101]
- 18098 2. Documented evaluation results [PA156.IG101.SP105.W102]

Subpractices

- 18100 1. Evaluate the proposed alternative solutions using the documented
18101 evaluation criteria. [PA156.IG101.SP105.SubP101]
- 18102 2. Evaluate the assumptions related to the selection criteria and the
18103 evidence that supports the assumptions. [PA156.IG101.SP105.SubP102]
- 18104

- 18105 3. Evaluate whether uncertainty in the values for alternative solutions
18106 affects the evaluation and address as appropriate.
18107 [PA156.IG101.SP105.SubP103]
- 18108 For instance, if the score can vary between two values, is the difference
18109 significant enough to make a difference in the final solution set? Does the
18110 variation in score represent a high risk? To address these concerns, simulations
18111 may be run, further studies may be performed, or evaluation criteria may be
18112 modified, among other things. [PA156.IG101.SP105.SubP103.N101]
- 18113 4. Perform simulations, modeling, prototypes, and pilots as necessary
18114 to test the selection criteria. [PA156.IG101.SP105.SubP104]
- 18115 5. Consider new alternative solutions if the proposed alternatives do
18116 not test well. [PA156.IG101.SP105.SubP105]
- 18117 6. Document the results of the evaluation. [PA156.IG101.SP105.SubP106]
- 18118 Document the rationale for the addition of new alternatives or studies and
18119 changes to criteria, as well as the results of interim evaluations.
18120 [PA156.IG101.SP105.SubP106.N101]

SP 1.6-1 Select Solutions

Select solutions from the alternatives based on the evaluation criteria. [PA156.IG101.SP106]

18124 Selecting solutions involves weighing the results from the evaluation of
18125 alternatives. Risks associated with the solutions or execution of the
18126 structured decision-making process must be assessed. The final
18127 selection of the solutions is contingent upon the approval of the
18128 stakeholder community. [PA156.IG101.SP106.N101]

Typical Work Products

- 18129 1. Solutions to significant problems or issues [PA156.IG101.SP106.W101]
18130

Subpractices

- 18131 1. Assess the risks associated with making a decision.
18132 [PA156.IG101.SP106.SubP101]
18133

18134 Decisions must often be made with incomplete information. There can be
18135 substantial risk associated with the decision as a result of having incomplete
18136 information. [PA156.IG101.SP106.SubP101.N101]

18137 When decisions must be made according to a specific schedule, time and
18138 resources may not be available for gathering complete information. Consequently,
18139 risky decisions made with incomplete information may require re-evaluation at a
18140 later time. Identified risks should be monitored. [PA156.IG101.SP106.SubP101.N102]

18141 Refer to the Risk Management process area for more information about
18142 how to follow up on risks. [PA156.IG101.SP106.SubP101.R101]

18143 2. Document the results and rationale of the decision.
18144 [PA156.IG101.SP106.SubP102]

18145 Generic Practices by Goal

18146 **GG 1 Achieve Specific Goals**

18147 *The process supports and enables achievement of the specific goals of the*
18148 *process area by transforming identifiable input work products to produce*
18149 *identifiable output work products.*

18150 **GP 1.1 Identify Work Scope**

18151 *Identify the scope of the work to be performed and work products*
18152 *to be produced for decision analysis and resolution, and*
18153 *communicate this information to those performing the work.* [GP101]

18154 **GP 1.2 Perform Base Practices**

18155 *Perform the base practices of the decision analysis and resolution*
18156 *process to develop work products and provide services to achieve*
18157 *the specific goals of the process area.* [GP102]

18158 **GG 2 Institutionalize a Managed Process**

18159 *The process is institutionalized as a managed process.*

18160 **GP 2.1 Establish an Organizational Policy**

18161 *Establish and maintain an organizational policy for planning and*
18162 *performing the decision analysis and resolution process.* [GP103]

18163 Elaboration:

18164 This policy establishes organizational expectations for making decisions
18165 using a structured approach that evaluates identified alternatives
18166 against established criteria. The policy should also provide guidance on
18167 which decisions require a structured decision-making approach.

18168 [PA156.EL101]

18169 **GP 2.2 Plan the Process**

18170 ***Establish and maintain the requirements and objectives, and plans***
18171 ***for performing the decision analysis and resolution process.*** [GP104]

18172 **GP 2.3 Provide Resources**

18173 ***Provide adequate resources for performing the decision analysis***
18174 ***and resolution process, developing the work products and***
18175 ***providing the services of the process.*** [GP105]

18176 Elaboration:

18177 Examples of tools used to perform the activities of the Decision Analysis
18178 and Resolution process area include the following: [PA156.EL102]

- 18179 • Simulators and modeling tools
- 18180 • Prototyping tools
- 18181 • Support tools for group decision-making

18182
18183 **GP 2.4 Assign Responsibility**

18184 ***Assign responsibility and authority for performing the process,***
18185 ***developing the work products, and providing the services of the***
18186 ***decision analysis and resolution process.*** [GP106]

18187 **GP 2.5 Train People**

18188 ***Train the people performing or supporting the decision analysis***
18189 ***and resolution process as needed.*** [GP107]

18190 Elaboration:

18191 Examples of training topics include the following: [PA156.EL103]

- 18192 • Formal decision analysis
- 18193 • Decision-making techniques (e.g., trade studies, Delphi methods,
18194 quality function deployment, group decision-making techniques)

18195
18196 **GP 2.6 Manage Configurations**

18197 ***Place designated work products of the decision analysis and***
18198 ***resolution process under appropriate levels of configuration***
18199 ***management.*** [GP109]

18200

Elaboration:

18201

Examples of work products placed under configuration management include the following: [PA156.EL104]

18202

18203

- Guidelines for when to apply structured decision-making

18204

- Evaluation report

18205

18206

GP 2.7 Identify and Involve Relevant Stakeholders

18207

Identify and involve the relevant stakeholders of the decision analysis and resolution process as planned. [GP124]

18208

18209

Elaboration:

18210

Examples of activities for stakeholder involvement include: [PA156.EL109]

18211

- Establishing guidelines for which issues are subject to a structured decision analysis and resolution process

18212

18213

- Developing evaluation criteria

18214

- Identifying and evaluating alternatives

18215

- Selecting a solution

18216

18217

GP 2.8 Monitor and Control the Process

18218

Monitor and control the decision analysis and resolution process against the plan and take appropriate corrective action. [GP110]

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18220

Elaboration:

18221

Examples of measures used in monitoring and controlling the activities of the decision analysis and resolution process area include the following: [PA156.EL105]

18222

18223

18224

- Cost to benefit ratio of an instance of the Decision and Analysis and Resolution process

18225

18226

GP 2.9 Objectively Evaluate Adherence

18227

Objectively evaluate adherence of the decision analysis and resolution process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

18228

18229

18230

18231 Elaboration:

18232 Examples of activities reviewed include the following: [PA156.EL106]
18233 • Evaluating alternatives

18234
18235 Examples of work products reviewed include the following: [PA156.EL108]
18236 • Guidelines for when to apply structured decision-making
18237 • Evaluation report
18238

18239 **GP 2.10 Review Status with Higher-Level Management**

18240 *Review the activities, status, and results of the decision analysis*
18241 *and resolution process with higher-level management and resolve*
18242 *issues.* [GP112]

18243 **GG 3 Institutionalize a Defined Process**

18244 *The process is institutionalized as a defined process.*

18245 **GP 3.1 Establish a Defined Process**

18246 *Establish and maintain the description of a defined decision*
18247 *analysis and resolution process.* [GP114]

18248 **GP 3.2 Collect Improvement Information**

18249 *Collect work products, measures, measurement results, and*
18250 *improvement information derived from planning and performing*
18251 *the decision analysis and resolution process to support the future*
18252 *use and improvement of the organization's processes and process*
18253 *assets.* [GP117]

18254 **GG 4 Institutionalize a Quantitatively Managed Process**

18255 *The process is institutionalized as a quantitatively managed process.*

18256 **GP 4.1 Establish Quality Objectives**

18257 *Establish and maintain quantitative objectives for the decision*
18258 *analysis and resolution process about quality and process*
18259 *performance based on customer needs and business objectives.*

[GP118]

18261 **GP 4.2 Stabilize Subprocess Performance**

18262 *Stabilize the performance of one or more subprocesses of the*
18263 *decision analysis and resolution process to determine its ability to*
18264 *achieve the established quantitative quality and process*
18265 *performance objectives.* [GP119]

18266 **GG 5 Institutionalize an Optimizing Process**

18267 *The process is institutionalized as an optimizing process.*

18268 **GP 5.1 Ensure Continuous Process Improvement**

18269 *Ensure continuous improvement of the decision analysis and*
18270 *resolution process in fulfilling the relevant business goals of the*
18271 *organization.* [GP125]

18272 **GP 5.2 Correct Common Cause of Problems**

18273 *Identify and correct the root causes of defects and other problems*
18274 *in the decision analysis and resolution process.* [GP121]

18275 ORGANIZATIONAL ENVIRONMENT FOR INTEGRATION

18276 Support

18277 Purpose

18278 The purpose of Organizational Environment for Integration is to provide
18279 an IPPD infrastructure and manage people for integration. [PA169]

18280 Introductory Notes

18281 Successful integration of business and technical elements in projects is
18282 dependent upon substantive and proactive organizational processes
18283 and guidelines. The organization is an integrated system capable of
18284 providing and sustaining the people, products, and processes
18285 necessary for the effective and efficient execution of its projects. The
18286 organization must raise performance expectations from all projects
18287 while providing mechanisms that stimulate both team and individual
18288 excellence. [PA169.N101]

18289 Important characteristics of effective environments for integration
18290 include people trained to exploit the collaborative environment, a
18291 workplace that provides resources to maximize the productivity of
18292 people and facilitate integrated teams; and organizational standard
18293 processes and process assets that culturally enable an IPPD
18294 environment that promotes and rewards team as well as individual
18295 excellence. [PA169.N102]

18296 Related Process Areas

18297 *Refer to the Integrated Project Management (IPPD) process area for*
18298 *more information about managing stakeholder involvement, resolving*
18299 *coordination issues, establishing the project's shared vision, and*
18300 *organizing integrated teams.* [PA169.R101]

18301 *Refer to the Organizational Process Definition process area for more*
18302 *information about establishing the organization's set of standard*
18303 *processes and library of process assets.* [PA169.R102]

18304 *Refer to the Organizational Training process area for more information*
18305 *about identifying training needs and providing the necessary training.*
18306 [PA169.R103]

18307 Specific Goals

18308 **SG 1** Provide IPPD Infrastructure [PA169.IG101]

18309 *An infrastructure that maximizes the productivity of people and effects the*
18310 *collaboration necessary for integration is provided.*

18311 **SG 2** Manage People for Integration [PA169.IG102]

18312 *People are managed to nurture the integrative and collaborative behaviors of*
18313 *an IPPD environment.*

18314 Generic Goals

18315 **GG 1** Achieve Specific Goals [CL102.GL101]

18316 *The process supports and enables achievement of the specific goals of the*
18317 *process area by transforming identifiable input work products to produce*
18318 *identifiable output work products.*

18319 **GG 2** Institutionalize a Managed Process [CL103.GL101]

18320 *The process is institutionalized as a managed process.*

18321 **GG 3** Institutionalize a Defined Process [CL104.GL101]

18322 *The process is institutionalized as a defined process.*

18323 **GG 4** Institutionalize a Quantitatively Managed Process [CL105.GL101]

18324 *The process is institutionalized as a quantitatively managed process.*

18325 **GG 5** Institutionalize an Optimizing Process [CL106.GL101]

18326 *The process is institutionalized as an optimizing process.*

18327 Practice to Goal Relationship Table

18328	SG 1 Provide IPPD Infrastructure [PA169.IG101]	
18329	SP 1.1-1	Establish the Organization's Shared Vision
18330	SP 1.2-1	Establish an Integrated Work Environment
18331	SP 1.3-1	Identify IPPD-Unique Skill Requirements
18332	SG 2 Manage People for Integration [PA169.IG102]	
18333	SP 2.1-1	Establish Leadership Mechanisms
18334	SP 2.2-1	Establish Incentives for Integration
18335	SP 2.3-1	Establish Mechanisms to Balance Team and Home Organization Re-
18336		responsibilities
18337	GG 1 Achieve Specific Goals [CL102.GL101]	
18338	GP 1.1	Identify Work Scope
18339	GP 1.2	Perform Base Practices
18340	GG 2 Institutionalize a Managed Process [CL103.GL101]	
18341	GP 2.1	Establish an Organizational Policy
18342	GP 2.2	Plan the Process
18343	GP 2.3	Provide Resources
18344	GP 2.4	Assign Responsibility
18345	GP 2.5	Train People
18346	GP 2.6	Manage Configurations
18347	GP 2.7	Identify and Involve Relevant Stakeholders
18348	GP 2.8	Monitor and Control the Process
18349	GP 2.9	Objectively Evaluate Adherence
18350	GP 2.10	Review Status with Higher-Level Management
18351	GG 3 Institutionalize a Defined Process [CL104.GL101]	
18352	GP 3.1	Establish a Defined Process
18353	GP 3.2	Collect Improvement Information
18354	GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]	
18355	GP 4.1	Establish Quality Objectives
18356	GP 4.2	Stabilize Subprocess Performance
18357	GG 5 Institutionalize an Optimizing Process [CL106.GL101]	
18358	GP 5.1	Ensure Continuous Process Improvement
18359	GP 5.2	Correct Common Cause of Problems

18360 Specific Practices by Goal

18361 **SG 1 Provide IPPD Infrastructure** [PA169.IG101]

18362 ***An infrastructure that maximizes the productivity of people and effects the***
 18363 ***collaboration necessary for integration is provided.***

18364 An organizational infrastructure that supports and promotes IPPD
 18365 concepts is critical if IPPD is to be successfully sustained over the long
 18366 term. An IPPD infrastructure includes: [PA169.IG101.N101]

- 18367 • An organization shared vision that promotes IPPD concepts such
 18368 as concurrent development and integrated teaming

- 18369 • A work environment that enables efficient and effective
- 18370 collaboration and integration
- 18371 • People trained to collaborate, integrate, and lead others, as
- 18372 necessary

18373 SP 1.1-1 Establish the Organization's Shared Vision

18374 ***Establish and maintain a shared vision for the organization.***

18375 [PA169.IG101.SP101]

18376 Establishing and maintaining the organization's shared vision involves

18377 creating, communicating, using, and periodically evaluating and revising

18378 the shared vision. A shared vision captures the organization's guiding

18379 principles including mission, objectives, expected behavior, and values.

18380 The shared vision of a project's integrated teams should be consistent

18381 with the project's shared vision, which in turn should be consistent with

18382 the organization's shared vision. [PA169.IG101.SP101.N101]

18383 Creating a shared vision involves establishing, and actively maintaining

18384 agreement and commitment about what is to be done and how it will be

18385 accomplished, both procedurally and behaviorally. A shared vision is a

18386 result of an ongoing dialogue among all the people who will make it

18387 real. It continues to evolve as more ideas are shared. [PA169.IG101.SP101.N102]

18388 The organization's shared vision facilitates people working together,

18389 helps to attain unity of purpose, and creates a common understanding

18390 of the end state the organization is aiming to achieve. The

18391 organization's shared vision must speak to every element of the

18392 organization. Effectively impacting the lowest levels of the organization

18393 necessitates impacting the highest levels as well. The organization's

18394 leaders need to be role models for the actions of the organization.

18395 Their commitment to IPPD is critical to its success in the organization.

18396 They must clearly communicate their expectations for the organization's

18397 projects and integrated teams and what the projects and integrated

18398 teams can expect from the management. [PA169.IG101.SP101.N103]

18399 The organization's shared vision needs to be grounded in reality.

18400 Organizations may be tempted to include in their vision broad

18401 statements about integrated teaming and employee empowerment. It is

18402 more important, however to use the vision to set reasonable

18403 expectations on the rate of change in an organization. Unrealistic

18404 proclamations can transform the vision into a source of frustration and

18405 cause the organization to retreat from it after initial pilot demonstrations.

18406 [PA169.IG101.SP101.N104]

18407 The shared vision should be articulated in sufficient detail to provide
18408 criteria against which the project and integrated teams' shared visions
18409 can be aligned. For example, the organization's shared vision should
18410 address the use of integrated teams for projects, the focus on the
18411 customer, and the concurrent development of both product-related life
18412 cycle processes and the product. These concepts should in turn be
18413 reflected in the project and integrated team shared visions. Guidelines
18414 for how projects and integrated teams should develop their shared
18415 visions should be made part of the organization's process asset library.
18416 [PA169.IG101.SP101.N105]

18417 Maintenance of the organization's shared vision involves evaluating its
18418 use and currency. Results of evaluations may indicate the need to
18419 update the organization's shared vision or to establish and maintain
18420 organizational practices and structures that implement the shared
18421 vision. [PA169.IG101.SP101.N106]

18422 **Typical Work Products**

- 18423 1. Organization's shared vision [PA169.IG101.SP101.W101]
- 18424 2. Evaluations of the organization's shared vision [PA169.IG101.SP101.W102]
- 18425 3. Guidelines for shared vision building within projects and integrated
18426 teams [PA169.IG101.SP101.W103]

18427 **Subpractices**

- 18428 1. Identify expectations, constraints, interfaces, and boundary
18429 conditions applicable to the organization's shared vision.
18430 [PA169.IG101.SP101.SubP101]
- 18431 2. Create a shared vision for the organization. [PA169.IG101.SP101.SubP102]

18432 The shared vision can include project, integrated team, and people expectations
18433 from the organization (for example, some organizations have developed an
18434 "employee's bill of rights"). [PA169.IG101.SP101.SubP102.N101]

- 18435 3. Communicate the shared vision both externally and internally.
18436 [PA169.IG101.SP101.SubP103]
- 18437 4. Ensure that organizational practices and structures are aligned with
18438 the shared vision. [PA169.IG101.SP101.SubP104]
- 18439 5. Periodically review the shared vision and update it as necessary.
18440 [PA169.IG101.SP101.SubP105]

18441 Reexamine the vision to determine weaknesses and misunderstood parts.
18442 Revise the vision to improve its clarity and applicability to the present reality of the
18443 organization. Periodically reinforce the clarity and reality of the vision.
18444 [PA169.IG101.SP101.SubP105.N101]

18445 6. Provide guidelines for shared vision building for use by projects
18446 and integrated teams. [PA169.IG101.SP101.SubP106]

18447 These guidelines should establish the context for the project and integrated team
18448 shared visions. [PA169.IG101.SP101.SubP106.N101]

18449 Project visions should be focused on product and contribute to the organizational
18450 vision achievement. Project visions could relate the minimum competencies, or
18451 demonstrated capabilities, for people assigned to integrated teams such as
18452 individual leadership capabilities. Proposed products, activities, partnerships,
18453 organizational and project structures, and project visions are tested against the
18454 organizational vision. [PA169.IG101.SP101.SubP106.N102]

18455 For the integrated teams, nurturing integration necessitates special attention to
18456 the objectives, values, and behaviors that are needed to effect integrated
18457 teamwork throughout the life cycle. Aspects such as team operations, team
18458 behaviors, team responsibilities, and collaboration with interfacing teams can be
18459 addressed. [PA169.IG101.SP101.SubP106.N103]

18460 **SP 1.2-1 Establish an Integrated Work Environment**

18461 ***Establish and maintain an integrated work environment that***
18462 ***supports IPPD by enabling collaboration and concurrent***
18463 ***development.*** [PA169.IG101.SP102]

18464 An integrated work environment includes the physical infrastructure
18465 (e.g., facilities, tools, equipment, and support needed to effectively use
18466 them) that people need to perform their jobs effectively. Properly
18467 functioning environments help people communicate clearly and
18468 efficiently about the product, processes, people needs, and
18469 organization. An integrated work environment helps integrate the
18470 business and technical functions and the interfaces among teams,
18471 projects, and organizations. [PA169.IG101.SP102.N101]

18472 The integrated work environment must accommodate both collocated
18473 and distributed integrated teams as required. Two-way communications
18474 media should be easily accessible by all relevant stakeholders.
18475 [PA169.IG101.SP102.N102]

18476 Encouraging open dialogue by providing communication mechanisms
 18477 enables everyone to effectively engage in and contribute to the
 18478 information sharing. This can improve effectiveness, especially early in
 18479 the product life cycle. Appropriate mechanisms might include meeting
 18480 rooms, email, fax, ftp or Web sites, video teleconferencing capabilities
 18481 and others depending on the organization's culture and project and
 18482 integrated team preferences for efficient and effective information
 18483 sharing. The types of information needed, which agents (projects,
 18484 integrated teams, or individuals), and how many of them produce, own,
 18485 and need that information should be considered in deciding the
 18486 mechanisms to be used. [PA169.IG101.SP102.N103]

18487 Integrated communication tool sets reduce wasted time spent
 18488 converting information from one medium or platform to another, and
 18489 correcting transcription or misunderstandings when people do the
 18490 conversions. Requirements for product and process information
 18491 usability across the product life cycle are important characteristics to
 18492 consider in the selection of information exchange tools. In an IPPD
 18493 environment, it is particularly important that the tools for designing and
 18494 developing the product-related life cycle processes are integrated with
 18495 the tools for designing and developing the product and product
 18496 components. [PA169.IG101.SP102.N104]

18497 Integrated work environments are developed with the same, or greater,
 18498 rigor as that used to develop a specific product or service. Integrated
 18499 work environments are capital assets that are often expensive, have
 18500 unique implementations, are irreversible (their implementation can
 18501 destroy or make unusable the assets being replaced), and whose
 18502 modification disrupts on-going activities. The rigor appropriate to the
 18503 development should be matched to the magnitude of the needs to be
 18504 resolved and the deployment risks. [PA169.IG101.SP102.N105]

18505 **Typical Work Products**

- 18506 1. Requirements for the integrated work environment [PA169.IG101.SP102.W101]
- 18507 2. Design of the integrated work environment [PA169.IG101.SP102.W102]
- 18508 3. Integrated work environment [PA169.IG101.SP102.W103]

18509 **Subpractices**

- 18510 1. Determine requirements for the integrated work environment.
 18511 [PA169.IG101.SP102.SubP101]

18512 Requirements for the integrated work environment are typically based on the
 18513 following: [PA169.IG101.SP102.SubP101.N101]

- 18514 • The organization's set of standard processes
- 18515 • The objectives of the organization articulated in the organization's shared vision

- 18516 • The needs associated with developing, maintaining, and delivering the products
18517 and services of the organization
- 18518 2. Regularly evaluate the effectiveness of the existing environment
18519 and forecast the need for additional, upgraded, or new tools or
18520 integrated work environment components. [PA169.IG101.SP102.SubP102]
- 18521 3. Maintain awareness of current and emerging technologies, tools,
18522 and resources that are related to the integrated work environment.
18523 [PA169.IG101.SP102.SubP103]
- 18524 Maintaining awareness may be accomplished through industry journals,
18525 professional societies, conferences, trade shows, and benchmarking.
18526 [PA169.IG101.SP102.SubP103.N101]
- 18527 Examples of technologies, tools, and resources include: [PA169.IG101.SP102.SubP103.N102]
- 18528 • Computing resources and software productivity tools
18529 • Communications systems, tools, and resources
18530 • Communication tools (e-mail, telephone, databases, archives, etc.)
18531 • Manufacturing and production facilities
18532 • Engineering or simulation tools
18533 • Proprietary engineering tools
18534 • Prototyping or production equipment
18535 • Work space
18536 • Office equipment and supplies
18537 • Raw or stock input materials
18538 • Transportation resources
18539 • "Hot-lines" and "help-desks"
18540 • Information brokerage services
18541 • Support staff and/or services
18542 • Information technology capabilities
18543 • Process enactment and management tools
- 18544 4. Plan, design, and implement an integrated work environment.
18545 [PA169.IG101.SP102.SubP104]

18546 The critical aspects of the work environment are, like any other system,
18547 requirements driven. Work environment functionality (stimulated by customer
18548 needs and requirements) is explored with the same rigor as any other system
18549 development. Are the performance improvements (for example, timely
18550 interoperable communications; safety; security; maintainability) worth the costs
18551 (for example, capital outlays; training; support structure; disassembly and disposal
18552 of existing environments; performance maintenance of the environment) and risks
18553 (for example, work flow and project disruptions)? Requirements are developed for
18554 the life cycle of the work environment and address, as appropriate, the three
18555 different cases for work environment improvements: development of a new
18556 environment, migrating an existing environment to new capabilities, and
18557 maintaining awareness of new and evolving technologies to exploit improvement
18558 opportunities. As required, the integrated work environment or some of its
18559 components can be developed in-house or acquired from external sources.
18560 [PA169.IG101.SP102.SubP104.N101]

18561 **5. Provide ongoing maintenance and operational support for the**
18562 **integrated work environment.** [PA169.IG101.SP102.SubP105]

18563 Maintenance and support of the integrated work environment can be
18564 accomplished either with capabilities inside the organization or hired from outside
18565 the organization. [PA169.IG101.SP102.SubP105.N101]

18566 Examples of maintenance and support methods include the following:

18567 [PA169.IG101.SP102.SubP105.N102]

- 18568 • Hiring people to perform the maintenance and support
- 18569 • Training people to perform the maintenance and support
- 18570 • Contracting the maintenance and support
- 18571 • Developing expert users for selected automation tools

18572 **6. Monitor and evaluate the adequacy of the integrated work**
18573 **environment to satisfy user needs.** [PA169.IG101.SP102.SubP106]

18574 The work environment should be monitored throughout its life cycle to ascertain if,
18575 and when, its performance degrades below that expected (or specified) as well as
18576 to identify opportunities for improvements. The key operating characteristics of
18577 the integrated work environment should be identified. The key operating
18578 characteristics are those performance, product, and process characteristics that
18579 can be measured and compared against expected capabilities of the integrated
18580 work environment. End users should be surveyed to determine the adequacy of
18581 the current environment and to identify potential improvements. Changes should
18582 be planned and implemented based on the analysis of usage and performance
18583 data and on identified real and potential problems. [PA169.IG101.SP102.SubP106.N101]

18584 *Refer to the Project Monitoring and Control process area for more*
18585 *information about practices for monitoring and controlling the work*
18586 *environment.* [PA169.IG101.SP102.SubP106.R101]

18587 7. Revise the integrated work environment as necessary, by adding,
18588 deleting, or replacing components. [PA169.IG101.SP102.SubP107]

18589 **SP 1.3-1 Identify IPPD-Unique Skill Requirements**

18590 ***Identify the unique skills needed to support the IPPD environment.***

18591 [PA169.IG101.SP103]

18592 *Refer to the Organizational Training process area for more information*
18593 *about determining training needs and delivering the training*

18594 [PA169.IG101.SP103.R101]

18595 IPPD is a sufficiently different view of product development that the
18596 organization's leadership and work force will need to develop new skills.
18597 IPPD requires integrative, leadership and interpersonal skills beyond
18598 those typically experienced in traditional environments where people
18599 tend to work alone or primarily interact with others from their own, or
18600 similar, functions or disciplines. Specific skills emphasized in an IPPD
18601 environment include: [PA169.IG101.SP103.N101]

- 18602 • The skills to integrate all appropriate business and technical
- 18603 functions and their processes
- 18604 • The interpersonal skills to coordinate and collaborate with others
- 18605 • The leadership skills to act, and successfully influence others to
- 18606 act, to achieve the shared vision

18607 Training to support these new skills needs to be established and
18608 maintained to sustain the ongoing adoption of IPPD in the organization.

18609 [PA169.IG101.SP103.N102]

18610 Each integrated team member needs to understand what is vital to
18611 other team members in terms of product characteristics and the
18612 capabilities, expectations, and interfaces of the processes associated
18613 with the other functions represented on the team. This understanding
18614 can often be augmented through cross training of individuals across
18615 their function or discipline boundaries. [PA169.IG101.SP103.N103]

18616 Collaboration among integrated team members is essential to create a
18617 team product rather than a collection of independent products.

18618 Enhanced interpersonal skills can help bridge not only the differences
18619 between disparate functions and disciplines, but also the differences in
18620 cultures, values, and backgrounds. [PA169.IG101.SP103.N104]

18621 The leadership demands also increase under IPPD. Leadership
18622 challenges include: ensuring all team members mutually understand
18623 their roles and responsibilities; employing people in their intended roles;
18624 and effectively accessing and integrating the depth and wealth of
18625 specific expertise resident in the organization into the overall integrated
18626 team effort. [PA169.IG101.SP103.N105]

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Typical Work Products

1. IPPD strategic training needs [PA169.IG101.SP103.W101]
2. IPPD tactical training needs [PA169.IG101.SP103.W102]

Subpractices

1. Provide requirements for IPPD skills to the organization’s strategic training plan. [PA169.IG101.SP103.SubP101]
2. Provide requirements for IPPD skills to the organization’s tactical training plan. [PA169.IG101.SP103.SubP102]
3. Ensure that IPPD skills are being provided. [PA169.IG101.SP103.SubP103]

SG 2 Manage People for Integration [PA169.IG102]

People are managed to nurture the integrative and collaborative behaviors of an IPPD environment.

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In an IPPD environment, special attention needs to be paid to aspects of organizational leadership and management. Nurturing integration necessitates focus on the objectives, values, and behaviors that are needed to effect integrated teamwork throughout the life cycle. The organization establishes the IPPD guidelines and processes that become part of the organization’s process assets and the project’s defined process. The organization’s standard processes enable, promote, and reinforce the integrative behaviors expected from projects, integrated teams, and people. For all IPPD processes and guidelines, people are recognized not as the tool or means to the end, but as part of a mutually beneficial collaboration to achieve the objectives. [PA169.IG102.N101]

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In stimulating the integration needed, team-related incentives may be appropriate for people who work together. However, the value of individual excellence should not be overlooked. A balanced approach that addresses both individual performance as well as team performance would help maintain high standards of both team and individual achievement. Expectations from projects, integrated teams, and people are typically communicated in the form of policies, operating procedures, guidelines, and other process assets. [PA169.IG102.N102]

SP 2.1-1 Establish Leadership Mechanisms

Establish and maintain leadership mechanisms to enable timely collaboration. [PA169.IG102.SP101]

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18662 Implementation of IPPD introduces challenges to leadership practices
18663 because of the cultural changes required when people and integrated
18664 teams are empowered and decisions are driven to the lowest level
18665 appropriate. The effectiveness and efficiency of communications
18666 mechanisms in the integrated work environment are critical to timely
18667 and sound decision-making. Once an integrated work environment is
18668 established and training is provided, mechanisms to handle
18669 empowerment, decision-making, and issue resolution also need to be
18670 provided to effect the timely collaboration of relevant stakeholders
18671 required for IPPD. [PA169.IG102.SP101.N101]

18672 In an IPPD environment, it is particularly important that clear channels
18673 of responsibility and authority be established. Within the projects and
18674 the organization, issues can arise when individuals or integrated teams
18675 assume too much or too little authority and when the level at which
18676 decisions are made, or who owns what decisions, is unclear.
18677 Organizational guidelines that scope the degree of empowerment for
18678 integrated teams serve an issue prevention role. Best practices promote
18679 documented and deployed organizational guidelines that can preclude
18680 issues arising from empowerment and authority misinterpretation.
18681 [PA169.IG102.SP101.N102]

18682 Empowerment does not necessarily mean that every decision in an
18683 IPPD environment needs to occur at the lowest level or needs to be
18684 done collaboratively or even reflect consensus among all integrated
18685 team members or project participants. Decisions on the style and
18686 procedures for leadership and decision-making for projects and among
18687 integrated teams need to be made in collaboration with the relevant
18688 stakeholders. In establishing the context for decision-making, the
18689 various kinds of issues are described and agreements are reached on
18690 the decision type that will be used to resolve each kind of issue.
18691 [PA169.IG102.SP101.N103]

18692 Some examples of decision types are: [PA169.IG102.SP101.N104]

- 18693 • Command The leader examines the issue and make a decision
18694 alone.
- 18695 • Consultative The leader receives and examines inputs on the
18696 issue from relevant stakeholders and makes the decision
- 18697 • Collaborative Issues are raised by any of the stakeholders,
18698 including the leader, the issues are discussed, and solutions voted
18699 upon. Rules are needed to determine whether this vote is binding
18700 on the leader.
- 18701 • Consensus -- Issues are raised by any of the stakeholders,
18702 including the leader, and discussed until all members of the
18703 integrated team can live with and support the decision.

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- **Structured** A major issue to be decided by structured decision making. The steps in structured decision making may be carried out in a collaborative way.
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- 18712
- [PA169.IG102.SP101.N105]
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- 18716
- [PA169.IG102.SP101.N106]
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- Leadership characteristics cannot be viewed as solely embodied in the manager/leader. When leadership characteristics are evident in more than the leader, individual group members lead decision-making and activities that heavily involve their area of expertise. This flexibility can result in improved group efficiency and effectiveness. [PA169.IG102.SP101.N107]
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- Even with well-intentioned empowerment, leadership, and decision-making, issues will arise that cannot be resolved at the same level. An organizational process for issue resolution can form the basis for project- and integrated team-specific procedures and help ensure that basic issue resolution avenues are available to projects and integrated teams when unresolved issues need to be escalated. An organizational process for issue resolution can serve both issue resolution and issue prevention roles. [PA169.IG102.SP101.N108]
- 18730
- Typical Work Products**
- 18731
- 18732
1. Guidelines for determining the degree of empowerment of people and integrated teams [PA169.IG102.SP101.W101]
- 18733
- 18734
2. Guidelines for setting leadership and decision-making context [PA169.IG102.SP101.W102]
- 18735
- 18736
3. Organizational process documentation for issue resolution [PA169.IG102.SP101.W103]
- 18737
- Subpractices**
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- 18739
1. Establish and maintain guidelines for the degree of empowerment provided to people and integrated teams. [PA169.IG102.SP101.SubP101]
- 18740
- 18741
2. Collaboratively determine rules for the use of different decision types in making various kinds of decisions. [PA169.IG102.SP101.SubP102]

18742 Refer to the Decision Analysis and Resolution process area for more
18743 information about structured decision making and evaluating and
18744 selecting among alternatives. [PA169.IG102.SP101.SubP102.R101]

18745 3. Define the process for using the decision-making rules.
18746 [PA169.IG102.SP101.SubP103]

18747 4. Define a process for conflict resolution when an issue cannot be
18748 decided at the level at which it arose. [PA169.IG102.SP101.SubP104]

18749 SP 2.2-1 Establish Incentives for Integration

18750 **Establish and maintain incentives for adopting and demonstrating**
18751 **integrative and collaborative behaviors at all levels of the**
18752 **organization.** [PA169.IG102.SP102]

18753 The recognition and reward systems in an organization are one of the
18754 motivators for behavior and value changes. To support IPPD, the
18755 recognition and reward systems (both positive rewards and negative
18756 consequences) need to recognize a shift in values from single point of
18757 success or failure (e.g., providing a management incentive package to
18758 the product or program manager alone) to integrated team success or
18759 failure (e.g., providing layered incentives to integrated team members
18760 based on degree of involvement and contribution). [PA169.IG102.SP102.N101]

18761 Individual excellence still needs to be recognized, but criteria should
18762 discern whether such excellence was achieved at the expense of the
18763 integrative behaviors expected or in support of it. For example,
18764 individuals (such as leaders) removing integration barriers or
18765 implementing collaboration capabilities may be just as important as an
18766 integrated team performing well. Care should be taken, however, not to
18767 single out individuals for recognition for a team's achievement.
18768 [PA169.IG102.SP102.N102]

18769 Incentives need to be consistent with the objectives of the organization
18770 and applied to achieve desired behavior at all levels of the organization.
18771 Criteria can establish guidelines for the reassignment of people unable
18772 to demonstrate desired behavior and the selection of people who can
18773 exhibit desired behavior for challenging or important jobs.
18774 [PA169.IG102.SP102.N103]

18775 Compensation is not the only motivator, although the giving of an object
18776 of some value is an appropriate recognition. Reinforcement of positive
18777 behavior via thanks or praise is usually appropriate, especially soon
18778 after the observed performance and such immediate recognition
18779 reinforces the collaborative nature of working in an IPPD environment. If
18780 staff have to wait for yearly performance appraisals, their motivation for
18781 working outside of their strict functional job description is lessened.
18782 [PA169.IG102.SP102.N104]

18783 The yearly performance appraisals also need to be addressed. Review
18784 mechanisms need to be structured so that both home organization
18785 supervisors and team leaders contribute to a person's performance
18786 review. [PA169.IG102.SP102.N105]

18787 **Typical Work Products**

- 18788 1. Compensation policies and procedures [PA169.IG102.SP102.W101]
18789 2. Integrated team and individual recognition and rewards
18790 [PA169.IG102.SP102.W102]

18791 **Subpractices**

- 18792 1. Structure the recognition and reward process to be consistent with
18793 the IPPD environment. [PA169.IG102.SP102.SubP101]

18794 The organization's recognition and reward process should recognize the value of
18795 individual and integrated team excellence and enable, promote, and reinforce
18796 integration. [PA169.IG102.SP102.SubP101.N101]

- 18797 2. Develop guidelines for team recognition as well as individual.
18798 [PA169.IG102.SP102.SubP102]

- 18799 3. Define procedures for integrated review processes that involve
18800 both the integrated team leader and the functional manager.
18801 [PA169.IG102.SP102.SubP103]

- 18802 4. Establish criteria for distinguishing behaviors that promote
18803 integrated team performance from those that establish barriers to
18804 team behaviors. [PA169.IG102.SP102.SubP104]

18805 **SP 2.3-1 Establish Mechanisms to Balance Team and Home Organization**
18806 **Responsibilities**

18807 ***Establish and maintain organizational guidelines to balance team***
18808 ***and home organization responsibilities.*** [PA169.IG102.SP103]

18809 Here "home organization" refers to that part of the organization to which
18810 personnel are assigned when they are not in an integrated team. This
18811 home organization may be called the "functional organization", "home
18812 base", "home office", or "direct organization." Regardless of what it is
18813 called, it is often responsible for the career growth of the personnel
18814 assigned to it, e.g., performance appraisals and training to maintain
18815 functional and discipline expertise. In an IPPD environment, reporting
18816 procedures and rating systems need to recognize that people's
18817 responsibility is focused on the integrated team, not to the traditional
18818 home organization. A balance must be struck, however, because the
18819 responsibility of integrated team members to their respective home
18820 organizations are still important, specifically for process implementation
18821 and improvement. Workloads should be balanced between projects
18822 and functions, while ensuring career growth and advancement.
18823 Mechanisms need to be created that support the home organization
18824 responsibility but align the work force to meet business objectives in a
18825 teaming environment. [PA169.IG102.SP103.N101]

18826 Striking this balance is difficult for an organization but exceedingly
18827 important for the personnel and the success of IPPD implementation.
18828 The balance must be reflected in the personal or career development
18829 plans for each individual. The knowledge and skills needed for an
18830 individual to succeed in both their functional and integrated team role
18831 should be honed, taking into account current and future assignments.
18832 [PA169.IG102.SP103.N102]

18833 Guidelines should also be in place for disbanding teams and
18834 maintaining home organizations. It has been observed that sometimes
18835 teams attempt to remain in place beyond their productive life in
18836 organizations that do not have a home organization for the team
18837 members to report back to after the team is dissolved. [PA169.IG102.SP103.N103]

18838 **Typical Work Products**

- 18839 1. Organizational guidelines for balancing team and home
18840 organization responsibilities [PA169.IG102.SP103.W101]
- 18841 2. Performance review process that considers both functional
18842 supervisor and team leader input [PA169.IG102.SP103.W102]

18843 **Subpractices**

- 18844 1. Establish guidelines for home organization responsibilities in
18845 promoting integrated team behavior. [PA169.IG102.SP103.SubP101]
- 18846 2. Establish guidelines for team management responsibilities to
18847 ensure integrated team members report appropriately to their home
18848 organization. [PA169.IG102.SP103.SubP102]
- 18849 3. Establish a performance review process that considers input from
18850 home organization and integrated team leaders. [PA169.IG102.SP103.SubP103]

18851 Generic Practices by Goal

18852 **GG 1 Achieve Specific Goals**

18853 *The process supports and enables achievement of the specific goals of the*
18854 *process area by transforming identifiable input work products to produce*
18855 *identifiable output work products.*

18856 **GP 1.1 Identify Work Scope**

18857 *Identify the scope of the work to be performed and work products*
18858 *to be produced for organizational environment for integration, and*
18859 *communicate this information to those performing the work. [GP101]*

18860 **GP 1.2 Perform Base Practices**

18861 *Perform the base practices of the organizational environment for*
18862 *integration process to develop work products and provide*
18863 *services to achieve the specific goals of the process area. [GP102]*

18864 **GG 2 Institutionalize a Managed Process**

18865 *The process is institutionalized as a managed process.*

18866 **GP 2.1 Establish an Organizational Policy**

18867 *Establish and maintain an organizational policy for planning and*
18868 *performing the organizational environment for integration process.*
18869 *[GP103]*

18870 Elaboration:

18871 This policy establishes organizational expectations for providing an
18872 IPPD infrastructure and managing people for integration. [PA169.EL101]

18873 **GP 2.2 Plan the Process**

18874 *Establish and maintain the requirements and objectives, and plans*
18875 *for performing the organizational environment for integration*
18876 *process. [GP104]*

18877 Elaboration:

18878 These requirements, objectives, and plans are described in the
18879 organization's plan for the organizational environment for integration.

18880 [PA169.EL102]

18881

GP 2.3 Provide Resources

18882

Provide adequate resources for performing the organizational environment for integration process, developing the work products and providing the services of the process. [GP105]

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Elaboration:

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Examples of special equipment and facilities include: [PA169.EL103]

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- Manufacturing and production facilities

18888

- Prototyping or production equipment

18889

- Work space

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- Office equipment and supplies

18891

- Raw or stock input materials

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- Transportation resources

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- "Hot-lines" and "help-desks"

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- Information brokerage services

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- Support staff and/or services

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Examples of tools used in performing the activities of the Organizational Environment for Integration process area include the following: [PA169.EL104]

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- Communications systems, tools, and resources

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- Computing resources and software productivity tools

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- Engineering or simulation tools

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- Proprietary engineering tools

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- Information technology capabilities

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GP 2.4 Assign Responsibility

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Assign responsibility and authority for performing the process, developing the work products, and providing the services of the organizational environment for integration process. [GP106]

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GP 2.5 Train People

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Train the people performing or supporting the organizational environment for integration process as needed. [GP107]

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18912 Elaboration:

- 18913 Examples of training topics include the following: [PA169.EL105]
- 18914 • Work environment development
 - 18915 • Ergonomics
 - 18916 • Leadership policies for IPPD
 - 18917 • Managing people for integration and collaboration
- 18918

18919 **GP 2.6 Manage Configurations**

18920 ***Place designated work products of the organizational environment***
18921 ***for integration process under appropriate levels of configuration***
18922 ***management.*** [GP109]

18923 Elaboration:

- 18924 Examples of work products placed under configuration management
- 18925 include the following: [PA169.EL106]
- 18926 • Organizational guidelines that determine the degree of
 - 18927 empowerment of individuals and integrated teams
 - 18928 • Organizational process documentation for issue resolution
 - 18929 • Organization's shared vision
- 18930

18931 **GP 2.7 Identify and Involve Relevant Stakeholders**

18932 ***Identify and involve the relevant stakeholders of the organizational***
18933 ***environment for integration process as planned.*** [GP124]

18934 Elaboration:

- 18935 Examples of activities for stakeholder involvement include: [PA169.EL107]
- 18936 • Establishing and maintaining the organization's shared vision
 - 18937 • Establishing and maintaining the integrated work environment
 - 18938 • Establishing IPPD skill needs
 - 18939 • Establishing and maintaining IPPD leadership mechanisms
 - 18940 • Establishing and maintaining organizational policies for the
 - 18941 management of people in an IPPD environment
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GP 2.8 Monitor and Control the Process

Monitor and control the organizational environment for integration process against the plan and take appropriate corrective action.

[GP110]

Elaboration:

Examples of measures used in monitoring and controlling the activities of the Organizational Environment for Integration process area include the following: [PA169.EL108]

- Parameters for key operating characteristics of the work environment

GP 2.9 Objectively Evaluate Adherence

Objectively evaluate adherence of the organizational environment for integration process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

Elaboration:

Examples of activities reviewed include the following: [PA169.EL109]

- Establishing the shared vision for the organization
- Developing guidelines for the degree of empowerment provided to people and teams
- Establishing and maintaining an issue resolution process for issues

Examples of work products reviewed include the following: [PA169.EL110]

- Organization's shared vision
- Organizational guidelines that determine the degree of empowerment of individuals and integrated teams
- Organizational process documentation for issue resolution
- Compensation policies and procedures

GP 2.10 Review Status with Higher-Level Management

Review the activities, status, and results of the organizational environment for integration process with higher-level management and resolve issues. [GP112]

18977 **GG 3 Institutionalize a Defined Process**

18978 *The process is institutionalized as a defined process.*

18979 **GP 3.1 Establish a Defined Process**

18980 *Establish and maintain the description of a defined organizational*
18981 *environment for integration process. [GP114]*

18982 **GP 3.2 Collect Improvement Information**

18983 *Collect work products, measures, measurement results, and*
18984 *improvement information derived from planning and performing*
18985 *the organizational environment for integration process to support*
18986 *the future use and improvement of the organization's processes*
18987 *and process assets. [GP117]*

18988 **GG 4 Institutionalize a Quantitatively Managed Process**

18989 *The process is institutionalized as a quantitatively managed process.*

18990 **GP 4.1 Establish Quality Objectives**

18991 *Establish and maintain quantitative objectives for the*
18992 *organizational environment for integration process about quality*
18993 *and process performance based on customer needs and business*
18994 *objectives. [GP118]*

18995 **GP 4.2 Stabilize Subprocess Performance**

18996 *Stabilize the performance of one or more subprocesses of the*
18997 *organizational environment for integration process to determine*
18998 *its ability to achieve the established quantitative quality and*
18999 *process performance objectives. [GP119]*

19000 **GG 5 Institutionalize an Optimizing Process**

19001 *The process is institutionalized as an optimizing process.*

19002 **GP 5.1 Ensure Continuous Process Improvement**

19003 *Ensure continuous improvement of the organizational*
19004 *environment for integration process in fulfilling the relevant*
19005 *business goals of the organization. [GP125]*

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GP 5.2 Correct Common Cause of Problems

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Identify and correct the root causes of defects and other problems in the organizational environment for integration process. [GP121]

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19009 CAUSAL ANALYSIS AND RESOLUTION

19010 Support

19011 Purpose

19012 The purpose of Causal Analysis and Resolution is to identify causes of
19013 defects and other problems and take action to prevent them from
19014 occurring in the future. [PA155]

19015 Introductory Notes

19016 Causal Analysis and Resolution involves the following: [PA155.N101]

- 19017 • Identifying and analyzing causes of defects and other problems
- 19018 • Taking specific actions to remove the causes and prevent the
- 19019 occurrence of those types of defects and problems in the future

19020 Causal analysis and resolution is the process of improving quality and
19021 productivity by preventing the introduction of defects into a product.
19022 Many development processes rely on defect detection and correction.
19023 However, reliance on detecting defects after they have been introduced
19024 is not cost effective. A more effective approach involves preventing
19025 defects from being introduced during development by integrating defect
19026 prevention activities into the development process. Causal analysis is
19027 applied during each stage of the development cycle. [PA155.N102]

19028 Since defects and problems may have been previously encountered on
19029 other projects or in earlier stages or tasks of the current project, causal
19030 analysis and resolution activities are a mechanism for communicating
19031 lessons learned among projects. [PA155.N103]

19032 The types of defects and other problems are analyzed to identify any
19033 trends. Based on an understanding of the defined process and how it is
19034 implemented, the root causes of the defects and the future implications
19035 of the defects are determined. [PA155.N104]

19036 Causal analysis may also be performed on problems unrelated to
19037 defects. For example, causal analysis may be used to improve quality
19038 attributes such as cycle time. Such analysis may be initiated by
19039 improvement proposals, simulations, dynamic systems models,
19040 engineering analyses, new business directives, or other means.

19041 [PA155.N105]

19042 Sometimes it may be impractical to perform causal analysis on all
19043 defects. In these cases, tradeoffs are made between estimated
19044 investments and estimated returns in quality, productivity, and cycle
19045 time are performed, and defect targets are selected for causal analysis.
19046 [PA155.N106]

19047 A measurement process should already be in place. The defined
19048 measures can be used or in some instances new measures may be
19049 needed to analyze the effects of the process change. [PA155.N107]

19050 *Refer to the Measurement and Analysis process area for more*
19051 *information about establishing a measurement process.* [PA155.N107.R101]

19052 Causal Analysis and Resolution activities provide a mechanism for
19053 projects to evaluate their processes at the local level and look for
19054 improvements that can be implemented. [PA155.N108]

19055 When improvements are judged to be effective, the information is
19056 extended to the organizational level. [PA155.N109]

19057 *Refer to the Organizational Innovation and Deployment process area*
19058 *for more information about improving organizational level processes*
19059 *through proposed improvements and action proposals.* [PA155.N109.R101]

19060 The informative material in this process area is written with the
19061 assumption that maturity level 4 process areas have been implemented,
19062 using terms like 'common cause' and 'stable process.' However,
19063 activities may be applicable with reduced value if this assumption is not
19064 met. [PA155.N110]

19065 Related Process Areas

19066 *Refer to the Quantitative Project Management process area for more*
19067 *information about practices regarding the analysis of process*
19068 *performance and the creation of process capability measures for*
19069 *selected project processes.* [PA155.R101]

19070 *Refer to the Organizational Innovation and Deployment process area*
19071 *for more information about practices regarding the selection and*
19072 *deployment of improvements to organizational processes and*
19073 *technologies.* [PA155.R102]

19074 *Refer to the Measurement and Analysis process area for more*
19075 *information about practices regarding the measurement of performance*
19076 *and performance change as a result of causal analysis and resolution*
19077 *actions.* [PA155.R103]

19078 Specific Goals

19079 **SG 1 Determine Causes of Defects** [PA155.IG101]

19080 *Root causes of defects and other problems are systematically determined.*

19081 **SG 2 Address Causes of Defects** [PA155.IG102]

19082 *Root causes of defects and other problems are systematically addressed to*
19083 *prevent their future occurrence.*

19084 Generic Goals

19085 **GG 1 Achieve Specific Goals** [CL102.GL101]

19086 *The process supports and enables achievement of the specific goals of the*
19087 *process area by transforming identifiable input work products to produce*
19088 *identifiable output work products.*

19089 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

19090 *The process is institutionalized as a managed process.*

19091 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

19092 *The process is institutionalized as a defined process.*

19093 **GG 4 Institutionalize a Quantitatively Managed Process** [CL105.GL101]

19094 *The process is institutionalized as a quantitatively managed process.*

19095 **GG 5 Institutionalize an Optimizing Process** [CL106.GL101]

19096 *The process is institutionalized as an optimizing process.*

19097	Practice to Goal Relationship Table	
19098	SG 1 Determine Causes of Defects [PA155.IG101]	
19099	SP 1.1-1	Select Defect Data for Analysis
19100	SP 1.2-1	Analyze Causes
19101	SG 2 Address Causes of Defects [PA155.IG102]	
19102	SP 2.1-1	Implement the Action Proposals
19103	SP 2.2-1	Evaluate the Effect of Changes
19104	SP 2.3-1	Record Data
19105	GG 1 Achieve Specific Goals [CL102.GL101]	
19106	GP 1.1	Identify Work Scope
19107	GP 1.2	Perform Base Practices
19108	GG 2 Institutionalize a Managed Process [CL103.GL101]	
19109	GP 2.1	Establish an Organizational Policy
19110	GP 2.2	Plan the Process
19111	GP 2.3	Provide Resources
19112	GP 2.4	Assign Responsibility
19113	GP 2.5	Train People
19114	GP 2.6	Manage Configurations
19115	GP 2.7	Identify and Involve Relevant Stakeholders
19116	GP 2.8	Monitor and Control the Process
19117	GP 2.9	Objectively Evaluate Adherence
19118	GP 2.10	Review Status with Higher-Level Management
19119	GG 3 Institutionalize a Defined Process [CL104.GL101]	
19120	GP 3.1	Establish a Defined Process
19121	GP 3.2	Collect Improvement Information
19122	GG 4 Institutionalize a Quantitatively Managed Process [CL105.GL101]	
19123	GP 4.1	Establish Quality Objectives
19124	GP 4.2	Stabilize Subprocess Performance
19125	GG 5 Institutionalize an Optimizing Process [CL106.GL101]	
19126	GP 5.1	Ensure Continuous Process Improvement
19127	GP 5.2	Correct Common Cause of Problems
19128	Specific Practices by Goal	

19129	SG 1	Determine Causes of Defects [PA155.IG101]
19130	<i>Root causes of defects and other problems are systematically determined.</i>	
19131	A root cause is an antecedent source of a defect such that if it is	
19132	removed, the defect is decreased or removed itself. [PA155.IG101.N101]	
19133	SP 1.1-1	Select Defect Data for Analysis
19134	<i>Select the defects and other problems for analysis.</i> [PA155.IG101.SP101]	

19135 **Typical Work Products**

- 19136 1. Defect and problem data selected for further analysis

19137 [PA155.IG101.SP101.W101]

19138 **Subpractices**

- 19139 1. Gather relevant defect data. [PA155.IG101.SP101.SubP101]

19140 Examples of relevant data may include the following: [PA155.IG101.SP101.SubP101.N101]

- 19141 • Project management problem reports requiring corrective action
- 19142 • Defects found in peer reviews
- 19143 • Defects found in testing
- 19144 • Process capability problems found from statistical analysis in managing the
- 19145 defined process

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19147 *Refer to the Verification process area for more information about work*

19148 *product verification.* [PA155.IG101.SP101.SubP101.N101.R101]

19149 *Refer to the Quantitative Project Management process area for more*

19150 *information about statistical management.* [PA155.IG101.SP101.SubP101.N101.R102]

- 19151 2. Determine which defects and other problems will be analyzed
- 19152 further. [PA155.IG101.SP101.SubP102]

19153 When determining which defects to analyze further, consider the impact of the

19154 defects, the frequency of occurrence, the similarity between defects, the cost of

19155 analysis, the time and resources needed, safety considerations, etc.

19156 [PA155.IG101.SP101.SubP102.N101]

19157 Examples of methods for selecting defects and other problems include the

19158 following: [PA155.IG101.SP101.SubP102.N102]

- 19159 • Pareto analysis
- 19160 • Histograms
- 19161 • Process capability analysis

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19163 **SP 1.2-1 Analyze Causes**

19164 ***Perform causal analysis of selected defects and other problems***

19165 ***and propose actions to address them.*** [PA155.IG101.SP102]

19166 The purpose of this analysis is to develop solutions to the identified

19167 problems by analyzing the relevant data and producing action proposals

19168 for implementation. [PA155.IG101.SP102.N101]

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Typical Work Products

1. Action proposal [PA155.IG101.SP102.W101]

Subpractices

1. Conduct causal analysis with the people who are responsible for performing the task. [PA155.IG101.SP102.SubP101]

Examples of when to perform causal analysis include the following:

[PA155.IG101.SP102.SubP101.N101]

- When a stable process does not meet its specified product quality, service quality, or process performance objectives.
- During the task, if and when the number of defects or the magnitude of identified problems warrants additional meetings
- During the task, when the performance of a stable process needs to be improved to meet process performance objectives.
- Periodically, during in-process tasks of long duration (e.g., a level-of-effort customer-support task)
- Periodically, after products are released to the customer(s) (internal and external)
- Shortly after the task is completed

Refer to the Quantitative Project Management process area for more information about achieving the project's quality and process performance objectives. [PA155.IG101.SP102.SubP101.N101.R101]

2. Group the selected defects and other problems based on their causes. [PA155.IG101.SP102.SubP102]

Examples of cause groups, or categories, include the following:

[PA155.IG101.SP102.SubP102.N101]

- Inadequate training
- Breakdown of communications
- Not accounting for all details of the problem
- Making mistakes in manual procedures (e.g., typing)
- Process deficiency

3. Analyze selected defects and other problems by group to determine their root causes. [PA155.IG101.SP102.SubP103]

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Examples of methods to determine root causes include the following:
[PA155.IG101.SP102.SubP103.N101]

- Cause-and-effect (fishbone) diagrams
- Check sheets

4. Propose and document actions that need to be taken to prevent the future occurrence of similar defects or other problems.

[PA155.IG101.SP102.SubP104]

Examples of proposed actions include changes to the following:
[PA155.IG101.SP102.SubP104.N101]

- The process in question
- Training
- Tools
- Methods
- Communications
- Work products

Examples of specific actions include the following: [PA155.IG101.SP102.SubP104.N102]

- Providing training in common problems and techniques for preventing them
- Changing a process so that error-prone steps do not occur
- Automating all or part of a process
- Reordering process activities
- Adding process steps to prevent defects, such as task kick-off meetings to review common defects and actions to prevent them

An action proposal usually documents the following: [PA155.IG101.SP102.SubP104.N103]

- Originator of the action proposal
- Description of the problem
- Description of the defect cause
- Defect cause category
- Stage when the problem was introduced
- Stage when the defect was identified
- Description of the action proposal
- Action proposal category

19236 **SG 2 Address Causes of Defects** [PA155.IG102]

19237 ***Root causes of defects and other problems are systematically addressed to***
19238 ***prevent their future occurrence.***

19239 Projects operating according to a well-defined process will
19240 systematically analyze the operation where problems still occur and
19241 implement process changes to eliminate common causes of selected
19242 problems. [PA155.IG102.N101]

19243 **SP 2.1-1 Implement the Action Proposals**

19244 ***Implement the selected action proposals that were developed in***
19245 ***causal analysis.*** [PA155.IG102.SP101]

19246 *Refer to the Measurement and Analysis process area for more*
19247 *information about how to evaluate and select action proposals.*
19248 [PA155.IG102.SP101.R101]

19249 Action proposals describe the tasks necessary to remove the root
19250 causes of the analyzed defects or problems and avoid their
19251 reoccurrence. [PA155.IG102.SP101.N101]

19252 Only changes that prove to be of value should be considered for broad
19253 implementation. [PA155.IG102.SP101.N102]

19254 **Typical Work Products**

- 19255 1. Action plans for implementing selected proposals
19256 [PA155.IG102.SP101.W101]

19257 **Subpractices**

- 19258 1. Analyze the action proposals and determine their priorities.
19259 [PA155.IG102.SP101.SubP101]

19260 Criteria for prioritizing action proposals include the following:
19261 [PA155.IG102.SP101.SubP101.N101]

- 19262 • Implications of not addressing the defects
19263 • Cost to implement process improvements to prevent the defects
19264 • Expected impact on quality

- 19265 2. Select the action proposals that will be implemented.
19266 [PA155.IG102.SP101.SubP102]

- 19267 3. Implement the action proposals. [PA155.IG102.SP101.SubP103]

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Examples of information provided in an action item include the following:
[PA155.IG102.SP101.SubP103.N101]

- Person responsible for implementing it
- Description of the areas affected by it
- People who are to be kept informed of its status
- Next date status will be reviewed
- Rationale for key decisions
- Description of implementation actions
- Time and cost for identifying the defect and correcting it
- Estimated cost of not fixing the problem

To implement the action proposals, the following tasks must be done:
[PA155.IG102.SP101.SubP103.N102]

- Make assignments
- Coordinate the persons doing the work
- Review the results
- Track the action items to closure

Experiments may be conducted for particularly complex changes.
[PA155.IG102.SP101.SubP103.N103]

Examples of experiments include the following: [PA155.IG102.SP101.SubP103.N105]

- Using a temporarily modified process
- Using a new tool

Action items may be assigned to members of the causal analysis team, members of the project team, or other members of the organization. [PA155.IG102.SP101.SubP103.N104]

4. Identify and remove similar defects that may exist in other processes and work products. [PA155.IG102.SP101.SubP104]
5. Identify and document improvement proposals for the organization's set of standard processes. [PA155.IG102.SP101.SubP105]

Refer to the Organizational Innovation and Deployment process area for more information about the selection and deployment of improvement proposals for the organization's set of standard processes. [PA155.IG102.SP101.SubP105.R101]

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SP 2.2-1 Evaluate the Effect of Changes

Evaluate the effect of changes on process performance.

[PA155.IG102.SP102]

Refer to the Quantitative Project Management process area for more information about analyzing process performance and creating process capability measures for selected project processes. [PA155.IG102.SP102.R101]

Once the changed process is deployed across the project, the effect of the changes must be checked to gather evidence that the process change has corrected the problem and improved performance.

[PA155.IG102.SP102.N101]

Typical Work Products

1. Measures of performance and performance change

[PA155.IG102.SP102.W101]

Subpractices

1. Measure the change in the performance of the project's defined process as appropriate. [PA155.IG102.SP102.SubP101]

This subpractice determines whether the selected change has positively influenced the process performance and by how much. [PA155.IG102.SP102.SubP101.N101]

An example of a change in the performance of the project's defined design process would be the change in the defect density of the design documentation, as statistically measured through peer reviews before and after the improvement has been made. On a statistical process control chart, this would be represented by a change in the mean. [PA155.IG102.SP102.SubP101.N102]

Refer to the Measurement and Analysis process area for more information about how to measure a change in performance.

[PA155.IG102.SP102.SubP101.R101]

2. Measure the capability of the project's defined process as appropriate. [PA155.IG102.SP102.SubP102]

This subpractice determines whether the selected change has positively influenced the ability of the process to meet its quality objectives, as determined by relevant stakeholders. [PA155.IG102.SP102.SubP102.N101]

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An example of a change in the capability of the project's defined design process would be the change in the ability of the process to stay within its process specification boundaries. This can be statistically measured by calculating the range of the defect density of design documentation, as collected in peer reviews before and after the improvement has been made. On a statistical process control chart, this would be represented by lowered control limits.

[PA155.IG102.SP102.SubP102.N102]

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Refer to the Measurement and Analysis process area for more information about how to measure process capability.

[PA155.IG102.SP102.SubP102.R101]

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SP 2.3-1 Record Data

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Record causal analysis and resolution data for use across the project and organization. [PA155.IG102.SP103]

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Data are recorded so other projects and organizations can make appropriate process changes and achieve similar results.

[PA155.IG102.SP103.N101]

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Record the following: [PA155.IG102.SP103.N102]

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- Data on defects and other problems that were analyzed
- Rationale for decisions
- Action proposals from causal analysis meetings
- Action items resulting from action proposals
- Cost of the analysis and resolution activities
- Measures of changes to the performance of the defined process resulting from resolutions

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Typical Work Products

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1. Causal analysis and resolution records [PA155.IG102.SP103.W101]

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Generic Practices by Goal

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GG 1 Achieve Specific Goals

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The process supports and enables achievement of the specific goals of the process area by transforming identifiable input work products to produce identifiable output work products.

19365 **GP 1.1 Identify Work Scope**

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Identify the scope of the work to be performed and work products to be produced for causal analysis and resolution, and communicate this information to those performing the work. [GP101]

19369 **GP 1.2 Perform Base Practices**

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Perform the base practices of the causal analysis and resolution process to develop work products and provide services to achieve the specific goals of the process area. [GP102]

19373 **GG 2 Institutionalize a Managed Process**

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The process is institutionalized as a managed process.

19375 **GP 2.1 Establish an Organizational Policy**

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Establish and maintain an organizational policy for planning and performing the causal analysis and resolution process. [GP103]

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Elaboration:

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This policy establishes organizational expectations for identifying and systematically addressing common causes of defects and other problems. [PA155.EL101]

19382 **GP 2.2 Plan the Process**

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Establish and maintain the requirements and objectives, and plans for performing the causal analysis and resolution process. [GP104]

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Elaboration:

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These requirements, objectives, and plans are described in the organization's plan for causal analysis and resolution. This plan differs from the action proposals and associated action plans described in the specific practice in this process area. The process action proposals and plans address the activities needed to remove the root cause under study; whereas the plan for causal analysis and resolution addresses the organization's overall process. [PA155.EL107]

19393 **GP 2.3 Provide Resources**

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Provide adequate resources for performing the causal analysis and resolution process, developing the work products and providing the services of the process. [GP105]

19397 Elaboration:

19398 Examples of tools used in performing the activities of the Causal
19399 Analysis and Resolution process area include the following: [PA155.EL102]
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- Database systems
- Process modeling tools
- Statistical analysis packages
- Tools, methods, and analysis techniques (e.g., Ishakawa or
19402 fishbone diagram, Pareto analysis, histograms, process capability
19403 studies, control charts)

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19407 **GP 2.4 Assign Responsibility**
19408 *Assign responsibility and authority for performing the process,*
19409 *developing the work products, and providing the services of the*
19410 *causal analysis and resolution process.* [GP106]

19411 **GP 2.5 Train People**
19412 *Train the people performing or supporting the causal analysis and*
19413 *resolution process as needed.* [GP107]

19414 Elaboration:

19415 Examples of training topics include the following: [PA155.EL103]
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- Quality management methods (e.g., root cause analysis)

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19418 **GP 2.6 Manage Configurations**
19419 *Place designated work products of the causal analysis and*
19420 *resolution process under appropriate levels of configuration*
19421 *management.* [GP109]

19422 Elaboration:

19423 Examples of work products placed under configuration management
19424 include the following: [PA155.EL104]
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- Action proposals
- Action plans for implementing selected proposals
- Causal analysis and resolution records

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GP 2.7 Identify and Involve Relevant Stakeholders

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Identify and involve the relevant stakeholders of the causal analysis and resolution process as planned. [GP124]

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Elaboration:

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Examples of activities for stakeholder involvement include: [PA155.EL110]

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- Conducting causal analysis

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- Assessing the action proposals

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GP 2.8 Monitor and Control the Process

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Monitor and control the causal analysis and resolution process against the plan and take appropriate corrective action. [GP110]

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Elaboration:

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Examples of measures used in monitoring and controlling the activities of the Causal Analysis and Resolution process area include the following: [PA155.EL105]

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- Number of root causes removed

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- Change in quality or process performance per instance of the Causal Analysis and Resolution process

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GP 2.9 Objectively Evaluate Adherence

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Objectively evaluate adherence of the causal analysis and resolution process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance. [GP113]

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Elaboration:

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Examples of activities reviewed include the following: [PA155.EL106]

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- Determining causes of defects

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- Addressing causes of defects

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Examples of work products reviewed include the following: [PA155.EL109]

- Action plans for implementing selected proposals
- Causal analysis and resolution records

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GP 2.10 Review Status with Higher-Level Management

Review the activities, status, and results of the causal analysis and resolution process with higher-level management and resolve issues. [GP112]

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GG 3 Institutionalize a Defined Process

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The process is institutionalized as a defined process.

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GP 3.1 Establish a Defined Process

Establish and maintain the description of a defined causal analysis and resolution process. [GP114]

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GP 3.2 Collect Improvement Information

Collect work products, measures, measurement results, and improvement information derived from planning and performing the causal analysis and resolution process to support the future use and improvement of the organization's processes and process assets. [GP117]

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GG 4 Institutionalize a Quantitatively Managed Process

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The process is institutionalized as a quantitatively managed process.

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GP 4.1 Establish Quality Objectives

Establish and maintain quantitative objectives for the causal analysis and resolution process about quality and process performance based on customer needs and business objectives.
[GP118]

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GP 4.2 Stabilize Subprocess Performance

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Stabilize the performance of one or more subprocesses of the causal analysis and resolution process to determine its ability to achieve the established quantitative quality and process performance objectives. [GP119]

19489

GG 5 Institutionalize an Optimizing Process

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The process is institutionalized as an optimizing process.

19491

GP 5.1 Ensure Continuous Process Improvement

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Ensure continuous improvement of the causal analysis and resolution process in fulfilling the relevant business goals of the organization. [GP125]

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GP 5.2 Correct Common Cause of Problems

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19497

Identify and correct the root causes of defects and other problems in the causal analysis and resolution process. [GP121]

19498

Appendixes

19499

A. References

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19505 Product Suite and are not publicly available.

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B. Acronyms

AB	Ability to Perform (common feature)
ARC	Assessment Requirements for CMMI
CAR	Causal Analysis and Resolution (process area)
CBA IPI	CMM-Based Appraisal for Internal Process Improvement
CCB	configuration control board
CM	Configuration Management (process area)
CMM	Capability Maturity Model
CMMI	Capability Maturity Model-Integrated
CMMI-SE/SW	Capability Maturity Model-Integrated for Software Engineering and Systems Engineering
CO	Commitment to Perform (common feature)
COTS	commercial off-the-shelf
CPM	critical path method
DAR	Decision Analysis and Resolution (process area)
DI	Directing Implementation (common feature)
DoD	Department of Defense
EIA/IS	Electronic Industries Association Interim Standard
GG	generic goal
GP	generic practice
IDEAL	Initiating, Diagnosing, Establishing, Acting, Leveraging
IPD-CMM	Integrated Product Development Capability Maturity Model
IPM	Integrated Project Management (process area)

IPPD	Integrated Product and Process Development
IPT	Integrated Product Team
ISO	International Organization for Standardization
ISO/IEC	International Organization for Standardization and International Electrotechnical Commission
IT	Integrated Teaming
MOA	Memorandum of Agreement
M&A	Measurement and Analysis (process area)
OEI	Organizational Environment for Integration
OID	Organizational Innovation and Deployment (process area)
OPD	Organizational Process Definition (process area)
OPF	Organizational Process Focus (process area)
OPP	Organizational Process Performance (process area)
OT	Organizational Training (process area)
OUSD/AT&L	Office of the Under Secretary of Defense, Acquisition, Technology, and Logistics
PA	process area
PAIS	Process Appraisal Information System
PERT	program evaluation and review technique
PI	Product Integration (process area)
PMC	Project Monitoring and Control (process area)
PP	Project Planning (process area)
PPQA	Product and Process Quality Assurance (process area)
QFD	Quality Function Deployment
QPM	Quantitative Project Management (process area)
RD	Requirements Development (process area)

REQM	Requirements Management (process area)
RSKM	Risk Management (process area)
SAM	Supplier Agreement Management (process area)
SCAMPI	Standard CMMI Assessment Method for Process Improvement
SE-CMM	Systems Engineering Capability Maturity Model
SECAM	Systems Engineering Capability Assessment Model
SECM	Systems Engineering Capability Model
SE/SW	systems engineering and software engineering
SG	specific goal
SP	specific practice
SW-CMM	Capability Maturity Model for Software
TS	Technical Solution (process area)
Val	Validation (process area)
Ver	Verification (process area)
VI	Verifying Implementation (common feature)
WBS	work breakdown structure

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C. Glossary

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The CMMI glossary defines many, but not all, terms used in the CMMI models. Glossary entries are typically multiple-word terms consisting of a noun and one or more restrictive modifiers. (There are some exceptions that are one-word terms.) [FM113.T101]

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The glossary was developed using clear methods for the selection of terms and definitions. Some terms were not included in the glossary because they were used in only one process area, or because the term was used in an everyday sense except for in one process area. In either case, the use of the term is explained in the process area. [FM113.T102]

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To be considered for the model glossary, terms must meet all of the following conditions: [FM113.T103]

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Condition 1 - The entry must appear in the CMMI models. We excluded terms from the glossary that are self-explanatory in the context of the CMMI product or that, through popular use, already are widely understood by model users. We also excluded terms only used as examples and which were not concepts critical to the use of the model. However, if we had any doubt as to how widely understood a term was, we chose to include the term in the glossary. [FM113.T104]

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Condition 2 - The definition of the term is not satisfied by common dictionary definition(s). We believe that the best reference source for term definitions is a standard English dictionary. Therefore, once a term was identified in the CMMI Product Suite, we looked up the term (or its component words) in WWWebster's (<http://www.m-w.com>). If the definition found there accurately characterized how the term was being used in CMMI products, we left the term out of the glossary because there was no compelling need to replicate common definitions found in the Webster's dictionary. [FM113.T105]

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Condition 3 - In some instances, we found that the terms used in the CMMI models were unique to the CMMI context. In these instances, we created original definitions not found in other contexts. When selecting or creating CMMI definitions, we took great care to ensure that the definitions did not have any of the following characteristics: [FM113.T106]

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- Circular definitions
- Self-defining definitions wherein a term is used to define itself

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- Terms that are differentiated when they really are synonyms according to the standard English dictionary
 - Overly restrictive definitions that would hinder use of the terms generally understood by the public in more commonplace situations
 - Definitions that provide explanatory information that more rightly belong elsewhere in the model
- 19549
- 19550
- 19551
- 19552
- 19553
- 19554
- You may notice that the term “process” is not defined in the glossary. The reason for its conspicuous absence is that it meets only one of the criteria for inclusion in the glossary. “Process” certainly appears in the model in multiple places (that is, it passes criteria 1). However, this term is defined adequately in the Webster’s dictionary and is not uniquely used in the CMMI models (that is, it fails criteria 2 and 3). [FM113.T107]
- 19555
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- 19562
- The Webster’s entry of “process” comprises multiple definitions, including those for the term as a noun, verb, or adjective. All of these definitions are valid; however, among them there is the following definition: “a series of actions or operations conducing to an end; especially a continuous operation or treatment especially in manufacture.” This definition most likely applies to most uses of the word “process” in CMMI products, but this word may also be used according to the other definitions provided in Webster’s. [FM113.T108]
- 19563
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- 19569
- When selecting definitions for terms in the CMMI glossary, we tried to use definitions from recognized sources where possible. Definitions were first selected from existing sources that have a widespread readership in the software and systems development domain. If we selected a definition from one of these sources, we included a note at the end of the definition in brackets (for example, [ISO 9000]). Our order of precedence when selecting definitions was as follows: [FM113.T109]
- 19570
- 19571
- 19572
- 19573
- 19574
- 19575
1. Webster’s Dictionary
 2. ISO/IEC 9000
 3. ISO/IEC 12207
 4. ISO/IEC 15504
 5. ISO/IEC 15288
 6. CMMI Source Models [FM113.T115]
 - IPD-CMM v0.98
 - EIA/IS 731 (SECM)
 - SW-CMM v 2, draft C
 7. CMMI A-Spec
 8. IEEE
 9. SW-CMM v1.1
 10. EIA 632
 11. SA-CMM
 12. FAA-CMM
 13. P-CMM [FM113.T116]
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The Glossary authors recognized the importance of using terminology that all model users can understand. We also recognize that words and terms can have different meanings in different contexts and environments. The CMMI model glossary is designed to capture the meanings of words and terms that should have the widest use and understanding by users of CMMI products. [FM113.T117]

ability to perform

A common feature of CMMI model process areas using a staged representation that describes the preconditions that must exist in the project or organization before the process can be consistently implemented. Ability to perform involves practices (including documenting the process and the plan); resource allocation (including people and tools); assignment of authority and responsibility; and training (including in-depth and overview training). (See also "staged representation" and "process area.")

**acceptable
alternative practice**

A practice that is a substitute for one or more generic or specific practices and that are effective in implementing and institutionalizing the goal associated with the generic or specific practices. Alternative practices accomplish a result that meets the goal associated with the specific or generic practice that it is replacing.

acceptance criteria

The criteria that a product or product component must satisfy in order to be accepted by a user, customer, or other authorized entity.

acceptance testing

Formal testing conducted to enable a user, customer, or other authorized entity to determine whether to accept a product or product component. (See also "integration testing," "regression testing," and "unit testing" for contrast)

achievement profile

In continuous representations of CMMI models, a list of process areas and their corresponding capability levels that represent the organization's progress for each process area while climbing up the capability levels. (See "target staging," "capability level profile," and "target profile.")

acquisition

The process of obtaining through contract; any discrete action or proposed action by the acquisition entity that would commit to invest (appropriated funds) for obtaining products and services.

**acquisition life
cycle**

A generic term covering all phases of acquisition, operation and logistics support of an item, beginning with concept definition and continuing through the disposal of the item.

acquisition strategy

The specific approach to acquiring products and services

that is based on considerations of supply sources, acquisition methods, requirements specification types, contract or agreement types, and the related acquisition risk.

agreement/contractual requirements

All technical and non-technical requirements related to an acquisition

allocated requirement

Requirement that levies all or part of the performance and functionality of a higher-level requirement on a lower-level architectural element or design component.

alternative practice

A practice that is a substitute for some generic or specific practices contained in the CMMI model. Alternative practices are not necessarily one-for-one replacements for the generic or specific practices.

assessment action plan

A detailed plan to address an assessment finding.

assessment class

A family of assessment methods that satisfy a defined subset of requirements in the Assessment Requirements for CMMI (ARC). These classes are defined so as to align with typical usage modes of assessment.

assessment finding

The results of an assessment that identify the most important issues, problems, or opportunities for process improvement within the assessment scope. Assessment findings are inferences drawn from validated observations.

assessment participants

Members of the organizational unit who participate in providing information during the assessment.

assessment rating

As used in CMMI assessment materials, the value assigned by an assessment team to either (1) a CMMI goal or process area, (2) the capability level of a process area or (3) the maturity level of an organizational unit. The rating is determined by enacting the defined rating process for the assessment method being employed.

assessment reference model

As used in CMMI assessment materials, the CMMI model to which an assessment team correlates process activities.

assessment scope

The definition of the boundaries of the assessment encompassing the organizational limits, the CMMI model limits, and the context within which the processes to be investigated operate.

assessment sponsor

The individual who authorizes an assessment, defines its goals and constraints, and commits to the use of the

assessment results.

assessment team leader

A person who leads the activities of an assessment.

assignable cause of process variation

In CMMI, the term "special cause of variation" is used in place of "assignable cause of variation" to ensure consistency. Both terms are defined identically. (See "special cause of process variation.")

audit

In CMMI process improvement work, an independent examination of a work product or set of work products to determine whether requirements are being met.

base measure

A distinct property or characteristic of an entity and the method for quantifying it. (See "derived measure.")

base practice

When using the continuous representation of CMMI, the base practices of a process area refer to all of the capability level one specific practices for the process area, or an equivalent alternative set.

baseline

1) An agreed-to description of the attributes of a product, at a point in time, which serves as a basis for defining change. (2) An approved and released document, or a set of documents, each of a specific revision; the purpose of which is to provide a defined basis for managing change. (3) The currently approved and released configuration documentation. (4) A released set of files comprising a software version and associated configuration documentation.

capability level

Achievement of process improvement within an individual process area. Activities within a capability level are described by generic practices and summarized by generic goals. (See "maturity level" for contrast. See also "process area," "generic practice," and "generic goal.")

capability level profile

In continuous representations of CMMI models, a list of process areas and their corresponding capability levels. (See "target staging," "capability level profile," "achievement profile," and "target profile.") The profile may be an achievement profile when it represents the organization's progress for each process area while climbing up the capability levels. Or, the profile may be a target profile when it represents an objective for process improvement.

capability maturity model	A capability maturity model (CMM) contains the essential elements of effective processes for one or more disciplines. It also describes an evolutionary improvement path from an ad hoc, immature process to a disciplined, mature process with improved quality and effectiveness.
capable process	A process that can satisfy its specified product quality, service quality, and process performance objectives. (See also "stable process," "standard process," "statistically managed process," and "well-defined process.")
causal analysis	The analysis of defects to determine their cause.
change management	Judicious use of means to effect a change, or proposed change, on a product, or service. (See also "configuration management.")
CMMI appraisal questionnaire	A set of questions about practices and goals in each process area of the assessment reference model. Depending on the ARC compliant appraisal method being used, the CMMI Appraisal Questionnaire response summaries may provide assessors with guidance for scripting questions for interviews, help in identifying documents for review, provide information for use in crafting observations and findings, serve as an independent source of data for corroboration of observations, or be used to support model training.
CMMI assessment tailoring	Selection of options within the assessment method for use in a specific instance. The intent of tailoring is to assist an organization in aligning application of the method with its business objectives.
CMMI Framework	The basic structure that organizes CMMI products and components, which include common elements and best features of the current CMMI models as well as rules and methods for generating models, their assessment methods (including associated artifacts), and their training materials.
CMMI model	A model that describes the essential elements of an effective process for a discipline that is generated from the CMMI Framework and conforms to the framework's rules.
CMMI model component	Any of the main architectural elements that comprise a CMMI model. Some of the main elements of a CMMI model include specific practices, generic practices, specific goals, generic goals, process areas, capability levels, and maturity levels.
CMMI model	The use of a subset of a CMMI model for purposes of

tailoring	making it suitable for a specific application. The intent of tailoring is to assist an organization in aligning application of the model with its business objectives.
CMMI Product Suite	The set of products produced from the CMMI Framework including the framework itself. (See also "CMMI Framework.")
commitment to perform	A common feature of CMMI model process areas using a staged representation that describes the actions that the organization must take to ensure that the relevant process is established and will endure. (See also "staged representation" and "process area.") Commitment to perform involves practices on organizational policies (to set expectations for process performance) and senior management sponsorship (specifically for organizational process areas).
common cause of process variation	The variation of a process that exists because of normal and expected interactions among the components of a process. (See "special cause of process variation" for contrast.)
competency management	The continuously improving process used to enhance the capability of the staff to perform their assigned tasks and responsibilities, and to achieve specific competency growth objectives.
concept of operations	(See "operational concept.")
configuration audit	An audit conducted to verify that a configuration item conforms to a specified standard or requirement. (See also "audit" and "configuration item.")
configuration baseline	The configuration information formally designated at a specific time during a product's or product component's life cycle. Configuration baselines, plus approved changes from those baselines, constitute the current configuration information. (See also "product life cycle.")
configuration control	An element of configuration management, consisting of the evaluation, coordination, approval or disapproval, and implementation of changes to configuration items after formal establishment of their configuration identification. (See also "configuration management," "configuration identification," and "configuration item.")
configuration control board	A group of people responsible for evaluating and approving or disapproving proposed changes to configuration items,

and for ensuring implementation of approved changes. (See also "configuration item.") Configuration control boards are also known as change control boards.

configuration identification

An element of configuration management, consisting of selecting the configuration items for a product, assigning unique identifiers to them, and recording their functional and physical characteristics in technical documentation. (See also "configuration management," "configuration item," and "product.")

configuration item

An aggregation of work products that is designated for configuration management and treated as a single entity in the configuration management process. (See also "configuration management.")

configuration management

A management process for establishing and maintaining consistency of a product's performance, functional, and physical attributes with its requirements, design and operational information throughout its life.

configuration status accounting

An element of configuration management, consisting of the recording and reporting of information needed to manage a configuration effectively. This information includes a listing of the approved configuration identification, the status of proposed changes to the configuration, and the implementation status of approved changes. (See also "configuration management" and "configuration identification.")

configuration unit

The lowest-level configuration entity of a configuration item or component that should be placed into, and retrieved from, a configuration management library system. (See "configuration item" for contrast.)

continuous representation

A capability maturity model structure wherein capability levels provide a recommended order for approaching process improvement within each specified process area. (See "staged representation" for contrast. See also "capability level," and "process area,")

contractor

(See "supplier")

core competency

The knowledge and skills needed within the workforce to perform an important business function of the organization.

corrective action

Acts or deeds used to remedy a situation, remove an error, or adjust a condition.

critical design

A review conducted to verify that the detailed design of one

review	or more configuration items satisfies specified requirements; to establish the compatibility among the configuration items and other items of equipment, facilities, software, and personnel; to assess risk. (See also "configuration item.")
customer	The party (individual, project, or organization) responsible for accepting the product or for authorizing payment. The customer is external to the project, but not necessarily external to the organization. The customer may be a higher-level project.
data management	Principles, processes, and systems for the sharing and management of data
defect density	Number of defects per unit of product size (e.g., problem reports per 1000 lines of code).
defined process	A managed process that is tailored from the organization's set of standard processes according to the organization's tailoring guidelines; has a maintained process description; and contributes work products, measures, and other process improvement information to the organization's process assets.
derived measures	Data resulting from the mathematical function of two or more base measures. (See "base measure.")
derived requirements	Requirements that are not explicitly stated in the customer requirements, but are inferred (1) from contextual requirements (e.g., applicable standards, laws, policies, common practices, and management decisions), or (2) from requirements needed to specify a product component. Derived requirements can also arise during analysis and design of components of the product or system. (See "product requirements" and "programmatic requirements" for contrast.)
design review	A formal, documented, comprehensive, and systematic examination of a design to evaluate the design requirements and the capability of the design to meet these requirements, and to identify problems and propose solutions.
detailed alternative solution	Detailed alternative solutions include the following: Cost (development, procurement/reprocurement, support, life cycle) Technical Performance Complexity of the product component and related life cycle processes Robustness to product operating and use conditions,

operating modes, environments, and variations in related life cycle processes
Product expansion and growth
Technology limitations
Sensitivity to construction methods and materials
Risk
Evolution of requirement drivers and technology
Disposal

developmental configuration

In configuration management, the evolving product and associated documentation that define the evolving configuration of a configuration item during development.
Note: The developmental configuration is under the developer's control, and therefore is not called a baseline. (See also "configuration item," and "configuration management.")

developmental plan

A plan for guiding, implementing, and controlling the design and development of one or more products. (See also "product life cycle.")

effectiveness analysis

An analytical approach to assess how well a design solution will perform or operate given anticipated environments, utilization rates, and operational scenarios. (See also "operational scenario.")

entry criteria

States of being that must be present before an effort can begin successfully.

equivalent staging

Equivalent staging is a target staging, created using a continuous representation, that is defined so that the results of using the target staging can be compared to the maturity levels of the staged representation. (See "target staging," "capability level profile," and "target profile.") Such staging permits benchmarking of progress between organizations, enterprises, and projects, regardless of the CMMI representation used. The organization may use more of the model than what is reported as equivalent staging in its actual process improvement activities. Equivalent staging is only a measure to relate where the organization is compared to maturity levels.

establish and maintain

In CMMI model goal and practice statements, this phrase means establish, use, document, and maintain.

exit criteria

States of being that must be present before an effort can end successfully.

expected CMMI

CMMI components that explain what may be done to satisfy

components	a required CMMI component. Model users can follow the expected components explicitly or follow equivalent alternative practices to these components. Specific practices are expected model components.
finding	(see "assessment finding")
functional analysis	Examination of a defined function to identify all the sub-functions necessary to the accomplishment of that function; identification of functional relationships and interfaces (internal and external) and capturing these in a functional architecture; and flow down of upper-level performance requirements and assignment of these requirements to lower-level sub-functions. (See also "functional architecture.")
functional architecture	The hierarchical arrangement of functions, their internal and external (external to the aggregation itself) functional interfaces and external physical interfaces, their respective functional and performance requirements, and design constraints. (See also "functional baseline.")
functional baseline	The initially approved documentation describing a system's or product's functional performance, interoperability, and interface requirements and the verification required to demonstrate the achievement of those specified requirements. (See also "functional architecture.")
generic goal	A goal attained by performing one or more practices that apply to multiple process areas. (See "quantitative objective," "organization's business objectives," "specific goal," and "quality objectives" for contrast.)
generic practice	A practice that is applicable to any process area, does not belong to a specific process area, and is important to stability and improvement within multiple process areas. (See also "process area.") Examples of generic practices are process planning, training, and configuration management.
goal	Required CMMI components that can be either generic goals or specific goals. Each goal within a process area must be achieved to consider the process area to be achieved. In CMMI models, the word "goal" is only used when referring to the model component.

incomplete process	A process that is not performed or only performed partially (also known as capability level 0). One or more of the specific goals of the process area are not satisfied.
informative CMMI components	CMMI components that help model users understand the required and expected components of the model. These components may contain examples, detailed explanations, or other helpful information. Subpractices, notes, references, goal titles, practice titles, sources, typical work products, discipline amplifications, and generic practice elaborations are informative model components.
institutionalization	The building and reinforcement and corporate culture that support methods, practices, and procedures so that they are the ongoing way of doing business, even after those who originally defined them are gone.
integrated product and process development	Integrated Product and Process Development provides a systematic approach to product development that achieves a timely collaboration of relevant stakeholders throughout the product life cycle to better satisfy customer needs.
integrated team	A group of people with complementary skills and expertise who are committed to delivering specified work products in timely collaboration. Integrated team members provide skills and advocacy appropriate to all phases of the work products' life cycle and are collectively responsible for delivering the work products as specified. An integrated team should include empowered representatives from organizations, disciplines, and functions that have a stake in the success of the work products.
integration testing	Testing in which software components, hardware components, or both are combined and tested to evaluate the interaction between them. (See "acceptance testing," "regression testing," and "unit testing" for contrast.)
interface control	In configuration management, the process of: 1. identifying all functional and physical characteristics relevant to the interfacing of two or more configuration items provided by one or more organizations, and 2. ensuring the proposed changes to these characteristics are evaluated and approved prior to implementation. (See also "configuration management" and "configuration item.") [IEEE 828-1983]
Lead Assessor	As used in the CMMI Product Suite, a person who has demonstrated the necessary skills, competencies and experience for leading CMMI process assessments.

life cycle model	A partitioning of the life of a product into phases that guide the project from identifying customer needs through product retirement.
managed process	A performed process that is planned and executed in accordance with policy, employs skilled people having adequate resources to produce controlled outputs, involves stakeholders, and is reviewed and evaluated for adherence to requirements.
maturity level	Degree of process improvement across a predefined set of process areas in which all goals within the set are attained. (See "capability level" for contrast. See also "process area.")
memorandum of agreement or memorandum of understanding	Binding documents of understanding or agreements between two or more parties.
natural bounds	The inherent process reflected by measures and metrics of process performance, sometimes referred to as "voice of the process." Techniques such as control charts, confidence intervals, and prediction intervals are used to determine whether the variation is due to common causes (i.e., the process is predictable or "stable") or is due to some special cause that can and should be identified and removed.
non-developmental item	An item of supply that was developed previous to its current use in an acquisition or development process. Such an item may require minor modifications to meet the requirements of its current intended use.
non-technical requirements	Contractual provisions, commitments, conditions, and terms, that affect [how] products or services are to be acquired; examples include products to be delivered, data rights for delivered Commercial Off the Shelf (COTS) Non-Developmental Items (NDIs), delivery dates, and milestones with exit criteria. Other non-technical requirements include training requirements, site requirements, and deployment schedules.
objective evidence	As used in CMMI assessment materials, qualitative or quantitative information, records, or statements of fact pertaining to the characteristics of an item or service or to

the existence and implementation of a process element, which is based on observation, measurement, or test and which can be verified. [Adapted from ISO 10011:1994].

objective review

An evaluation of activities and work products against criteria that minimize subjectivity and bias by the reviewer. (See also "audit.") An example of an objective review is an audit against requirements, standards, or procedures by an independent quality assurance function.

objectively verify

Making sure what is done adheres to standards, policies, plans, requirements, etc. by using techniques that are applied by people who are not directly responsible for managing or performing the activities of the process.

observation

As used in CMMI assessment materials, a statement that represents the assessment team members' understanding of information either seen or heard during the assessment data collection activities.

operational concept

A general description of the way in which an entity is used or operates. (Also known as "concept of operations.")

operational documentation

Usually printed or printable instructions used to install, use, and maintain something.

operational scenario

A description of an imagined sequence of events that includes the interaction of the product with its environment and users, as well as interaction among its product components. Operational scenarios are used to evaluate the requirements and design of the system and to verify and validate the system.

optimizing process

A quantitatively managed process that is improved based on an understanding of the common causes of variation inherent in the process. A process that focuses on continually improving the range of process performance through both incremental and innovative improvements. (See "quantitatively managed process" and "defined process" for contrast. See also "common cause of process variation.")

organization's business objectives

Senior-management developed strategies designed to ensure an organization's continued existence and enhance its profitability, market share, and other factors influencing the organization's success. (See "generic goal," "quantitative objective," "specific goal," and "quality objectives" for contrast.)

Such objectives may include: reducing the number of change requests during a system's integration phase,

reducing development cycle time, increasing the number of errors found in a product's first or second phase of development, reducing the number of customer-reported defects, etc., when applied to systems engineering activities.

organization's measurement program

The set of related elements for addressing an organization's measurement needs. This set includes the definition of organization-wide measurements, methods, and practices.

organization's set of standard processes

The definition of the basic processes that are used as the basis for establishing common processes across the organization. It describes the fundamental process elements that are expected to be incorporated into the defined processes. It also describes the relationships (e.g., ordering and interfaces) between these process elements. (See also "defined process" and "process elements.")

organizational maturity

The extent to which an organization has explicitly and consistently deployed processes that are documented, manage, measured, controlled, and continually improved. Organization process maturity may be measured via a process appraisal.

organizational policy

A guiding principle, typically established by senior management that is adopted by an organization to influence and determine decisions.

organizational unit

That part of an organization that is the subject of an assessment. (See also "project.") [ISO/IEC TR 15504-9]
An organizational unit deploys one or more processes that have a coherent process context and operates within a coherent set of business goals. An organizational unit is typically part of a larger organization, although in a small organization, the organizational unit may be the whole organization. An organizational unit may be, for example:
a specific project or set of (related) projects;
a unit within an organization focused on a specific lifecycle phase (or phases) such as acquisition, development, maintenance or support;
a part of an organization responsible for all aspects of a particular product or product set.

outsourcing

(See "acquisition")

peer review

The review of work products performed by peers during the development of the work products to identify defects for removal.

performance parameters	The measures of effectiveness and other key metrics used to guide and control progressive development.
performed process	A process that accomplishes the needed work to produce identified output work products using identified input work products (also known as capability level 1). The specific goals of the process area are satisfied.
physical configuration audit	An audit conducted to verify that a configuration item, as built, conforms to the technical data package that defines it. (See also "audit" and "configuration item.")
planned process	A process that is documented both by a description and a plan. The description and plan should be coordinated, and the plan should include standards, requirements, objectives, resources, assignments, etc.
practice	Expected CMMI components that can be either generic practices or specific practices. Each practice within a process area, or an equivalent alternative must be achieved to consider the process area to be achieved. Every practice supports only one goal. (In CMMI models, the word "practice" is only used when referring to the model component).
process action team	A team that has the responsibility to develop and implement process improvement activities for an organization as documented in the process improvement action plan.
process area	A cluster of related practices in an area that, when performed collectively, achieve a set of goals considered important for establishing process capability in that area. (See also "process capability.")
process asset	Anything that the organization considers useful in attaining the goals of a process area. (See also "process area.")
process asset library	A collection of process asset holdings that can be used by an organization or project.
process capability	The extent to which a process is explicitly documented, managed, measured, controlled, and continually improved.
process capability baseline	A documented characterization of the range of expected results that would normally be achieved by following a specific process under typical circumstances.
process context	The set of factors, documented in the assessment plan that influences the judgment and comparability of assessment

ratings. These include, but are not limited to, the size of the organizational unit to be assessed, the demographics of the organizational unit, the application discipline of the products or services, the size, criticality, and complexity of the products or services, and the quality characteristics of the products or services.

process database

A repository into which all process data are entered. The database contains actual measurement data and related information needed to understand the measurement data and to assess it for reasonableness and applicability. Centralized control of this database ensures that the process data from all programs are permanently retained and protected.

process definition

The act of defining and describing a process. The result of process definition is a process description. (See also "process description.")

process description

A documented expression of a set of activities performed to achieve a given purpose that provides an operational definition of the major components of a process. The documentation specifies, in a complete, precise, and verifiable manner, the requirements, design, behavior, or other characteristics of a process. It also may include procedures for determining whether these provisions have been satisfied. Process descriptions may be found at the activity, project, or organizational level.

process element

The fundamental unit of process description. A process may be defined in terms of subprocesses or process elements. A subprocess can be further decomposed; a process element is not decomposed into finer-grained descriptions.

process group

A collection of specialists that facilitate the definition, maintenance, and improvement of the process(es) used by the organization.

process improvement

A program of activities designed to improve the performance and maturity of the organization's processes and the results of such a program.

process improvement goals

A set of target characteristics established to guide the effort to improve an existing process in a specific measurable way either in terms of resultant product characteristics (e.g., quality, performance, conformance to standards, etc.) or in the way in which the process is executed (e.g., elimination of redundant process steps, combining process steps, improving cycle time, etc.). (See "generic goal," "quantitative

goal," "organization's business goals," "specific goal," and "quality goals" for contrast.)

process measurement

The set of definitions, methods, and activities used to take measurements of a process and its resulting products for the purpose of characterizing and understanding the process.

process owner

The person (or team) responsible for defining and maintaining a process. At the organizational level, the process owner is the person (or team) responsible for the description of a standard process; at the project level, the defined process. A process may therefore have multiple owners at different levels of responsibility. (See also "standard process" and "defined process.")

process performance

A measure of actual results achieved by following a process. It is characterized by both process measures (e.g., effort, cycle time, and defect removal efficiency) and product measures (e.g., reliability, defect density, and response time).

process performance baseline

A documented characterization of the actual results achieved by following a process, which is used as a benchmark for comparing actual process performance against expected process performance. (See also "process performance.")

process tailoring

To make, alter, or adapt a process description for a particular end. For example, a project tailors its defined process from the organization's set of standard processes to meet the objectives, constraints, and environment of the project. (See also "process description," "organization's set of standard processes," and "defined process.")

product

A product is a work product that is delivered to the customer.

product baseline

In configuration management, the initial approved technical data package (including, for software, the source code listing) defining a configuration item during the production, operation, maintenance, and logistic support of its life cycle. (See also "configuration management" and "configuration item.") [derived from IEEE 610.12-1990]

product component

Any work product that must be engineered (requirements defined, designed, and integrated solution developed) to achieve the intended use of the product throughout its life cycle. Product components may be a part of the product delivered to the customer or serve in the manufacture or use

of the product. A car engine and a piston are examples of product components of a car (the product). The manufacturing process to machine the piston; the repair process used to remove the engine from the car for repair; and the process used to train the mechanic to repair the engine are also examples of product components.

product component requirements

Product component requirements provide a complete specification of a product component, including fit, form, function, performance, and any other requirement.

product life cycle

The period of time that begins when a product is conceived and ends when the product is no longer available for use. [derived from IEEE 610.12-1990]

product line

A group of products sharing a common, managed set of features that satisfy specific needs of a selected market or mission.

product quality objectives

Specific objectives, which if met, provide a level of confidence that the quality of a product is satisfactory. (See "generic goal," "quantitative objective," "organization's business objectives," and "specific goal" for contrast.)

product requirements

A refinement of the customer requirements into the developers' language, making implicit requirements into explicit derived requirements. (See "product component requirements," "derived requirements," and "programmatic requirements" for contrast.) The developer uses the product requirements to guide the design and building of the product.

program

(1) A project (2) A collection of related projects and the infrastructure that supports them, including objectives, methods, activities, plans, and success measures. (See "project" for contrast.)

programmatic requirements

Those requirements that describe the non-technical contractual aspects of product development. (See "product component requirements," "derived requirements," and "product requirements" for contrast.) Examples of programmatic requirements include cost, schedule, reports, and reviews.

project

A managed set of interrelated resources that delivers one or more products to a customer or end user. This set of resources has a definite beginning and end and typically operates according to a plan. Such a plan is frequently documented and specifies the product to be delivered or implemented, the resources and funds used, the work to be

done, and a schedule for doing the work.

project manager

The person responsible for planning, directing, controlling, structuring, and motivating the project. (See also "project.")

project progress and performance

What a project achieves with respect to implementing project plans, including effort, cost, schedule, and technical performance.

prototype

A preliminary type, form, or instance of a product or product component that serves as a model for later stages or for the final, complete version of the product. [derived from IEEE 610.1990]

This model (physical, electronic, digital, analytical, etc.) can be used for the purpose of, but not limited to:

1. assessing the feasibility of a new or unfamiliar technology,
2. assessing or mitigating technical risk,
3. validating requirements,
4. demonstrating critical features,
5. qualifying a product,
6. qualifying a process,
7. characterizing performance or product features, or
8. elucidating physical principles.

quality

The ability of a set of inherent characteristics of a product, product component, or process to fulfill requirements of customers. [derived from ISO DIS 9000:2000].

quality assurance

A planned and systematic means for assuring management that defined standards, practices, procedures, and methods of the process are applied.

quality control

The operational techniques and activities that are used to fulfill requirements for quality. (For contrast, see "quality assurance.") [ISO 8402-1994]

quality management system

All activities of the overall management function that determine the quality policy, objectives, and responsibilities, and implement them by means such as quality planning, quality control, quality assurance, and quality improvement within the quality management system.

quality planning

The activities that establish the objectives and requirements for quality and for the application of quality management system elements.

quantitative objective

Desired target value expressed as quantitative metrics. (See "generic goal," "organization's business objectives," "specific

	goal," and "quality objectives" for contrast.)
quantitatively managed process	A defined process that is controlled using statistical and other quantitative techniques. The product quality, service quality, and process performance attributes are measurable and controlled throughout the life cycle. (See "optimizing process," "defined process," and "statistically managed process" for contrast.)
reference model	A model that is used as a benchmark for measuring some attribute.
regression testing	Testing to determine that a change to a product component has not adversely affected its physical attributes, functionality, reliability, or performance. (See "acceptance testing," "integration testing," and "unit testing" for contrast.)
required CMMI components	CMMI components that are essential to achieving process improvement in a given process area. These components are used in assessments to determine process capability. Specific goals and generic goals are required model components.
requirement	(1) A condition or capability needed by a user to solve a problem or achieve an objective. (2) A condition or capability that must be met or possessed by a product or product component to satisfy a contract, standard, specification, or other formally imposed documents. (3) A documented representation of a condition or capability as in (1) or (2). [IEEE 610.12-1990]
requirements analysis	The determination of product-specific performance and functional characteristics based on analyses of: customer needs, expectations, , and constraints; operational concept; projected utilization environments for people, products, and processes; and measures of effectiveness.
requirements elicitation	Using systematic techniques, like prototypes and structured surveys, to proactively identify and document customer and end-user needs.
requirements traceability	The evidence of an association between a requirement and its source requirement, its implementation, and its verification.
return on investment	The ratio of revenue from output (product) to production costs, which determines whether an organization benefits from performing an action to produce something.

risk management	An organized, analytic process to identify what might cause harm or loss (identify risks), assess and quantify the identified risks, and to develop and, if needed, implement an appropriate approach to prevent or handle risk causes that could result in significant harm or loss.
risk mitigation strategies	The principles used to identify the activities that might be implemented to mitigate specific risks and identify the order in which risk mitigation activities are implemented.
root cause	A root cause is an antecedent source of a defect such that if it is removed, the defect is decreased or removed itself.
selection official	That individual within the organization who is authorized to select the offeror (and commit the organization) for award of a contract.
senior manager	A management role at a high enough level in an organization that the primary focus is the long-term vitality of the organization, rather than short-term project and contractual concerns and pressures. The senior manager has authority to direct the allocation or reallocation of resources in support of organizational process improvement effectiveness.
significant weakness	As used in CMMI assessment materials, a weakness that results in the rating of a CMMI model component to be "not satisfied."
software capability evaluation	A CMMI-based appraisal by a trained team of professionals to identify contractors who are qualified to perform the software work or to monitor the state of the software process used on an existing software effort.
software engineering	(1) The application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software (2) The study of approaches as in (1). [derived from IEEE 610.12-1990]
solicitation	The process of preparing a solicitation package and selecting a supplier (contractor).
solicitation package	A formal document delineating technical and non-technical requirements that is used to request offers on invitations for bids (bids) and requests for proposal (proposals), or to request statements of capabilities and price quotations (quotes). It is otherwise used as a basis for selecting a supply source/sources to provide products or services.

special cause of process variation	A cause of a defect that is specific to some transient circumstance and not an inherent part of a process. (See "common cause of process variation" for contrast.)
specific goal	A goal that is attained by performing specific practices within a process area. An organization must attain the associated goals of a process area to satisfy its requirements or the requirements of one of its capability levels. (See also "process area" and "capability level." See "generic goal," "quantitative objective," "organization's business objectives," and "quality objectives" for contrast.)
specific practice	A practice contained in a process area that describes an essential activity to, in part or in whole, accomplish a goal of the process area. (See also "process area" and "specific goal.")
stable process	The state in which all special causes of process variation have been removed and prevented from recurring so that only the common causes of process variation of the process remain. (See also "special cause of process variation" and "common cause of variation." See "standard process," "statistically managed process," "well-defined process," and "capable process" for contrast.)
staged representation	A capability maturity model structure wherein attaining the goals of a set of process areas establishes a maturity level; each level builds a foundation for subsequent levels. (See also "process area" and "maturity level.")
stakeholder	A group or individual that is affected by or is in some way accountable for the outcome of an undertaking.
standard	Mandatory requirements employed and enforced to prescribe a disciplined uniform approach to development.
standard process	An operational definition of the basic process that guides the establishment of a common process in an organization. (See also defined process) [ISO/IEC 15504-9] A standard process describes the fundamental process elements that are expected to be incorporated into any defined process. It also describes the relationships (e.g. ordering and interfaces) between these process elements.
statement of work	A description of contracted work required to complete a project. (See also "project.")
statistical predictability	The performance of a quantitative process that is controlled using statistical and other quantitative techniques.

statistical process control	Statistically based analysis of a process and measurements of process performance, which will identify common and special causes of variation in the process performance, and maintain process performance within limits. (See also "common cause of process variation" and "special cause of process variation.")
statistical techniques	An analytic technique that employs statistical methods (e.g., statistical process control, confidence intervals, prediction intervals).
statistically managed process	A process that is managed by a statistically based technique in which processes are analyzed, special causes of variation are identified, and performance is contained within well-defined limits. (See "stable process," "standard process," "well-defined process," and "capable process" for contrast. See also "special cause of process variation.")
strength	As used in CMMI assessment materials, implementation of practices which, in the judgment of the assessment team, contribute to the satisfaction of a goal. Strengths related to CMMI models are effective implementations of one or more of the CMMI model practices or alternative practices.
subpractice	Practices listed beneath the specific and generic practices in CMMI models that describe activities that may be implemented in establishing the specific or generic practice. Subpractices are for informational purposes only and are intended to provide clarification of the practices or ideas for possible use by the user.
subprocess	A process that is part of a larger process. (See "process description.")
supplier	(1) The entity delivering product(s) or performing services being acquired (2) An individual, partnership, company, corporation, association or other service, having a agreement (contract) with an acquirer for the design, development, manufacture, maintenance, modification, or supply of items under the terms of a contract.
sustainment environment	An infrastructure (organizational structure, mission and functions, concept of operations, and resources (people, facilities, and funding)) necessary to sustain a product.
systems engineering	The interdisciplinary approach governing the total technical and managerial effort required to transform a set of customer needs, expectations, and constraints into a product solution and support that solution throughout the product's life cycle. This includes the definition of technical

performance measures, the integration of engineering specialties towards the establishment of a product architecture, and the definition of supporting life cycle processes that balance cost, performance, and schedule objectives.

target profile

In continuous representations of CMMI models, a list of process areas and their corresponding capability levels that represent an objective for process improvement. (See "target staging," "capability level profile," "achievement profile," and "target profile.")

target staging

In continuous representations of CMMI models, a sequence of target profiles that describes the path of process improvement to be followed by the organization. This target staging must meet two requirements: It must be (1) monotone increasing and (2) admissible. (See "target staging," "capability level profile," "achievement profile," and "target profile.")

technical data package

The technical data package provides the description of a product or product component throughout the product life cycle. This description may support an acquisition strategy or the implementation, production, engineering, and logistics phases. A complete technical data package provides the following items to the extent applicable for a given product component:

- product component descriptions in terms of required life cycle functionality and performance
- developed process descriptions if not described as separate product components
- key product characteristics
- required physical characteristics and constraints
- interface requirements
- materials requirements (bills of material and material characteristics)
- fabrication/manufacturing requirements (for both the original equipment manufacturer and field support)
- the verification criteria used to ensure requirements have been achieved
- conditions of use (environments) and operating/usage scenarios, modes and states for operations, support, training, manufacturing, disposal, and verifications throughout the life cycle
- rationale for decisions (requirements, requirement allocations, design choices)

technical requirements

Properties [attributes] of products or services to be acquired or developed.

test procedure

Detailed instructions for the set-up, execution, and evaluation of results for a given test case.

	evaluation of results for a given test case.
trade study	An evaluation of alternatives based on criteria and systematic analysis, to select the best alternative for attaining determined objectives.
unit testing	Testing of individual hardware or software units or groups of related units. (See "acceptance testing," "integration testing," and "regression testing" for contrast.)
version control	The establishment and maintenance of baselines and the identification of changes to baselines that make it possible to return to the previous baseline.
weakness	As used in CMMI assessment materials, the ineffective implementation of, or lack of, practices which, in the judgment of the assessment team, detract from or interfere with achievement of a goal.
well-defined process	A documented, consistent, and complete process that has specified entry criteria, inputs, task descriptions, verification descriptions and criteria, outputs, and exit criteria. (See "defined process," "stable process," "standard process," "statistically managed process," and "capable process" for contrast. See also "entry criteria" and "exit criteria.")
work breakdown structure	An arrangement of work elements and their relationship to each other and to the end product.
work product	Any artifact produced by a process. This may include files, documents, parts of the product, services, processes, specifications, and invoices. Examples of processes as work products include a manufacturing process, a training process, and a disposal process. A key distinction between a work product and a product component is that a work product need not be engineered.
work product and task attributes	Characteristics of products, services, and project tasks used to help in estimating project work. These characteristics include items such as size, complexity, weight, form, fit, or function. They are typically used as one input to deriving other project and resource estimates (e.g., effort, cost, schedule).

19592

D. Required and Expected Model Elements

19593

PROCESS MANAGEMENT

19594 ORGANIZATIONAL PROCESS FOCUS

19595 Process Management
19596

19597 The purpose of Organizational Process Focus is to establish and
19598 maintain an understanding of the organization's processes and process
19599 assets, and to identify, plan, and implement the organization's process
19600 improvement activities. [PA152]

19601 Practices by Goal:

19602 **SG 1 Determine Process Improvement Opportunities**

19603 ***Strengths, weaknesses, and improvement opportunities for the organization's***
19604 ***processes are identified periodically and as needed.*** [PA152.IG101]

19605 **SP 1.1-1 Establish Organizational Process Needs**

19606 ***Establish and maintain the description of the process needs and***
19607 ***objectives for the organization.*** [PA152.IG101.SP101]

19608 **SP 1.2-1 Assess the Organization's Processes**

19609 ***Assess the processes of the organization periodically and as***
19610 ***needed to maintain an understanding of their strengths and***
19611 ***weaknesses.*** [PA152.IG101.SP102]

19612 **SP 1.3-1 Identify the Organization's Process Improvements**

19613 ***Identify improvements to the organization's processes and related***
19614 ***process assets.*** [PA152.IG101.SP103]

19615 **SG 2 Plan and Implement Process Improvement Activities**

19616 ***Improvements are planned and implemented, process assets are deployed,***
19617 ***and process-related experiences are incorporated into the organization's***
19618 ***process assets.*** [PA152.IG102]

19619 **SP 2.1-1 Establish Process Action Plans**

19620 ***Establish and maintain process action plans to address***
19621 ***improvements to the organization's processes and related process***
19622 ***assets.*** [PA152.IG102.SP101]

19623

SP 2.2-1 Implement Process Action Plans

19624

Implement process action plans across the organization.

19625

[PA152.IG102.SP102]

19626

SP 2.3-1 Deploy Process and Related Process Assets

19627

Deploy the process and related process assets across the organization. *[PA152.IG102.SP103]*

19628

19629

SP 2.4-1 Incorporate Process-Related Experiences into the Organization's Process Assets

19630

19631

Incorporate process-related work products, measures, and improvement information derived from planning and performing the process into the organization's process assets. *[PA152.IG102.SP104]*

19632

19633

19634 ORGANIZATIONAL PROCESS DEFINITION

19635 Process Management
19636

19637 The purpose of Organizational Process Definition is to establish and
19638 maintain a usable set of organizational process assets. [PA153]

19639 Practices by Goal:

19640 **SG 1 Create Organizational Process Assets**

19641 ***A set of organizational process assets is available.*** [PA153.IG101]

19642 **SP 1.1-1 Establish Standard Processes**

19643 ***Establish and maintain the organization's set of standard***
19644 ***processes.*** [PA153.IG101.SP101]

19645 **SP 1.2-1 Establish Life-Cycle Model Descriptions**

19646 ***Establish and maintain descriptions of the life-cycle process***
19647 ***models approved for use in the organization.*** [PA153.IG101.SP102]

19648 **SP 1.3-1 Establish Tailoring Criteria and Guidelines**

19649 ***Establish and maintain the tailoring criteria and guidelines for the***
19650 ***organization's set of standard processes.*** [PA153.IG101.SP103]

19651 **SG 2 Make Supporting Process Assets Available**

19652 ***Process assets that support the use of the organization's set of standard***
19653 ***processes are available.*** [PA153.IG102]

19654 **SP 2.1-1 Establish an Organizational Measurement Repository**

19655 ***Establish and maintain an organizational measurement repository***
19656 ***[PA153.IG102.SP101]***

19657 **SP 2.2-1 Establish an Organizational Process Asset Library**

19658 ***Establish and maintain the organization's library of process-***
19659 ***related assets.*** [PA153.IG102.SP102]

19660 ORGANIZATIONAL TRAINING

19661 Process Management
19662

19663 The purpose of Organizational Training is to develop the skills and
19664 knowledge of people so they can perform their roles effectively and
19665 efficiently. [PA158]

19666 Practices by Goal:

19667 **SG 1 Identify Training Needs and Make Training Available**

19668 *Training to support the organization's management and technical roles is*
19669 *identified and made available.* [PA158.IG101]

19670 **SP 1.1-1 Establish the Strategic Training needs**

19671 *Establish and maintain the strategic training needs of the*
19672 *organization.* [PA158.IG101.SP101]

19673 **SP 1.2-1 Determine Which Training Needs Are the Responsibility of the Or-**
19674 **ganization**

19675 *Determine which training needs are the responsibility of the*
19676 *organization and which will be left to the individual project or*
19677 *support group.* [PA158.IG101.SP102]

19678 **SP 1.3-1 Establish Organizational Training Tactical Plan**

19679 *Establish and maintain an organizational training tactical plan.*
19680 [PA158.IG101.SP103]

19681 **SP 1.4-1 Establish Training Capability**

19682 *Establish and maintain training capability to address*
19683 *organizational training needs.* [PA158.IG101.SP104]

19684 **SG 2 Provide Necessary Training**

19685 *Training necessary for individuals to perform their roles effectively is*
19686 *provided.* [PA158.IG102]

19687

SP 2.1-1 Deliver Training

19688

Deliver the training following an organizational training plan.

19689

[PA158.IG102.SP101]

19690

SP 2.2-1 Establish Training Records

19691

Establish and maintain records of the organizational training.

19692

[PA158.IG102.SP102]

19693

SP 2.3-1 Assess Training Effectiveness

19694

Assess the effectiveness of the organization's training program.

19695

[PA158.IG102.SP103]

19696 ORGANIZATIONAL PROCESS PERFORMANCE

19697 Process Management

19698

19699 The purpose of Organizational Process Performance is to establish and
19700 maintain a quantitative understanding of the performance of the
19701 organization's set of standard processes, and to provide the process
19702 performance data, baselines, and models to quantitatively manage the
19703 organization's projects. [PA164]

19704 Practices by Goal:

19705 **SG 1 Establish Performance Baselines and Models**

19706 ***Baselines and models that characterize the expected process performance of***
19707 ***the organization's set of standard processes are established and maintained.***
19708 [PA164.IG101]

19709 **SP 1.1-1 Select Processes**

19710 ***Select the processes or process elements in the organization's set***
19711 ***of standard processes that are to be included in the organization's***
19712 ***process performance analyses.*** [PA164.IG101.SP101]

19713 **SP 1.2-1 Establish Process Performance Measures**

19714 ***Establish and maintain definitions of the measures that are to be***
19715 ***included in the organization's process performance analyses.***
19716 [PA164.IG101.SP102]

19717 **SP 1.3-1 Establish Quality and Process Performance Objectives**

19718 ***Establish and maintain quantitative objectives for quality and***
19719 ***process performance for the organization.*** [PA164.IG101.SP103]

19720 **SP 1.4-1 Establish Process Performance Baselines**

19721 ***Establish and maintain the organization's process performance***
19722 ***baselines.*** [PA164.IG101.SP104]

19723

SP 1.5-1 Establish Process Performance Models

19724

Establish and maintain the process performance models for the organization's set of standard processes. [PA164.IG101.SP105]

19725

19726 ORGANIZATIONAL INNOVATION AND DEPLOYMENT

19727 Process Management

19728

19729 The purpose of Organizational Innovation and Deployment is to select
19730 and deploy incremental and innovative improvements that measurably
19731 improve the organization's processes and technologies. The
19732 improvements support the organization's quality and process
19733 performance objectives as derived from the organization's business
19734 objectives. [PA161]

19735 Practices by Goal:

19736 **SG 1 Select Improvements**

19737 ***Process and technology improvements that contribute to meeting quality and***
19738 ***process performance objectives are selected.*** [PA161.IG101]

19739 **SP 1.1-1 Collect and Analyze Improvement Proposals**

19740 ***Collect and analyze process and technology improvement***
19741 ***proposals.*** [PA161.IG101.SP101]

19742 **SP 1.2-1 Identify Innovations**

19743 ***Identify innovative improvements that would increase the***
19744 ***organization's quality and process performance.*** [PA161.IG101.SP102]

19745 **SP 1.3-1 Pilot Improvements**

19746 ***Pilot process and technology improvements to select which ones***
19747 ***to implement.*** [PA161.IG101.SP103]

19748 **SP 1.4-1 Select Improvements for Deployment**

19749 ***Select process and technology improvement proposals for***
19750 ***deployment across the organization.*** [PA161.IG101.SP104]

19751 **SG 2 Deploy Improvements**

19752 ***Measurable improvements to the organization's processes and technologies***
19753 ***are continually and systematically deployed.*** [PA161.IG102]

19754 **SP 2.1-1 Plan the Deployment**

19755 *Establish and maintain the plans for deploying the selected*
19756 *process and technology improvements.* [PA161.IG102.SP101]

19757 **SP 2.2-1 Manage the Deployment**

19758 *Manage the deployment of the selected process and technology*
19759 *improvements.* [PA161.IG102.SP102]

19760 **SP 2.3-1 Measure Improvement Effects**

19761 *Measure the effects of the deployed process and technology*
19762 *improvements.* [PA161.IG102.SP103]

19763

PROJECT MANAGEMENT

19764 PROJECT PLANNING

19765 Project Management
19766

19767 The purpose of Project Planning is to establish and maintain plans that
19768 define project activities. [PA163]

19769 Practices by Goal:

19770 **SG 1 Establish Estimates**

19771 ***Estimates of project planning parameters are established and maintained.***
19772 [PA163.IG101]

19773 **SP 1.1-1 Estimate the Scope of the Project**

19774 ***Establish and maintain a top-level work breakdown structure***
19775 ***(WBS) to estimate of the scope of the project.*** [PA163.IG101.SP101]

19776 **SP 1.2-1 Establish Estimates of Project Attributes**

19777 ***Establish and document estimates of the attributes of the work***
19778 ***products and tasks.*** [PA163.IG101.SP102]

19779 **SP 1.3-1 Define Project Life Cycle**

19780 ***Define the project life-cycle phases upon which to scope the***
19781 ***planning effort.*** [PA163.IG101.SP103]

19782 **SP 1.4-1 Determine Estimates of Effort and Cost**

19783 ***Estimate the project effort and cost for the attributes of the work***
19784 ***products and tasks based on estimation rationale.*** [PA163.IG101.SP104]

19785 **SG 2 Develop a Project Plan**

19786 ***A project plan is established and maintained as the basis for managing the***
19787 ***project.*** [PA163.IG102]

19788	SP 2.1-1	Establish the Budget and Schedule
19789		<i>Establish and maintain the project's budget and schedule.</i>
19790		[PA163.IG102.SP101]
19791	SP 2.2-1	Identify Project Risks
19792		<i>Identify and analyze project risks.</i> [PA163.IG102.SP103]
19793	SP 2.3-1	Plan for Data Management
19794		<i>Plan for the management of project data.</i> [PA163.IG102.SP102]
19795	SP 2.4-1	Plan for Project Resources
19796		<i>Plan for necessary resources to perform the project.</i> [PA163.IG102.SP104]
19797	SP 2.5-1	Plan for Needed Knowledge and Skills
19798		<i>Plan for knowledge and skills needed to perform the project.</i>
19799		[PA163.IG102.SP105]
19800	SP 2.6-1	Plan Stakeholder Involvement
19801		<i>Plan the involvement with identified stakeholders.</i> [PA163.IG102.SP106]
19802	SP 2.7-1	Establish the Project Plan
19803		<i>Establish and maintain the overall project plan content.</i>
19804		[PA163.IG102.SP107]
19805	SG 3	Obtain Commitment to the Plan
19806		<i>Commitments to the project plan are established and maintained.</i> [PA163.IG103]
19807	SP 3.1-1	Review Subordinate Plans
19808		<i>Review subordinate plans to understand project commitments.</i>
19809		[PA163.IG103.SP103]

19810

SP 3.2-1 Reconcile Work and Resource Levels

19811

Reconcile the project plan to reflect available and projected resources. [PA163.IG103.SP101]

19812

19813

SP 3.3-1 Obtain Plan Commitment

19814

Obtain commitment from relevant stakeholders responsible for performing and supporting plan execution. [PA163.IG103.SP102]

19815

19816 PROJECT MONITORING AND CONTROL

19817 Project Management
19818

19819 The purpose of Project Monitoring and Control is to provide
19820 understanding into the project's progress so that appropriate corrective
19821 actions can be taken when the project's performance deviates
19822 significantly from the plan. [PA162]

19823 Practices by Goal:

19824 **SG 1 Monitor Project Against Plan**

19825 ***Actual performance and progress of the project is monitored against the***
19826 ***project plan.*** [PA162.IG101]

19827 **SP 1.1-1 Monitor Project Planning Parameters**

19828 ***Monitor the actual values of the project planning parameters***
19829 ***against the project plan.*** [PA162.IG101.SP101]

19830 **SP 1.2-1 Monitor Commitments**

19831 ***Monitor commitments against those identified in the project plan.***
19832 [PA162.IG101.SP102]

19833 **SP 1.3-1 Monitor Project Risks**

19834 ***Monitor risks against those identified in the project plan.***
19835 [PA162.IG101.SP103]

19836 **SP 1.4-1 Monitor Data Management**

19837 ***Monitor the management of project data.*** [PA162.IG101.SP106]

19838 **SP 1.5-1 Monitor Stakeholder Involvement**

19839 ***Monitor stakeholder involvement against the project plan.***
19840 [PA162.IG101.SP107]

19841 **SP 1.6-1 Conduct Progress Reviews**

19842 *Periodically review the project's progress, performance, and*
19843 *issues.* [PA162.IG101.SP104]

19844 **SP 1.7-1 Conduct Milestone Reviews**

19845 *Review the accomplishments and results of the project at selected*
19846 *project milestones.* [PA162.IG101.SP105]

19847 **SG 2 Manage Corrective Action to Closure**

19848 *Corrective actions are managed to closure when the project's performance or*
19849 *results deviate significantly from the plan.* [PA162.IG102]

19850 **SP 2.1-1 Analyze Issues**

19851 *Collect and analyze the issues and determine the corrective*
19852 *actions necessary to address the issues.* [PA162.IG102.SP101]

19853 **SP 2.2-1 Take Correction Action**

19854 *Take corrective action on identified issues.* [PA162.IG102.SP102]

19855 **SP 2.3-1 Manage Corrective Action**

19856 *Manage corrective actions to closure.* [PA162.IG102.SP103]

19857 SUPPLIER AGREEMENT MANAGEMENT

19858 Project Management
19859

19860 The purpose of Supplier Agreement Management is to manage the
19861 acquisition of products and services from suppliers external to the
19862 project for which there exists a formal agreement. [PA166]

19863 Practices by Goal:

19864 **SG 1 Establish Supplier Agreements**

19865 ***Agreements with the suppliers are established and maintained.*** [PA166.IG101]

19866 **SP 1.1-1 Analyze Needs and Requirements Determined by the Project**

19867 ***Analyze the project's needs and requirements that will be fulfilled***
19868 ***by sources outside the project to determine how the needs and***
19869 ***requirements will be satisfied.*** [PA166.IG101.SP101]

19870 **SP 1.2-1 Select Suppliers**

19871 ***Select suppliers based on an evaluation of their ability to meet the***
19872 ***specified requirements and established criteria.*** [PA166.IG101.SP102]

19873 **SP 1.3-1 Establish Supplier Agreements**

19874 ***Establish and maintain formal agreements with the supplier.***
19875 [PA166.IG101.SP103]

19876 **SG 2 Satisfy Supplier Agreements**

19877 ***Agreements with the suppliers are satisfied by both the project and the***
19878 ***supplier.*** [PA166.IG102]

19879 **SP 2.1-1 Acquire COTS Products**

19880 ***Acquire COTS products to satisfy the specified requirements that***
19881 ***are covered under a supplier agreement.*** [PA166.IG102.SP101]

19882 **SP 2.2-1 Execute the Supplier Agreement**

19883 *Perform activities with the supplier as specified in the supplier*
19884 *agreement.* [PA166.IG102.SP102]

19885 **SP 2.3-1 Conduct Acceptance Testing**

19886 *Ensure that the supplier agreement is satisfied before accepting*
19887 *the acquired product.* [PA166.IG102.SP103]

19888 **SP 2.4-1 Transition Products**

19889 *Transition the acquired products from the supplier to the project.*
19890 [PA166.IG102.SP104]

19891 INTEGRATED PROJECT MANAGEMENT (IPPD)

19892 Project Management
19893

19894 The purpose of Integrated Project Management (IPPD) is to establish
19895 and manage the project and the involvement of the relevant
19896 stakeholders according to an integrated and defined process that is
19897 tailored from the organization's set of standard processes. It also covers
19898 the establishment of a shared vision for the project and a team structure
19899 for integrated teams that will carry out the objectives of the project .
19900 [PA167]

19901 Practices by Goal:

19902 **SG 1 Use the Project's Defined Process**

19903 *The project is conducted using a defined process that is tailored from the*
19904 *organization's set of standard processes.* [PA167.IG101]

19905 **SP 1.1-1 Establish the Project's Defined Process**

19906 *Establish and maintain the project's defined process.* [PA167.IG101.SP101]

19907 **SP 1.2-1 Use Organizational Process Assets for Planning Project Activities**

19908 *Use the organization's process assets and measurement*
19909 *repository for estimating and planning the project's activities.*
19910 [PA167.IG101.SP102]

19911 **SP 1.3-1 Integrate Plans**

19912 *Integrate the project plan and the subordinate plans to describe*
19913 *the project's defined process.* [PA167.IG101.SP103]

19914 **SP 1.4-1 Manage the Project Using the Integrated Plans**

19915 *Manage the project using the project plan, the subordinate plans,*
19916 *and the project's defined process.* [PA167.IG101.SP104]

19917 **SP 1.5-1 Contribute to the Organization's Process Assets**

19918 *Contribute work products, measures, and documented*
19919 *experiences to the organization's process assets.* [PA167.IG101.SP105]

19920 **SG 2 Coordinate and Collaborate with Relevant Stakeholders**

19921 ***Coordination and collaboration of the project with relevant stakeholders is***
19922 ***conducted.*** [PA167.IG102]

19923 **SP 2.1-1 Manage Stakeholder Involvement**

19924 ***Manage the involvement of the relevant stakeholders in the***
19925 ***project.*** [PA167.IG102.SP101]

19926 **SP 2.2-1 Manage Dependencies**

19927 ***Participate with relevant stakeholders to identify, negotiate, and***
19928 ***track critical dependencies.*** [PA167.IG102.SP102]

19929 **SP 2.3-1 Resolve Coordination Issues**

19930 ***Resolve issues with relevant stakeholders.*** [PA167.IG102.SP103]

19931 **SG 3 Use the Project's Shared Vision**

19932 ***The project is conducted using the project's shared vision.*** [PA167.IG103]

19933 **SP 3.1-1 Define Project's Shared Vision Context**

19934 ***Identify expectations, constraints, interfaces, and operational***
19935 ***conditions applicable to the project's shared vision.*** [PA167.IG103.SP101]

19936 **SP 3.2-1 Establish the Project's Shared Vision**

19937 ***Establish and maintain a shared vision for the project.*** [PA167.IG103.SP102]

19938 **SG 4 Organize Integrated Teams**

19939 ***The integrated teams needed to execute the project are identified, defined,***
19940 ***structured, and tasked.*** [PA167.IG104]

19941 **SP 4.1-1 Determine Integrated Team Structure for the Project**

19942 ***Determine the integrated team structure that will best meet the***
19943 ***project objectives and constraints.*** [PA167.IG104.SP101]

19944

SP 4.2-1 Develop a Preliminary Distribution of Requirements to Integrated Teams

19945

19946

19947

19948

Develop a preliminary distribution of requirements, responsibilities, authorities, tasks, and interfaces to teams in the selected integrated team structure. [PA167.IG104.SP102]

19949

SP 4.3-1 Establish Integrated Teams

19950

19951

Establish and maintain teams in the integrated team structure.
[PA167.IG104.SP103]

19952 RISK MANAGEMENT

19953 Project Management

19954

19955 The purpose of Risk Management is to identify potential problems
19956 before they occur, so that risk-handling activities may be planned and
19957 invoked as needed across the life cycle to mitigate adverse impacts on
19958 achieving objectives. [PA148]

19959 Practices by Goal:

19960 **SG 1 Prepare for Risk Management**

19961 ***Preparation for risk management is conducted.*** [PA148.IG101]

19962 **SP 1.1-1 Determine Risk Sources and Categories**

19963 ***Determine risk sources and categories.*** [PA148.IG101.SP101]

19964 **SP 1.2-1 Define Risk Parameters**

19965 ***Define the parameters used to analyze and classify risks, and the***
19966 ***parameters used to control the risk management effort.***

19967 [PA148.IG101.SP102]

19968 **SP 1.3-1 Establish a Risk Management Strategy**

19969 ***Establish and maintain the strategy and methods to be used for***
19970 ***risk management.*** [PA148.IG101.SP103]

19971 **SG 2 Identify and Analyze Risks**

19972 ***Risks are identified and analyzed to determine their relative importance.***
19973 [PA148.IG102]

19974 **SP 2.1-1 Identify Risks**

19975 ***Identify and document the risks.*** [PA148.IG102.SP101]

19976	SP 2.2-1	Evaluate, Classify, and Prioritize Risks	
19977			<i>Evaluate and classify each identified risk using the defined risk categories and parameters, and determine its relative priority.</i>
19978			
19979			<small>[PA148.IG102.SP102]</small>
19980	SG 3	Mitigate Risks	
19981			<i>Risks are handled and mitigated, where appropriate, to reduce adverse impacts on achieving objectives.</i> <small>[PA148.IG103]</small>
19982			
19983	SP 3.1-1	Develop Risk Mitigation Plans	
19984			<i>Develop a risk mitigation plan for the most important risks to the project, as defined by the risk management strategy.</i> <small>[PA148.IG103.SP101]</small>
19985			
19986	SP 3.2-1	Implement Risk Mitigation Plans	
19987			<i>Monitor the status of each risk periodically and implement the risk mitigation plan as appropriate.</i> <small>[PA148.IG103.SP102]</small>
19988			

19989 INTEGRATED TEAMING

19990 Project Management
19991

19992 The purpose of Integrated Teaming is to form and sustain an integrated
19993 team for the development of work products. [PA170]

19994 Practices by Goal:

19995 **SG 1 Establish Team Composition**

19996 *Team composition that provides the knowledge and skills required to deliver*
19997 *the team's product is established and maintained.* [PA170.IG101]

19998 **SP 1.1-1 Identify Team Tasks**

19999 *Identify and define the team's specific internal tasks to generate*
20000 *the team's expected output.* [PA170.IG101.SP101]

20001 **SP 1.2-1 Identify Needed Knowledge and Skills**

20002 *Identify the knowledge, skills, and functional expertise needed to*
20003 *perform team tasks.* [PA170.IG101.SP102]

20004 **SP 1.3-1 Assign Appropriate Team Members**

20005 *Assign the appropriate personnel to be team members based on*
20006 *required knowledge and skills.* [PA170.IG101.SP103]

20007 **SG 2 Govern Team Operation**

20008 *Operation of the integrated team is governed according to established*
20009 *principles.* [PA170.IG102]

20010 **SP 2.1-1 Establish a Shared Vision**

20011 *Establish and maintain a shared vision for the integrated team that*
20012 *is aligned with any overarching or higher-level vision.*
20013 [PA170.IG102.SP101]

20014	SP 2.2-1	Establish a Team Charter
20015		<i>Establish and maintain a team charter based on the integrated</i>
20016		<i>team's shared vision and overall team objectives.</i> [PA170.IG102.SP102]
20017	SP 2.3-1	Define Roles and Responsibilities
20018		<i>Clearly define and maintain each team member's roles and</i>
20019		<i>responsibilities.</i> [PA170.IG102.SP103]
20020	SP 2.4-1	Establish Operating Procedures
20021		<i>Establish and maintain integrated team operating procedures.</i>
20022		[PA170.IG102.SP104]
20023	SP 2.5-1	Collaborate among Interfacing Teams
20024		<i>Establish and maintain collaboration among interfacing teams.</i>
20025		[PA170.IG102.SP105]

20026 QUANTITATIVE PROJECT MANAGEMENT

20027 Project Management
20028

20029 The purpose of the Quantitative Project Management process area is to
20030 quantitatively manage the project's defined process to achieve the
20031 project's established quality and process performance objectives. [PA165]

20032 Practices by Goal:

20033 **SG 1 Quantitatively Manage the Project**

20034 *The project is quantitatively managed using quality and process performance*
20035 *objectives.* [PA165.IG101]

20036 **SP 1.1-1 Establish the Project's Objectives**

20037 *Establish and maintain the project's quality and process*
20038 *performance objectives.* [PA165.IG101.SP101]

20039 **SP 1.2-1 Compose the Defined Process**

20040 *Select the processes and process elements that comprise the*
20041 *project's defined process based on historical stability and*
20042 *capability data.* [PA165.IG101.SP102]

20043 **SP 1.3-1 Select the Subprocesses to be Managed**

20044 *Select the subprocesses of the project's defined process that will*
20045 *be statistically managed* [PA165.IG101.SP103]

20046 **SP 1.4-1 Manage Project Performance**

20047 *Monitor the project to determine whether the project's objectives*
20048 *for quality and process performance will be satisfied, and take*
20049 *corrective action as appropriate.* [PA165.IG101.SP104]

20050 **SG 2 Statistically Manage Subprocess Performance**

20051 *The performance of selected subprocesses within the project's defined*
20052 *process is statistically managed.* [PA165.IG102]

20053	SP 2.1-1	Select Measures and Analytic Techniques
20054		<i>Select the measures and analytic techniques to be used in</i>
20055		<i>statistically managing the selected subprocesses.</i> [PA165.IG102.SP101]
20056	SP 2.2-1	Apply Statistical Methods to Understand Variation
20057		<i>Establish and maintain an understanding of the variance of the</i>
20058		<i>selected subprocesses using the selected measures and analytic</i>
20059		<i>techniques.</i> [PA165.IG102.SP102]
20060	SP 2.3-1	Monitor Performance of the Selected Subprocesses
20061		<i>Monitor the performance of the selected subprocesses to</i>
20062		<i>determine their capability to satisfy their quality and process</i>
20063		<i>performance objectives, and take corrective action as necessary.</i>
20064		[PA165.IG102.SP103]
20065	SP 2.4-1	Record Statistical Management Data
20066		<i>Record statistical and quality management data in the</i>
20067		<i>organization's measurement repository.</i> [PA165.IG102.SP104]

20068

ENGINEERING

20069 REQUIREMENTS MANAGEMENT

20070 Engineering
20071

20072 The purpose of Requirements Management is to manage the
20073 requirements of the project's products and product components and to
20074 identify inconsistencies between those requirements and the project's
20075 plans and work products. [PA146]

20076 Practices by Goal:

20077 **SG 1 Manage Requirements**

20078 ***Requirements are managed and inconsistencies with project plans and work***
20079 ***products are identified.*** [PA146.IG101]

20080 **SP 1.1-1 Obtain an Understanding of Requirements**

20081 ***Develop an understanding with the requirements providers on the***
20082 ***meaning of the requirements.*** [PA146.IG101.SP101]

20083 **SP 1.2-2 Obtain Commitment to Requirements**

20084 ***Obtain commitment to the requirements from the project***
20085 ***participants.*** [PA146.IG101.SP102]

20086 **SP 1.3-1 Manage Requirements Changes**

20087 ***Manage changes to the requirements as they evolve during the***
20088 ***project.*** [PA146.IG101.SP103]

20089 **SP 1.4-2 Maintain Bi-directional Traceability of Requirements**

20090 ***Maintain bi-directional traceability among the requirements and***
20091 ***the project plans and work products.*** [PA146.IG101.SP104]

20092 **SP 1.5-1 Identify Inconsistencies between Project Work and Requirements**

20093 ***Identify inconsistencies between the project plans and work***
20094 ***products and the requirements.*** [PA146.IG101.SP105]

20095 REQUIREMENTS DEVELOPMENT

20096 Engineering
20097

20098 The purpose of Requirements Development is to produce and analyze
20099 customer, product, and product component requirements. [PA157]

20100 Practices by Goal:

20101 **SG 1 Develop Customer Requirements**

20102 ***Stakeholder needs, expectations, constraints, and interfaces are collected and***
20103 ***translated into customer requirements.*** [PA157.IG101]

20104 **SP 1.1-1 Collect Stakeholder Needs**

20105 ***Identify and collect stakeholder needs, expectations, constraints,***
20106 ***and interfaces for all phases of the product's life cycle.***
20107 [PA157.IG101.SP101]

20108 In the staged representation, this specific practice is only included as informative
20109 material and appears after specific practice 1.1-2 Elicit Needs

20110 **SP 1.1-2 Elicit Needs**

20111 ***Elicit stakeholder needs, expectations, constraints, and interfaces***
20112 ***for all phases of the product's life cycle.*** [PA157.IG101.SP102]

20113 In the staged representation, this specific practice takes the place of specific
20114 practice: SP 1.1-1 Collect Stakeholder Needs.

20115 **SP 1.2-1 Transform Stakeholder Needs, Expectations, Constraints, and In-**
20116 ***terfaces into Customer Requirements***

20117 ***Transform stakeholder needs, expectations, constraints, and***
20118 ***interfaces into customer requirements.*** [PA157.IG101.SP103]

20119 **SG 2 Develop Product Requirements**

20120 ***Customer requirements are refined and elaborated to develop product and***
20121 ***product component requirements for the product life cycle.*** [PA157.IG103]

20122	SP 2.1-1	Establish Product and Product Component Requirements
20123		<i>Establish and maintain, from the customer requirements, product and product component requirements essential to product and product component effectiveness and affordability.</i> [PA157.IG103.SP101]
20124		
20125		
20126	SP 2.2-1	Allocate Product Component Requirements
20127		<i>Allocate the requirements for each product component.</i>
20128		[PA157.IG103.SP102]
20129	SP 2.3-1	Identify Interface Requirements
20130		<i>Identify interface requirements.</i> [PA157.IG103.SP103]
20131	SG 3	Analyze and Validate Requirements
20132		<i>The requirements are analyzed and validated, and a definition of required functionality is developed.</i> [PA157.IG102]
20133		
20134	SP 3.1-1	Establish Operational Concepts and Scenarios
20135		<i>Establish and maintain operational concepts and scenarios.</i>
20136		[PA157.IG102.SP101]
20137	SP 3.2-1	Establish a Definition of Required Functionality
20138		<i>Establish and maintain a definition of required functionality.</i>
20139		[PA157.IG102.SP102]
20140	SP 3.3-1	Analyze Requirements
20141		<i>Analyze derived requirements to ensure that they are necessary and sufficient.</i> [PA157.IG102.SP103]
20142		
20143	SP 3.4-3	Evaluate Product Cost, Schedule and Risk
20144		<i>Analyze requirements with the purpose of reducing the life-cycle cost, schedule and risk of product development.</i> [PA157.IG102.SP104]
20145		
20146	SP 3.5-1	Validate Requirements
20147		<i>Validate requirements to ensure the resulting product will perform appropriately in its intended use environment.</i> [PA157.IG102.SP105]
20148		

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20151

In the staged representation, this specific practice is only included as informative material and appears after specific practice 3.5-2 Validate Requirements with Comprehensive Methods

20152
20153
20154
20155

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. [PA157.IG102.SP106]

20156
20157

In the staged representation, this specific practice takes the place of specific practice: SP 3.5-1 Validate Requirements.

20158 TECHNICAL SOLUTION

20159 Engineering
20160

20161 The purpose of Technical Solution is to develop, design, and implement
20162 solutions to requirements. Solutions, designs and implementations
20163 encompass products, product components, and product related
20164 processes either singly or in combinations as appropriate. [PA160]

20165 Practices by Goal:

20166 **SG 1 Select Product Component Solutions**

20167 ***Product or product component solutions, including applicable product related***
20168 ***processes, are selected from alternative solutions.*** [PA160.IG101]

20169 **SP 1.1-1 Develop Alternative Solutions and Selection Criteria**

20170 ***Develop alternative solutions and establish selection criteria.***
20171 [PA160.IG101.SP101]

20172 In the staged representation, this specific practice is only included as informative
20173 material and appears after specific practice 1.1-2 Develop Detailed Alternative
20174 Solutions and Selection Criteria

20175 **SP 1.1-2 Develop Detailed Alternative Solutions and Selection Criteria**

20176 ***Develop detailed alternative solutions and selection criteria.***
20177 [PA160.IG101.SP102]

20178 In the staged representation, this specific practice takes the place of specific
20179 practice: SP 1.1-1 Develop Alternative Solutions and Selection Criteria.

20180 **SP 1.2-2 Evolve Operational Concepts and Scenarios**

20181 ***Evolve the operational concept, scenarios, and environments to***
20182 ***describe the conditions, operating modes, and operating states***
20183 ***specific to each product component.*** [PA160.IG101.SP103]

20184 **SP 1.3-1 Select Product Component Solutions**

20185 ***Select the product component solutions that best satisfy the***
20186 ***criteria established.*** [PA160.IG101.SP104]

20187 **SG 2** **Develop the Design**

20188 ***Product or product component designs are developed.*** [PA160.IG102]

20189 **SP 2.1-1** **Use Effective Design Methods**

20190 ***Establish and use effective design methods.*** [PA160.IG102.SP101]

20191 **SP 2.2-1** **Develop a Technical Data Package**

20192 ***Develop a product or product component technical data package.***
20193 [PA160.IG102.SP102]

20194 In the staged representation, this specific practice is only included as informative
20195 material and appears after specific practice 2.2-3 Establish a Complete Technical
20196 Data Package

20197 **SP 2.2-3** **Establish a Complete Technical Data Package**

20198 ***Establish and maintain a complete technical data package.***
20199 [PA160.IG102.SP103]

20200 In the staged representation, this specific practice takes the place of specific
20201 practice: SP 2.2-1 Develop a Technical Data Package.

20202 **SP 2.3-1** **Establish Interface Descriptions**

20203 ***Establish and maintain the solution for product component***
20204 ***interfaces.*** [PA160.IG102.SP104]

20205 In the staged representation, this specific practice is only included as informative
20206 material and appears after specific practice 2.3-3 Design Comprehensive
20207 Interface

20208 **SP 2.3-3** **Design Comprehensive Interface**

20209 ***Design product component interfaces in terms of established and***
20210 ***maintained criteria.*** [PA160.IG102.SP105]

20211 In the staged representation, this specific practice takes the place of specific
20212 practice: SP 2.3-1 Establish Interface Descriptions.

20213

SP 2.4-3 Perform Make, Buy, or Reuse Analyses

20214

Evaluate whether the product components should be developed, purchased, or reused based on established criteria. [PA160.IG102.SP106]

20215

20216

SG 3 Implement the Product Design

20217

Product components, and associated support documentation, are implemented from their designs. [PA160.IG103]

20218

20219

SP 3.1-1 Implement the Design

20220

Implement the designs of the product components. [PA160.IG103.SP101]

20221

SP 3.2-1 Establish Product Support Documentation

20222

Establish and maintain the end-use documentation. [PA160.IG103.SP102]

20223 PRODUCT INTEGRATION

20224 Engineering
20225

20226 The purpose of Product Integration is to assemble the product from the
20227 product components, ensure that the product, as integrated, functions
20228 properly, and deliver the product. [PA147]

20229 Practices by Goal:

20230 **SG 1 Prepare for Product Integration**

20231 ***The strategy for conducting product integration is established and***
20232 ***maintained.*** [PA147.IG101]

20233 **SP 1.1-1 Establish a Product Integration Strategy**

20234 ***Establish and maintain a strategy for integration of the product***
20235 ***components.*** [PA147.IG101.SP101]

20236 **SP 1.2-2 Establish the Product Integration Environment**

20237 ***Establish and maintain the environment needed to support the***
20238 ***integration of the product components.*** [PA147.IG101.SP102]

20239 **SP 1.3-3 Define Detailed Product Integration Procedures**

20240 ***Define detailed procedures and criteria for integration of the***
20241 ***product components.*** [PA147.IG101.SP103]

20242 **SG 2 Ensure Interface Compatibility**

20243 ***The product component interfaces, both internal and external, are compatible.***
20244 [PA147.IG102]

20245 **SP 2.1-1 Review Interface Descriptions for Completeness**

20246 ***Review interface descriptions for coverage and completeness.***
20247 [PA147.IG102.SP101]

20248	SP 2.2-1	Manage Interfaces
20249		<i>Manage internal and external interface definitions, designs, and changes for products and product components.</i> [PA147.IG102.SP102]
20250		
20251	SG 3	Assemble Product Components and Deliver the Product
20252		<i>Verified product components are assembled and the integrated, verified, and validated product is delivered.</i> [PA147.IG103]
20253		
20254	SP 3.1-1	Confirm Readiness of Product Components for Integration
20255		<i>Confirm, prior to assembly, that each product component required to assemble the product has been properly identified, functions according to its description, and that the product component interfaces comply with the interface descriptions.</i> [PA147.IG103.SP101]
20256		
20257		
20258		
20259	SP 3.2-1	Assemble Product Components
20260		<i>Assemble product components according to the product integration strategy.</i> [PA147.IG103.SP102]
20261		
20262	SP 3.3-1	Checkout Assembled Product Components
20263		<i>Checkout an assembly of product components.</i> [PA147.IG103.SP103]
20264	SP 3.4-1	Package and Deliver the Product or Product Component
20265		<i>Package the assembled product or product component and deliver it to the appropriate customer.</i> [PA147.IG103.SP104]
20266		

20267 VERIFICATION

20268 Engineering
20269

20270 The purpose of Verification is to assure that selected work products
20271 meet their specified requirements. [PA150]

20272 Practices by Goal:

20273 **SG 1 Prepare for Verification**

20274 ***Preparation for verification is conducted.*** [PA150.IG101]

20275 **SP 1.1-1 Establish a Verification Strategy**

20276 ***Establish and maintain a verification strategy for selected work***
20277 ***products.*** [PA150.IG101.SP101]

20278 **SP 1.2-2 Establish the Verification Environment**

20279 ***Establish and maintain the environment needed to support***
20280 ***verification.*** [PA150.IG101.SP102]

20281 **SP 1.3-3 Establish Detailed Verification Plans**

20282 ***Establish and maintain detailed verification plans for selected***
20283 ***work products.*** [PA150.IG101.SP103]

20284 **SG 2 Perform Peer Reviews**

20285 ***Peer reviews are performed on selected work products.*** [PA150.IG102]

20286 **SP 2.1-1 Prepare for Peer Reviews**

20287 ***Prepare for peer reviews of selected work products.*** [PA150.IG102.SP101]

20288 **SP 2.2-1 Conduct Peer Reviews**

20289 ***Conduct peer reviews on selected work products and identify***
20290 ***issues resulting from the peer review.*** [PA150.IG102.SP102]

20291	SP 2.3-2	Analyze Peer Review Data
20292		<i>Analyze data about preparation, conduct, and results of the peer</i>
20293		<i>reviews.</i> [PA150.IG102.SP103]
20294	SG 3	Verify Selected Work Products
20295		<i>Selected work products are verified against their specified requirements.</i>
20296		[PA150.IG103]
20297	SP 3.1-1	Perform Verification
20298		<i>Perform verification according to the verification strategy.</i>
20299		[PA150.IG103.SP101]
20300	SP 3.2-2	Analyze Verification Results and Identify Corrective Action
20301		<i>Analyze the results of all verification activities and identify</i>
20302		<i>corrective action.</i> [PA150.IG103.SP102]
20303	SP 3.3-1	Perform Re-Verification
20304		<i>Perform re-verification of corrected work products and ensure that</i>
20305		<i>work products have not been negatively impacted.</i> [PA150.IG103.SP103]

20306 VALIDATION

20307 Engineering
20308

20309 The purpose of Validation is to demonstrate that a product or product
20310 component fulfills its intended use when placed in its intended
20311 environment. [PA149]

20312 Practices by Goal:

20313 **SG 1 Prepare for Validation**

20314 *Preparation for validation is conducted.* [PA149.IG101]

20315 **SP 1.1-1 Establish a Validation Strategy**

20316 *Establish and maintain a validation strategy.* [PA149.IG101.SP101]

20317 **SP 1.2-2 Establish the Validation Environment**

20318 *Establish and maintain the environment needed to support*
20319 *validation.* [PA149.IG101.SP102]

20320 **SP 1.3-3 Define Detailed Validation Procedures**

20321 *Define detailed procedures and criteria for validation.* [PA149.IG101.SP103]

20322 **SG 2 Validate Product or Product Components**

20323 *The product or product components are validated to ensure that they are*
20324 *suitable for use in their intended operating environment.* [PA149.IG102]

20325 **SP 2.1-1 Perform Validation**

20326 *Perform validation according to the validation strategy.*
20327 [PA149.IG102.SP101]

20328 **SP 2.2-1 Capture and Analyze Validation Results**

20329 *Capture and analyze the results of the validation activities and*
20330 *identify issues.* [PA149.IG102.SP102]

20331

SUPPORT

20332 CONFIGURATION MANAGEMENT

20333 Support
20334

20335 The purpose of Configuration Management is to establish and maintain
20336 the integrity of work products using configuration identification,
20337 configuration control, configuration status accounting, and configuration
20338 audits. [PA159]

20339 Practices by Goal:

20340 **SG 1 Establish Baselines**

20341 ***Baselines of identified work products are established and maintained.*** [PA159.IG101]

20342 **SP 1.1-1 Identify Configuration Items**

20343 ***Identify the configuration items, components, and related work***
20344 ***products that will be placed under configuration management.***

20345 [PA159.IG101.SP101]

20346 **SP 1.2-1 Establish a Configuration Management System**

20347 ***Establish and maintain a configuration management and change***
20348 ***management system for controlling work products.*** [PA159.IG101.SP102]

20349 **SP 1.3-1 Create or Release Baselines**

20350 ***Create or release baselines for internal use and for delivery to the***
20351 ***customer.*** [PA159.IG101.SP103]

20352 **SG 2 Track and Control Changes**

20353 ***Changes to the work products under configuration management are tracked***
20354 ***and controlled.*** [PA159.IG102]

20355 **SP 2.1-1 Track Changes**

20356 ***Track change requests for the configuration items.*** [PA159.IG102.SP101]

20357 **SP 2.2-1 Control Changes**

20358 ***Control changes to the content of configuration items.*** [PA159.IG102.SP102]

20359 **SG 3 Establish Integrity**

20360 ***Integrity of baselines is established and maintained.*** [PA159.IG103]

20361 **SP 3.1-1 Establish Configuration Management Records**

20362 ***Establish and maintain records describing configuration items.***

20363 [PA159.IG103.SP101]

20364 **SP 3.2-1 Perform Configuration Audits**

20365 ***Perform configuration audits to maintain integrity of the***
20366 ***configuration baselines.*** [PA159.IG103.SP102]

20367 **PROCESS AND PRODUCT QUALITY ASSURANCE**

20368 **Support**
20369

20370 The purpose of Process and Product Quality Assurance is to provide
20371 staff and management with objective insight into the processes and
20372 associated work products. [PA145]

20373 **Practices by Goal:**

20374 **SG 1 Objectively Evaluate Processes and Work Products**

20375 ***Adherence of the performed process and associated work products and***
20376 ***services to applicable process descriptions, standards and procedures is***
20377 ***objectively evaluated.*** [PA145.IG101]

20378 **SP 1.1-1 Objectively Evaluate Processes**

20379 ***Objectively evaluate the designated performed processes against***
20380 ***the applicable process descriptions, standards and procedures.***
20381 [PA145.IG101.SP101]

20382 **SP 1.2-1 Objectively Evaluate Work Products and Services**

20383 ***Objectively evaluate the designated work products and services***
20384 ***against the applicable process descriptions, standards, and***
20385 ***procedures.*** [PA145.IG101.SP102]

20386 **SG 2 Provide Objective Insight**

20387 ***Noncompliance issues are objectively tracked and communicated, and***
20388 ***resolution is ensured.*** [PA145.IG102]

20389 **SP 2.1-1 Communicate and Ensure Resolution of Noncompliance Issues**

20390 ***Communicate quality issues and ensure resolution of***
20391 ***noncompliance issues with the staff and managers.*** [PA145.IG102.SP101]

20392 **SP 2.2-1 Establish Records**

20393 ***Establish and maintain records of the quality assurance activities.***
20394 [PA145.IG102.SP102]

20395 MEASUREMENT AND ANALYSIS

20396 Support
20397

20398 The purpose of Measurement and Analysis is to develop and sustain a
20399 measurement capability that is used to support management
20400 information needs. [PA154]

20401 Practices by Goal:

20402 **SG 1 Align Measurement and Analysis Activities**

20403 ***Measurement objectives and practices are aligned with identified information***
20404 ***needs and objectives.*** [PA154.IG101]

20405 **SP 1.1-1 Establish Measurement Objectives**

20406 ***Establish and maintain measurement objectives that are derived***
20407 ***from identified information needs and objectives.*** [PA154.IG101.SP101]

20408 **SP 1.2-1 Specify Measures**

20409 ***Specify measures to address the measurement objectives.***
20410 [PA154.IG101.SP102]

20411 **SP 1.3-1 Specify Data Collection and Storage Procedures**

20412 ***Specify how measurement data will be obtained and stored.***
20413 [PA154.IG101.SP103]

20414 **SP 1.4-1 Specify Analysis Procedures**

20415 ***Specify how measurement data will be analyzed and reported.***
20416 [PA154.IG101.SP104]

20417 **SG 2 Provide Measurement Results**

20418 ***Measurement results that address identified information needs and objectives***
20419 ***are provided.*** [PA154.IG102]

20420	SP 2.1-1	Collect Measurement Data
20421		<i>Obtain specified measurement data.</i> [PA154.IG102.SP101]
20422	SP 2.2-1	Analyze Measurement Data
20423		<i>Analyze and interpret measurement data.</i> [PA154.IG102.SP102]
20424	SP 2.3-1	Store Data and Results
20425		<i>Manage and store measurement data, measurement specifications, and analysis results.</i> [PA154.IG102.SP103]
20426		
20427	SP 2.4-1	Communicate Results
20428		<i>Report results of measurement and analysis activities to all affected stakeholders.</i> [PA154.IG102.SP104]
20429		

20430 DECISION ANALYSIS AND RESOLUTION

20431 Support
20432

20433 The purpose of Decision Analysis and Resolution is to make decisions
20434 using a structured approach that evaluates identified alternatives
20435 against established criteria. [PA156]

20436 Practices by Goal:

20437 **SG 1 Evaluate Alternatives**

20438 ***Decisions are based on an evaluation of alternatives using established***
20439 ***criteria.*** [PA156.IG101]

20440 **SP 1.1-1 Establish and Use Guidelines for Decision Analysis**

20441 ***Establish and use guidelines to determine which issues are***
20442 ***subject to a structured decision analysis and resolution process.***
20443 [PA156.IG101.SP101]

20444 **SP 1.2-1 Select Decision-Making Techniques**

20445 ***Select the decision-making techniques.*** [PA156.IG101.SP102]

20446 **SP 1.3-1 Establish Evaluation Criteria**

20447 ***Establish the evaluation criteria and their relative ranking.***
20448 [PA156.IG101.SP103]

20449 **SP 1.4-1 Identify Alternative Solutions**

20450 ***Identify alternative solutions to issues.*** [PA156.IG101.SP104]

20451 **SP 1.5-1 Evaluate Alternatives**

20452 ***Evaluate alternative solutions using the documented criteria.***
20453 [PA156.IG101.SP105]

20454

SP 1.6-1 Select Solutions

20455

Select solutions from the alternatives based on the evaluation criteria. [PA156.IG101.SP106]

20456

20457 ORGANIZATIONAL ENVIRONMENT FOR INTEGRATION

20458 Support
20459

20460 The purpose of Organizational Environment for Integration is to provide
20461 an IPPD infrastructure and manage people for integration. [PA169]

20462 Practices by Goal:

20463 **SG 1 Provide IPPD Infrastructure**

20464 ***An infrastructure that maximizes the productivity of people and effects the***
20465 ***collaboration necessary for integration is provided.*** [PA169.IG101]

20466 **SP 1.1-1 Establish the Organization's Shared Vision**

20467 ***Establish and maintain a shared vision for the organization.***
20468 [PA169.IG101.SP101]

20469 **SP 1.2-1 Establish an Integrated Work Environment**

20470 ***Establish and maintain an integrated work environment that***
20471 ***supports IPPD by enabling collaboration and concurrent***
20472 ***development.*** [PA169.IG101.SP102]

20473 **SP 1.3-1 Identify IPPD-Unique Skill Requirements**

20474 ***Identify the unique skills needed to support the IPPD environment.***
20475 [PA169.IG101.SP103]

20476 **SG 2 Manage People for Integration**

20477 ***People are managed to nurture the integrative and collaborative behaviors of***
20478 ***an IPPD environment.*** [PA169.IG102]

20479 **SP 2.1-1 Establish Leadership Mechanisms**

20480 ***Establish and maintain leadership mechanisms to enable timely***
20481 ***collaboration.*** [PA169.IG102.SP101]

20482 **SP 2.2-1 Establish Incentives for Integration**

20483 *Establish and maintain incentives for adopting and demonstrating*
20484 *integrative and collaborative behaviors at all levels of the*
20485 *organization.* [PA169.IG102.SP102]

20486 **SP 2.3-1 Establish Mechanisms to Balance Team and Home Organization**
20487 **Responsibilities**

20488 *Establish and maintain organizational guidelines to balance team*
20489 *and home organization responsibilities.* [PA169.IG102.SP103]

20490 CAUSAL ANALYSIS AND RESOLUTION

20491 Support
20492

20493 The purpose of Causal Analysis and Resolution is to identify causes of
20494 defects and other problems and take action to prevent them from
20495 occurring in the future. [PA155]

20496 Practices by Goal:

20497 **SG 1 Determine Causes of Defects**

20498 ***Root causes of defects and other problems are systematically determined.***
20499 [PA155.IG101]

20500 **SP 1.1-1 Select Defect Data for Analysis**

20501 ***Select the defects and other problems for analysis.*** [PA155.IG101.SP101]

20502 **SP 1.2-1 Analyze Causes**

20503 ***Perform causal analysis of selected defects and other problems***
20504 ***and propose actions to address them.*** [PA155.IG101.SP102]

20505 **SG 2 Address Causes of Defects**

20506 ***Root causes of defects and other problems are systematically addressed to***
20507 ***prevent their future occurrence.*** [PA155.IG102]

20508 **SP 2.1-1 Implement the Action Proposals**

20509 ***Implement the selected action proposals that were developed in***
20510 ***causal analysis.*** [PA155.IG102.SP101]

20511 **SP 2.2-1 Evaluate the Effect of Changes**

20512 ***Evaluate the effect of changes on process performance.***
20513 [PA155.IG102.SP102]

20514

SP 2.3-1 Record Data

20515

Record causal analysis and resolution data for use across the project and organization. [PA155.IG102.SP103]

20516

20517 **GENERIC GOALS AND GENERIC PRACTICES**

20518 **GG 1 Achieve Specific Goals**

20519 *The process supports and enables achievement of the specific goals of the*
20520 *process area by transforming identifiable input work products to produce*
20521 *identifiable output work products.*

20522 **GP 1.1 Identify Work Scope**

20523 *Identify the scope of the work to be performed and work products*
20524 *or services to be produced, and communicate this information to*
20525 *those performing the work. [GP101]*

20526 **GP 1.2 Perform Base Practices**

20527 *Perform the base practices of the process to develop work*
20528 *products and provide services to achieve the specific goals of the*
20529 *process area. [GP102]*

20530 **GG 2 Institutionalize a Managed Process**

20531 *The process is institutionalized as a managed process.*

20532 **GP 2.1 Establish an Organizational Policy**

20533 *Establish and maintain an organizational policy for planning and*
20534 *performing the process [GP103]*

20535 **GP 2.2 Plan the Process**

20536 *Establish and maintain the requirements and objectives, and plan*
20537 *for performing the process. [GP104]*

20538 **GP 2.3 Provide Resources**

20539 *Provide adequate resources for performing the process,*
20540 *developing the work products, and providing the services of the*
20541 *process. [GP105]*

20542 **GP 2.4 Assign Responsibility**
20543 *Assign responsibility and authority for performing the process,*
20544 *developing the work products, and providing the services of the*
20545 *process* [GP106]

20546 **GP 2.5 Train People**
20547 *Train the people performing or supporting the process as needed.*
20548 [GP107]

20549 **GP 2.6 Manage Configurations**
20550 *Place designated work products of the process under appropriate*
20551 *levels of configuration management.* [GP109]

20552 **GP 2.7 Identify and Involve Relevant Stakeholders**
20553 *Identify and involve the relevant stakeholders as planned.* [GP124]

20554 **GP 2.8 Monitor and Control the Process**
20555 *Monitor and control the process against the plan and take*
20556 *appropriate corrective action.* [GP110]

20557 **GP 2.9 Objectively Evaluate Adherence**
20558 *Objectively evaluate adherence of the process and the work*
20559 *products and services of the process to the applicable*
20560 *requirements, objectives, and standards, and address*
20561 *noncompliance.* [GP113]

20562 **GP 2.10 Review Status with Higher-Level Management**
20563 *Review the activities, status, and results of the process with*
20564 *higher-level management and resolve issues.* [GP112]

20565 **GG 3 Institutionalize a Defined Process**
20566 *The process is institutionalized as a defined process.*

20567 **GP 3.1 Establish a Defined Process**
20568 *Establish and maintain the description of a defined process.* [GP114]

20569	GP 3.2	Collect Improvement Information	
20570			<i>Collect work products, measures, measurement results, and improvement information derived from planning and performing the process to support the future use and improvement of the organization's processes and process assets. [GP117]</i>
20571			
20572			
20573			
20574	GG 4	Institutionalize a Quantitatively Managed Process	
20575			<i>The process is institutionalized as a quantitatively managed process.</i>
20576	GP 4.1	Establish Quality Objectives	
20577			<i>Establish and maintain quantitative objectives for the process about quality and process performance based on customer needs and business objectives. [GP118]</i>
20578			
20579			
20580	GP 4.2	Stabilize Subprocess Performance	
20581			<i>Stabilize the performance of one or more subprocesses of the process to determine its ability to achieve the established quantitative quality and process performance objectives. [GP119]</i>
20582			
20583			
20584	GG 5	Institutionalize an Optimizing Process	
20585			<i>The process is institutionalized as an optimizing process.</i>
20586	GP 5.1	Ensure Continuous Process Improvement	
20587			<i>Ensure continuous improvement of the process in fulfilling the relevant business goals of the organization. [GP125]</i>
20588			
20589	GP 5.2	Correct Common Cause of Problems	
20590			<i>Identify and correct the root causes of defects and other problems in the process. [GP121]</i>
20591			

20592

E. CMMI Project Participants

20593

20594

20595

The following people were involved in the CMMI project as product development team members, steering group members, or members of the stakeholder/reviewer team. [FM116.T101]

20596

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20597

[FM116.T102]

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F. Equivalent Staging

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20602
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Equivalent staging is a target staging that is defined so that the results of the target staging can be equivalent to the maturity levels of the staged representation. Such staging permits benchmarking of progress between organizations, enterprises, and projects, regardless of the CMMI representation used. [FM115.T101]

20606
20607
20608

Table 2 shows the target profiles that must be achieved when using the continuous representation in order to be equivalent to a maturity level when using a staged representation. [FM115.T102]

20609

The columns of the figure have the following meanings: [FM115.T103]

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20611
20612
20613
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- “Category” is the category to which the process area is assigned.
- “Name” is the full name of the process area.
- “ML” is the maturity level assignment of the process area in the staged representation.
- “CL1,” “CL2,” “CL3,” “CL4,” “CL5” are headings for the columns assigned to capability levels in the continuous representation.

20616
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The shaded areas in the capability level columns indicate target profiles that are equivalent to maturity levels in the staged representation.

[FM115.T104]

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- To achieve Target Profile 2, the first 7 process areas (Requirements Management to Configuration Management) must have satisfied Capability Levels 1 and 2.
- To achieve Target Profile 3, the first 18 process areas (Requirements Management to Organizational Training) must have satisfied capability levels 1, 2, and 3.
- To achieve Target Profile 4, the first 20 process areas (Requirements Management to Quantitative Project Management) must have satisfied Capability Levels 1, 2, and 3.
- To achieve Target Profile 5, all of the process areas must have satisfied Capability Levels 1, 2, and 3.

Name	Abbr	ML	CL1	CL2	CL3	CL4	CL5
Requirements Management	REQM	2	Target Profile 2				
Measurement and Analysis	MA	2					
Project Monitoring and Control	PMC	2					
Project Planning	PP	2					
Process and Product Quality Assurance	PPQA	2					
Supplier Agreement Management	SAM	2					
Configuration Management	CM	2					
Decision Analysis and Resolution	DAR	3	Target Profile 3				
Product Integration	PI	3					
Requirements Development	RD	3					
Technical Solution	TS	3					
Validation	VAL	3					
Verification	VER	3					
Organizational Process Definition	OPD	3					
Organizational Process Focus	OPF	3					
Integrated Project Management (IPPD)	IPM	3					
Risk Management	RSKM	3					
Organizational Training	OT	3					
Integrated Teaming	IT	3					
Organizational Environment for Integration	OEI	3					
Organizational Process Performance	OPP	4	Target Profile 4				
Quantitative Project Management	QPM	4					
Organizational Innovation and Deployment	OID	5	Target Profile 5				
Causal Analysis and Resolution	CAR	5					

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Table 2: Target Profiles and Equivalent Staging [FM115.T109]

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To reach Maturity Levels 4 and 5, specific process areas are required to attain Capability Levels 4 and 5. The Maturity Level 4 process areas operate on the selection of the organization's subprocesses to be stabilized and quantitatively understood, based on the business objectives of the organization. [FM115.T106]

20637 Users of the continuous representation may wish to extend their
20638 capability level target profiles for individual process areas above
20639 Capability Level 3. This extension is assessable if a valid mapping of
20640 subprocesses to process areas has been constructed, so that you can
20641 tell whether a process area has been placed under quantitative
20642 management. [FM115.T107]

20643 Some past users of continuous models have found it beneficial to being
20644 with the engineering process areas. The correlation of these process
20645 areas with Maturity Level 3 is due to equivalence with the staged
20646 maturity levels and is not intended to preclude earlier application.
20647 [FM115.T108]