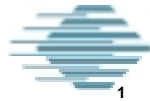




Carnegie Mellon Software Engineering Institute

Pittsburgh, PA 15213-3890

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, Staged Representation (CMMI-SE/SW/IPPD, V1.1, Staged)* (CMU/SEI-2002-TR-004, <http://www.sei.cmu.edu/publications/documents/02.reports/02tr004.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

Staged Representation

CMU/SEI-2000-TR-030

ESC-TR-2000-095

CMMI Product Development Team

November 2000

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38
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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]

91 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]

430

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]

436

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]

- 439 • Allow you to select the order of improvement that best meets the
440 organization's business objectives and mitigates the organization's
441 areas of risk
- 442 • Enable comparisons across and among organizations on a process
443 area by process area basis or by comparing maturity levels through
444 the use of equivalent staging
- 445 • Provide an easy migration from EIA/IS 731 to CMMI
- 446 • Afford an easy comparison of process improvement to ISO/IEC
447 15504 because the organization of process areas is derived from
448 ISO/IEC 15504

449 **Staged Representation**

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

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

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

464 [FM108.HDA101.HDB103.T102]

465 **Disciplines and Environments: Which to Choose?**

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

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

- 480 • Two additional process areas
- 481 • A number of amplifications throughout the process areas
- 482 • A revised Integrated Project Management (IPPD) process area
- 483 • A new definition in the glossary
- 484 • Two new entries in the acronym list
- 485 • A revised equivalent staging graphic (in the continuous
- 486 representation)
- 487 • Some new and revised material in the Overview section of the
- 488 model

489 **Systems Engineering**

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

495 **Software Engineering**

496 The software engineering discipline covers the development of software
497 systems. Software engineers focus on applying systematic, disciplined,
498 and quantifiable approaches to the development, operation, and
499 maintenance of software. [FM108.HDA101.HDB106.T101]

500 **Integrated Product and Process Development**

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

508 IPPD is not a separate discipline, but an approach and an environment
509 in which a project or organization performs the CMMI-SE/SW/IPPD
510 processes. The IPPD processes are integrated with the processes in
511 the CMMI-SE/SW model. The IPPD process areas, specific goals, and
512 specific practices alone cannot achieve IPPD. If a project or
513 organization chooses IPPD, it performs the IPPD practices concurrently
514 with the systems engineering and/or software engineering practices.
515 That is, if an organization or project wishes to use the IPPD
516 environment, it chooses the CMMI-SE/SW/IPPD model.⁵
517 [FM108.HDA101.HDB107.T102]

518 About CMMI Models

519 A process is a leverage point for an organization's sustained
520 improvement. The purpose of CMM Integration is to provide guidance
521 for improving your organization's processes and your ability to manage
522 the development, acquisition, and maintenance of products or services.
523 CMM Integration places proven practices into a structure that helps
524 your organization assess its organizational maturity or process area
525 capability, establish priorities for improvement, and implement these
526 improvements. [FM108.HDA102.T101]

527 Your organization can use a CMMI model to help set process
528 improvement objectives and priorities, improve processes, and provide
529 guidance for ensuring stable, capable, and mature processes. CMM
530 Integration can serve as a guide for organizational self-improvement.
531 [FM108.HDA102.T102]

532 The CMMI Product Suite contains and is produced from a framework
533 that provides the ability to generate multiple models and associated
534 training and assessment materials. These models may represent
535 software and systems engineering, integrated product and process
536 development, newly identified disciplines, or combinations of
537 disciplines. [FM108.HDA102.T103]

538 Professional judgment should be used by your organization to interpret
539 CMMI practices. Although process areas depict behavior that should be
540 exhibited in any organization, practices must be interpreted using an in-
541 depth knowledge of the CMMI model, the organization, the business
542 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/>.

543 The Content of CMMI Models

544 CMMI models with a staged representation consist of seven chapters
545 and five appendices: [FM108.HDA103.T101]

- 546 • Chapter 1: The Introduction chapter (this chapter) offers a broad
547 view of the model, suggestions on where to look for other
548 information not included in this volume, and the typographical
549 conventions used throughout the model.
- 550 • Chapter 2: The Structure of the Model chapter describes the
551 components of the model, including maturity levels, goals, and
552 practices.
- 553 • Chapter 3: The Model Terminology chapter describes the
554 approach taken to using terms in the model as well as how terms
555 were selected and defined in the glossary.
- 556 • Chapter 4: The Maturity Levels, Common Features, and Generic
557 Practices chapter describes the maturity levels, generic goals, and
558 generic practices, which ensure that the implementation of process
559 areas is effective, repeatable, and lasting.
- 560 • Chapter 5: The Understanding the Model chapter provides insight
561 into the meaning of the model for your organization.
- 562 • Chapter 6: The Using the Model chapter explains the ways in
563 which your organization can use the model.
- 564 • Chapter 7: The Process Areas chapter contains descriptions of the
565 required, expected, and informative components of the model,
566 including goals, practices, subpractices, and typical work products.

567 The Appendices are as follows: [FM108.HDA103.T104]

- 568 • Appendix A: The References appendix contain information you
569 can use to locate the documented sources, such as reports,
570 process improvement models, industry standards, and books, that
571 were used to create the content of the CMMI Product Suite.
- 572 • Appendix B: The Acronym List appendix defines acronyms used in
573 the CMMI models.
- 574 • Appendix C: The Glossary appendix defines terms used in the
575 CMMI Product Suite that are not adequately defined in the context
576 of this model by the Webster's American English dictionary.
- 577 • Appendix D: The Required and Expected Model Components
578 appendix contains the required and expected components for each
579 of the process areas. No informative material is given other than
580 the process area purpose, titles, and component names. This view
581 of the model is convenient when you want to quickly understand
582 the content and flow of large portions of the model or are intimately
583 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.

587

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. [FM108.HDA104.T101]

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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]

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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]

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Specific and Generic Goals

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

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SG 1. Establish Estimates

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

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Specific and Generic Practices

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All specific practice names within the process areas appear in bold and the practice statements appear in bold italics within a gray box indicating that it is the statement that you use for process improvement and assessments, not the name. The name is only used for easy reference. Here is an example: [FM108.HDA105.HDB102.T102]

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SP 2.1 Select Suppliers

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

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References

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

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640

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

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Introductory Notes, Typical Work Products, and Subpractices

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

644 **Generic Practice Elaborations**

645 Within the common features⁶ of every process area, the generic
646 practice names and statements (in bold and bold italics respectively)
647 appear for the generic practices that apply to the process area. After
648 each generic practice statement, an elaboration may appear in plain
649 text with the heading “Elaboration.” The elaboration provides
650 information about how the generic practice should be interpreted for the
651 process area. If there is no elaboration present, it is because we
652 judged the application of the generic practice to be obvious without it.

653 [FM108.HDA105.HDB105.T101]

654 **Discipline Amplifications**

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

661 **Numbering Scheme**

662 In the staged representation, we numbered specific goals so that they
663 correspond to the specific goals in the staged. Each specific goal has a
664 number beginning with SG, for example, SG1. [FM108.HDA105.HDB107.T101]

665 Specific practices are numbered so that you can identify to which goal
666 the practice is mapped and its sequence number. For example, in the
667 Requirements Management process area, the first practice is numbered
668 SP1.1 and the second is SP1.2. (In the continuous representation, each
669 practice number also indicates the capability level [for example, SP1.1-
670 1 indicates a practice at capability level one].) [FM108.HDA105.HDB107.T103]

671 The generic goals are numbered the same as the specific goals;
672 however, since this numbering scheme ensures that goals and
673 practices in the two representations have the same numbers, the
674 generic goals will either begin with GG2 or GG3 in the staged
675 representation. [FM108.HDA105.HDB107.T108]

676 The generic practices have both the numbering described above for
677 specific practices and a second number that indicates the common
678 feature group to which it belongs and the sequence number within the
679 common feature. For example, the first generic practice associated with
680 GG2 is numbered GP2.1 and CO 1. The GP 2.1 number corresponds to
681 the generic practice number used in the continuous representation. The
682 CO 1 number indicates that the generic practice is the first practice
683 organized under the Commitment to Perform common feature.

684 [FM108.HDA105.HDB107.T109]

⁶ Common features are model components that group generic goals and practices into categories.

685

Refer to the Structure of the Model chapter for more information about common features. [FM108.HDA105.HDB107.T110]

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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.

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[FM108.HDA105.HDB107.T111]

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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.

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[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 staged 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.T102]

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The staged representation organizes process areas into maturity levels to support and guide process improvement. Within each process area, the specific goals and specific practices are listed first followed by the generic goals and generic practices. The staged representation uses four common features to organize the generic practices in the process areas. [FM103.T104]

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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 staged representation. [FM103.T106]

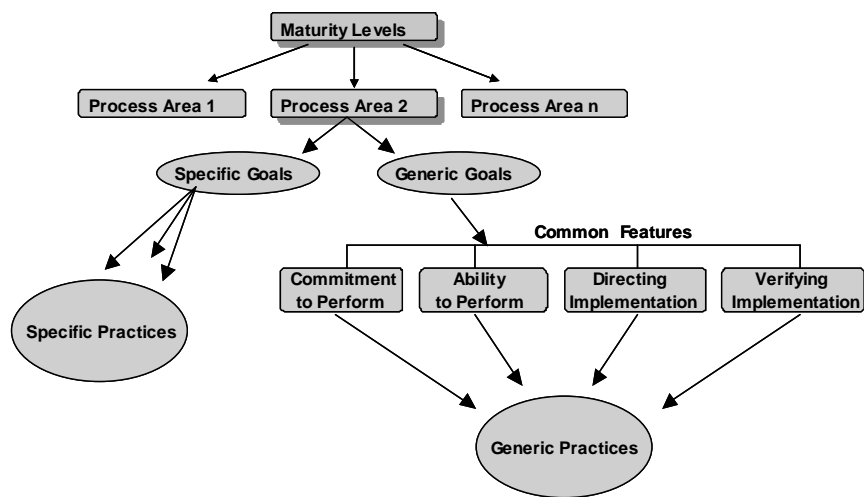
714 Structural Overview

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A CMMI model with a staged representation is illustrated in Figure 1.

[FM103.HDA101.T102]



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718

Figure 1: CMMI Model Components [FM103.HDA101.T104]

719 CMMI models are designed to describe discrete levels of process
720 improvement. In the staged representation, maturity levels provide a
721 recommended order for approaching process improvement in stages so
722 that not all process areas are addressed at the same time. As illustrated
723 in Figure 1, maturity levels organize the process areas. Within the
724 process areas are generic and specific goals as well as generic and
725 specific practices. Generic practices are organized by common
726 features. [FM103.HDA101.T106]

727 **Maturity Levels**

728 The maturity level of an organization provides a way to predict the
729 future performance of an organization within a given discipline or set of
730 disciplines. Experience has shown that organizations do their best when
731 they focus on a manageable number of process areas that require
732 increasingly sophisticated effort as the organization improves.

733 [FM103.HDA101.HDB101.T101]

734 A maturity level is a defined evolutionary plateau of process
735 improvement. Each maturity level stabilizes an important part of the
736 organization's processes. Achieving each maturity level results in an
737 increase in the process capability of the organization.

738 [FM103.HDA101.HDB101.T102]

739 There are five maturity levels, each a layer in the foundation for ongoing
740 process improvement, designated by the numbers 1 through 5:

741 [FM103.HDA101.HDB101.T103]

- 742 • Initial
- 743 • Managed
- 744 • Defined
- 745 • Quantitatively Managed
- 746 • Optimizing

747 Maturity levels are measured by the achievement of the specific and
748 generic goals that apply to a predefined set of process areas. The
749 characteristics of these levels are described in the Maturity Levels,
750 Common Features, and Generic Practices chapter. [FM103.HDA101.HDB101.T105]

751 Since organizational maturity describes the range of expected results
752 that can be achieved by an organization, it is one means of predicting
753 the most likely outcomes from the next project the organization
754 undertakes. For instance, at maturity level 2, the organization has been
755 elevated from ad hoc to disciplined by establishing sound project
756 management controls. As your organization achieves the generic and
757 specific goals for a the set of process areas in a maturity level, you are
758 increasing your organization's process maturity and reaping the benefits
759 of process improvement. [FM103.HDA101.HDB101.T107]

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Skipping Maturity Levels

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The staged representation identifies the maturity levels through which an organization should evolve to establish a culture of excellence.

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Because each maturity level forms a necessary foundation on which to build the next level, trying to skip maturity levels is usually

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counterproductive. [FM103.HDA101.HDB102.T101]

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At the same time, you must recognize that process improvement efforts should focus on the needs of the organization in the context of its

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business environment and that higher-level practices may address the current needs of an organization or project. For example, organizations

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seeking to move from maturity level 1 to maturity level 2 are frequently told to establish an engineering process group, which is an attribute of

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maturity level 3 organizations. While this group is not a necessary

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characteristic of a maturity level 2 organization, it can be a useful part of the organization's strategy for achieving maturity level 2.

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[FM103.HDA101.HDB102.T102]

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Organizations can institute specific process improvements at any time they choose, even before they are prepared to advance to the maturity

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level at which the specific practice is recommended. However,

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organizations should understand that the stability of these

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improvements is at a greater risk since the foundation for their

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successful institutionalization⁷ has not been completed. Processes

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without the proper foundation may fail at the very point they are needed

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most - under stress. [FM103.HDA101.HDB102.T103]

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A defined process that is characteristic of a maturity level 3 organization can be placed at great risk if maturity level 2 management practices are

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deficient. For example, management may make a poorly planned

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schedule commitment or fail to control changes to the baselined

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requirements. Similarly, many organizations collect the detailed data

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characteristics of maturity level 4, only to find that the data are

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uninterpretable because of inconsistency in product development

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processes and measurement definitions. [FM103.HDA101.HDB102.T105]

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This situation is sometimes characterized as "establishing a maturity

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level 1 engineering process group to bootstrap the maturity level 1

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organization to maturity level 2." Maturity level 1 process improvement

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activities may depend primarily on the insight and competence of the

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engineering process group staff until an infrastructure to support more

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disciplined and widespread improvement is in place. [FM103.HDA101.HDB102.T106]

⁷ 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.

798 Another example of using processes from higher maturity level process
799 areas is in the process of building products. Certainly, we would expect
800 maturity level 1 organizations to perform requirements analysis, design,
801 build, and verification. However, these activities are not described until
802 maturity level 3 where they are described as coherent, well-integrated
803 engineering processes. [FM103.HDA101.HDB102.T107]

804 Such variations in implementing process improvement practices are
805 artifacts for the way process areas are defined. A process area in the
806 staged representation describes a fully implemented and
807 institutionalized process—one that has been mastered by the
808 organization. A maturity level 1 organization could implement almost
809 any process described in this model, although perhaps in an incomplete
810 or ad hoc fashion. [FM103.HDA101.HDB102.T108]

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.⁸ [FM103.HDA101.HDB103.T102]

851 Model Components

852 Process Areas

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

858 The process areas at maturity level 2 include the following:

859 [FM103.HDA102.HDB101.T102]

- 860 • Requirements Management manages the requirements of the
 861 project's product and product components and identifies
 862 inconsistencies between the project's plans and work products and
 863 the requirements.
- 864 • Project Planning establishes and maintains plans that define
 865 project activities.
- 866 • Project Monitoring and Control provides understanding into the
 867 project's progress so that appropriate corrective actions can be
 868 taken when the project's performance deviates significantly from
 869 the plan.
- 870 • Supplier Agreement Management manages the acquisition of
 871 products and services from suppliers external to the project for
 872 which there exists a formal agreement.
- 873 • Measurement and Analysis develops and sustains a measurement
 874 capability that is used to support management information needs.
- 875 • Process and Product Quality Assurance provides staff and
 876 management with objective insight into the processes and
 877 associated work products.
- 878 • Configuration Management establishes and maintains the integrity
 879 of work products using configuration identification, configuration
 880 control, configuration status accounting, and configuration audits.

⁸ For additional information about alternative practices, see the Model Terminology section.

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The process areas at maturity level 3 include: [FM103.HDA102.HDB101.T104]

- Requirements Development produces customer, product, and product component requirements and analyses required for their development and understanding.
- Technical Solution develops, designs, and implements solutions to requirements. Solutions, designs and implementations encompass products, product components, and product related processes either singly or in combinations as appropriate.
- Product Integration assembles the product from the product components, ensures that the product, as integrated, functions properly, and delivers the product.
- Verification assures that selected work products meet their specified requirements.
- Validation demonstrates that a product or product component fulfills its intended use when placed in its intended environment.
- Organizational Process Focus establishes and maintains an understanding of the organization's processes and process assets, and identifies, plans, and implements the organization's process improvement activities.
- Organizational Process Definition establishes and maintains a usable set of organizational process assets.
- Organizational Training develops the skills and knowledge of people so they can perform their roles effectively and efficiently.
- Integrated Project Management (IPPD) establishes and manages the project and the involvement of the relevant stakeholders according to an integrated and defined process that is tailored from the organization's set of standard processes. It also covers the establishment of a shared vision for the project and a team structure for integrated teams that will carry out the objectives of the project.
- Risk Management identifies potential problems before they occur, so that risk handling activities may be planned and invoked as needed across the lifecycle to mitigate adverse impacts on achieving objectives.
- Decision Analysis and Resolution makes decisions using a structured approach that evaluates identified alternatives against established criteria.
- Organizational Environment for Integration provides an IPPD infrastructure and manages people for integration.
- Integrated Teaming forms and sustains an integrated team for the development of work products.

The process areas at maturity level 4 include: [FM103.HDA102.HDB101.T105]

- 923 • Organizational Process Performance establishes and maintains a
924 quantitative understanding of the performance of the organization's
925 set of standard processes and provides the process performance
926 data, baselines, and models to quantitatively manage the
927 organization's projects.
- 928 • Quantitative Project Management quantitatively manages the
929 project's defined process to achieve the project's established
930 quality and process performance objectives.

931 The process areas at maturity level 5 include: [FM103.HDA102.HDB101.T106]

- 932 • Organizational Innovation and Deployment selects and deploys
933 incremental and innovative improvements that measurably improve
934 the organization's processes and technologies. The improvements
935 support the organization's quality and process performance
936 objectives as derived from the organization's business objectives.
- 937 • Causal Analysis and Resolution identifies causes of defects and
938 other problems and takes action to prevent them from occurring in
939 the future.

940 **Specific Goals**

941 Specific goals apply to only one process area and address the unique
942 characteristics that describe what must be implemented to satisfy the
943 purpose of the process area. Goals are required model components
944 and are used in assessments to determine whether a process area is
945 satisfied. [FM103.HDA102.HDB103.T101]

946 **Specific Practices**

947 A specific practice is an activity that is considered important in
948 achieving the specific goal that it is mapped to. The specific practices
949 describe the activities expected to result in achievement of the specific
950 goal of a process area. [FM103.HDA102.HDB104.T101]

951 **Generic Goals**

952 Generic goals apply to all process areas. Achievement of each of these
953 goals in each process area signifies whether the implementation and
954 institutionalization of each process area is effective, repeatable, and
955 lasting. Generic goals and generic practices appear in chapter 4.

956 [FM103.HDA102.HDB105.T101]

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Common Features

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Four common features organize the generic practices of each process area. Common feature names are model components that are informative. They are only groupings that provide a way to present the generic practices. Each is designated in the model by an abbreviation as shown. [FM103.HDA102.HDB106.T101]

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Commitment to Perform (CO) groups all generic practices related to creating policies and securing sponsorship for process improvement efforts. [FM103.HDA102.HDB106.T102]

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Ability to Perform (AB) groups all generic practices related to ensuring that the project and/or organization has the resources it needs to pursue process improvement. [FM103.HDA102.HDB106.T103]

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Directing Implementation (DI) groups the generic practices related to collecting, measuring, and analyzing data related to processes. The purpose of these activities is to provide insight into the performance of processes. [FM103.HDA102.HDB106.T104]

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Verifying Implementation (VE) groups all generic practices related to verifying that the projects and/or organization's activities conform to requirements, processes, and procedures. [FM103.HDA102.HDB106.T105]

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Refer to chapter four for a more detailed description of the common features. [FM103.HDA102.HDB106.T106]

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Generic Practices

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Generic practices are practices that apply to every process area because in principle, they can improve the performance and control of any process. Generic practices provide the institutionalization features that will ensure that the process area will be effective, repeatable, and lasting. Generic practices are expected components in the model.

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[FM103.HDA102.HDB107.T102]

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Typical Work Products

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Typical Work Products are an informative model component that provide example outputs from 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. [FM103.HDA102.HDB113.T101]

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990 **Subpractices**

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

996 **Discipline Amplifications**

997 Discipline amplifications are informative model components that contain
998 information relevant to a particular discipline and are associated with
999 specific practices. For example, if in the CMMI-SE/SW model, you want
1000 to find a discipline amplification for Software Engineering, you would
1001 look in the model for items labeled “For Software Engineering.”
1002 [FM103.HDA102.HDB115.T101]

1003 **Generic Practice Elaborations**

1004 Generic practice elaborations are informative model components that
1005 appear in each process area to provide guidance on how the generic
1006 practices should uniquely be applied to the process area. For example,
1007 when the generic practice “Train the people performing or supporting
1008 the planned process as needed” is incorporated into the Configuration
1009 Management process area, the specific kinds of training for doing
1010 configuration management is described. [FM103.HDA102.HDB116.T101]

1011 *Refer to the details of the generic practices in chapter 4.*

1012 [FM103.HDA102.HDB116.T101.R101]

1013 **References**

1014 References are informative model components that direct the user to
1015 additional or more detailed information in related process areas. Typical
1016 phrases expressing these pointers are “Refer to the Decision and
1017 Analysis and Resolution process area for determining the best
1018 integration strategy” or “Refer to the Project Planning process area for
1019 more information about global project planning.” All references are
1020 clearly marked in the model in italics. [FM103.HDA102.HDB117.T101]

1021 **Model Representation Comparison**

1022 The continuous representation uses capability levels, while the staged
1023 representation uses maturity levels. The main difference between these
1024 two types of levels is the representation they belong to and how they
1025 are applied: [FM103.HDA103.T101]

- 1026 • Capability levels apply to an organization’s process-improvement
1027 achievement for each process area. There are six capability levels,

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numbered 0 through 5. Each capability level corresponds to a generic goal and a defined set of generic practices.

- Maturity levels, which belong to a staged representation, apply to an organization’s overall process capability and organizational maturity. Each maturity level comprises a predefined set of process areas and generic goals. There are five maturity levels, numbered 1 through 5.

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

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[FM103.HDA103.T102]

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Equivalent staging enables the results of assessments using the continuous representation to be translated into maturity levels.

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[FM103.HDA103.T103]

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Refer to Appendix F of the continuous representation for details of how equivalent staging is designed to work. [FM103.HDA103.T103.R101]

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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]

1109 **Project Manager**

1110 In the CMMI Product Suite, a “project manager” is the person
1111 responsible for planning, directing, controlling, structuring, and
1112 motivating the project. The project manager is ultimately responsible to
1113 the customer. In some matrix organizations, only the business staff may
1114 report directly to the project manager, whereas the engineering groups
1115 report to the project manager indirectly. [FM114.HDA102.HDB106.T101]

1116 **Senior Manager**

1117 The term “senior manager,” when used in a CMMI model, refers to a
1118 management role at a high enough level in an organization that the
1119 primary focus of the person filling the role is the long-term vitality of the
1120 organization, rather than short-term project and contractual concerns
1121 and pressures. A senior manager has authority to direct the allocation
1122 or reallocation of resources in support of organizational process
1123 improvement effectiveness. [FM114.HDA102.HDB107.T101]

1124 A senior manager can be any manager who satisfies this description,
1125 including the head of the organization. Synonyms for “senior manager”
1126 include “executive” and “top-level manager.” However, these synonyms
1127 are not used in CMMI models to ensure consistency and usability.

1128 [FM114.HDA102.HDB107.T102]

1129 **Organization**

1130 An organization is typically an administrative structure in which people
1131 collectively manage one or more projects as a whole, and whose
1132 projects share a senior manager and operate under the same policies.
1133 However, the word “organization” as used throughout CMMI models
1134 can apply to one person who performs a function in a small organization
1135 that might be performed by a group of people in a large organization.

1136 [FM114.HDA102.HDB108.T101]

1137 **Enterprise**

1138 When CMMI models refer to an “enterprise,” they illustrate the larger
1139 entity not always reached by the word “organization.” Very large
1140 companies may consist of many organizations in many different
1141 locations with different customers. The word “enterprise” refers to the
1142 full composition of these large companies. [FM114.HDA102.HDB109.T101]

1143 **Development**

1144 The word “development,” when used in the CMMI Product Suite, implies
1145 not only development activities, but also maintenance activities.
1146 Projects that benefit from the best practices of CMMI can focus
1147 exclusively on maintenance, development, or both activities.

1148 [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]

1183 Product components may be a part of the product delivered to the
1184 customer or serve in the manufacture or use of the product. A car
1185 engine and a piston are examples of product components of a car (the
1186 product). The manufacturing process to machine the piston; the repair
1187 process used to remove the engine from the car for repair; and the
1188 process used to train the mechanic to repair the engine are also
1189 examples of product components. These latter examples are product
1190 components even if they are not delivered to the customer, but
1191 developed by the project for internal use or for use by another party.
1192 [FM114.HDA102.HDB114.T102]

1193 **Assessment**

1194 CMMI follows ISO/IEC 15504 in using the term “assessment” rather
1195 than the EIA/IS 731 term, “appraisal” or using both terms, as in SW-
1196 CMM. [FM114.HDA102.HDB115.T101]

1197 **Objective Review**

1198 An “objective review” is another concept that CMMI models use when
1199 discussing quality assurance. These reviews can be done by
1200 independent groups, or by project members themselves.
1201 [FM114.HDA102.HDB116.T101]

1202 **Tailoring Guidelines**

1203 Tailoring a process makes, alters, or adapts the process description for
1204 a particular end. For example, a project tailors its defined process from
1205 the organization’s set of standard processes to meet the objectives,
1206 constraints, and environment of the project. [FM114.HDA102.HDB117.T101]

1207 “Tailoring guidelines” are used in CMMI models to enable organizations
1208 to implement standard processes appropriately in their projects. The
1209 organization’s set of standard processes is described at a general level
1210 that may not be directly usable to perform a process. [FM114.HDA102.HDB117.T102]

1211 Tailoring guidelines aid those who establish the defined processes for
1212 projects. Tailoring guidelines cover (1) selecting a standard process, (2)
1213 selecting an approved product life cycle, and (3) tailoring the selected
1214 standard process and life cycle to fit project needs. Tailoring guidelines
1215 describe what can and cannot be modified and identify process
1216 components that are candidates for modification. [FM114.HDA102.HDB117.T103]

1217 **Project Development Plan**

1218 The project’s defined process is usually not specific enough to be
1219 performed directly because it doesn’t specify who will assume the roles,
1220 what work products to create, or when tasks will be performed.
1221 [FM114.HDA102.HDB118.T101]

1222 In CMMI models, the “project development plan,” as a single plan or
1223 collection of plans, links the project’s defined process to how the project
1224 will be performed. The project’s defined process and its development
1225 plan together make it possible to perform and manage the process. You
1226 can also look at a “project development plan” as a “project management
1227 plan” because it can cover product maintenance and/or product
1228 development. [FM114.HDA102.HDB118.T102]

1229 **ISO/IEC 15504 Compatibility and Conformance**

1230 One objective that the CMMI Product Suite was designed to achieve is
1231 that of “ISO/IEC 15504 compatibility and conformance.” There are two
1232 aspects of conformance to the 1998 Technical Report version of
1233 ISO/IEC 15504—model compatibility and assessment conformance.
1234 When the full international standard version of ISO/IEC 15504 is
1235 published (estimated to occur in 2003), there will be some changes to
1236 what ISO/IEC 15504 conformance means. [FM114.HDA102.HDB119.T101]

1237 For an assessment model (for example, Bootstrap, CMMI SE/SW, and
1238 so on) to claim to be ISO/IEC 15504 conformant (an ISO/IEC 15504
1239 compatible model), a “demonstration of compatibility” document would
1240 need to show how the model compatibility requirements of ISO/IEC
1241 15504-2 have been addressed. These requirements are constructed to
1242 provide reasonable assurance that the model will work properly with the
1243 associated documented assessment process (assessment method).
1244 [FM114.HDA102.HDB119.T102]

1245 There are also ISO/IEC 15504 requirements that pertain to the actual
1246 conduct (planning as well as performance) of an assessment. If the
1247 conduct of an assessment is such that the requirements in ISO/IEC
1248 15504-3 are satisfied, then the assessment is said to be ISO/IEC 15504
1249 conformant. One of these requirements is that a ISO/IEC 15504
1250 compatible assessment model is used. [FM114.HDA102.HDB119.T103]

1251 **Integrated**

1252 When the term “integrated” is used in the CMMI Product Suite, the
1253 integration refers to the use of the models to apply to multiple
1254 disciplines. In other words, your organization’s engineering process
1255 group can learn one model that it can use to introduce process
1256 improvement into software engineering, systems engineering, and, as
1257 time goes on, more disciplines. Integration does not refer to your
1258 organization’s structure. The decision to integrate departments or
1259 development processes is best determined by analyzing business
1260 objectives. [FM114.HDA102.HDB120.T101]

1261 **Verification and Validation**

1262 Although “verification and validation” at first seem quite similar in CMMI
1263 models, on closer inspection you can see that each addresses different
1264 issues. Verification confirms that work products properly reflect the
1265 requirements specified for them. Validation confirms that the product, as
1266 provided, will fulfill its intended use. [FM114.HDA102.HDB121.T101]

1267 **Goal**

1268 A “goal” is a required CMMI component that can be either a generic
1269 goal or specific goal. Each goal within a process area must be achieved
1270 to consider the process area to be achieved. When you see the word
1271 “goal” in a CMMI model, it always refers to model components (for
1272 example, generic goal, specific goal). [FM114.HDA102.HDB122.T101]

1273 **Objective**

1274 Instead of using “goal” in its common everyday sense, the term
1275 “objective” is used to avoid confusion. [FM114.HDA102.HDB123.T101]

1276 **Practice**

1277 A “practice” is an expected CMMI component that can be either a
1278 generic practice or specific practice. Each practice within a process
1279 area, or an equivalent alternative must be achieved to consider the
1280 process area to be achieved. Every practice supports only one goal.
1281 [FM114.HDA102.HDB124.T101]

1282 When you see the word “practice” in a CMMI model, it always refers to
1283 model components (for example, generic practice, specific practice).
1284 Instead of using “practice” in its common everyday sense, we chose
1285 another term that means the same thing (for example, carry out,
1286 perform, apply, follow, rehearse, attempt, exercise). [FM114.HDA102.HDB124.T102]

1287 **Standard**

1288 When you see the word “standard” in a CMMI model, it refers to the
1289 formal mandatory requirements developed and used to prescribe
1290 consistent approaches to development (for example, ISO standards,
1291 IEEE standards). Instead of using “standard” in its common everyday
1292 sense, we chose another term that means the same thing (for example,
1293 typical, traditional, usual, customary). [FM114.HDA102.HDB125.T101]

1294 **CMMI-Specific Terminology**

1295 The following terms were created for CMMI products or are critical to
1296 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.

[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.

[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.

[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]

1405 **Process Elements**

1406 A “process element” is a fundamental unit of process description. A
1407 process may be defined in terms of subprocesses or process elements.
1408 A subprocess can be further decomposed; a process element cannot
1409 be decomposed into finer-grained descriptions. [FM114.HDA103.HDB112.T101]

1410 Each process element covers a closely related set of activities (for
1411 example, estimating element, peer review element). Process elements
1412 can be portrayed using templates to be completed, abstractions to be
1413 refined, or descriptions to be modified or used. A process element can
1414 be an activity or task. [FM114.HDA103.HDB112.T102]

1415 **Product Life Cycle**

1416 A “product life cycle” is the period of time that begins when a product is
1417 conceived and ends when the product is no longer available for use.
1418 Since an organization may be producing multiple products for multiple
1419 customers, one product life cycle may not be adequate. Therefore, the
1420 organization may define a set of approved product life cycles. These life
1421 cycles are typically found in published literature and are likely to be
1422 modified to fit the organization. [FM114.HDA103.HDB113.T101]

1423 An example of a product life cycle is (1) concept/vision, (2) feasibility,
1424 (3) design/development, (4) production, and (5) phase-out. A project life
1425 cycle is a different concept that describes the development process
1426 used by the project (for example, waterfall, spiral). [FM114.HDA103.HDB113.T102]

1427 **Organizational Measurement Repository**

1428 The “organizational measurement repository” is a repository used to
1429 collect and make available measurement data on processes and work
1430 products, particularly as they relate to the organization’s set of standard
1431 processes. This repository contains or references actual measurement
1432 data and related information needed to understand and assess the
1433 measurement data. [FM114.HDA103.HDB114.T101]

1434 Examples of process and work product data include estimated size of
1435 work products, effort estimates, and cost estimates; actual size of work
1436 products, actual effort expended, and actual cost amounts; peer review
1437 efficiency and coverage statistics; and the number and severity of
1438 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]

1453 4 Maturity Levels, Common Features, and 1454 Generic Practices

1455 Overview

1456 The maturity levels and generic model components of CMMI models
1457 focus on the maturity of the organization's ability to pursue process
1458 improvement. Using common features, generic goals, and generic
1459 practices, users are able to improve their processes, demonstrate and
1460 evaluate their organization's progress as they improve their processes,
1461 and move from one maturity level to another. [FM122.HDA101.T101]

1462 Maturity Levels

1463 In the staged representation, maturity levels provide a recommended
1464 order for approaching process improvement in stages so that not all
1465 process areas are addressed at the same time. This recommended
1466 order allows organizations to focus improvement efforts on the critical
1467 few processes that will have the most benefit to the organization. Each
1468 level also provides a necessary foundation for effective implementation
1469 of the processes at the next level. [FM122.HDA102.T101]

1470 "Institutionalization" is an important dimension to each of the maturity
1471 levels. When mentioned below in the maturity level descriptions,
1472 institutionalization implies that the implementation of the process area is
1473 appropriate to ensure that the process area is an ingrained and lasting
1474 part of the way the work is performed in the organization. [FM122.HDA102.T102]

1475 There are five maturity levels, numbered 1 through 5. Maturity levels
1476 are measured by the achievement of the specific and generic goals that
1477 apply to the process areas at each level. [FM122.HDA102.T103]

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Maturity Level 1: Initial

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A maturity level 1 is typically ad hoc and chaotic. The organization typically does not provide a stable environment. Success in these organizations depends on the competence and heroics of the people in the organization and cannot be repeated unless the same competent and experienced individuals are assigned to the next project. In spite of this ad hoc, chaotic environment, maturity level 1 organizations frequently produce products that work; however, they often greatly exceed the budget and schedule of the project. [FM122.HDA102.HDB101.T101]

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Maturity Level 2: Managed

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At maturity level 2, an organization has achieved all of the goals of the maturity level 2 process areas. In other words, the organization has ensured that its processes are planned, documented, performed, monitored, and controlled at the project level. [FM122.HDA102.HDB102.T101]

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Maturity level 2 process areas are Requirements Management, Project Planning, Project Monitoring and Control, Supplier Agreement Management, Measurement and Analysis, Process and Product Quality Assurance, and Configuration Management. [FM122.HDA102.HDB102.T102]

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At maturity level 2, objectives of processes are achieved, and they are planned, documented, performed, monitored, and controlled. Furthermore, at maturity level 2, objectives established for the process, such as cost, schedule, and quality objectives are achieved.

[FM122.HDA102.HDB102.T103]

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The process discipline reflected by maturity level 2 helps to ensure that existing practices are retained during times of stress. When these practices are used on efforts similar to the current effort, similar results are expected. [FM122.HDA102.HDB102.T104]

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At maturity level 2, the requirements, standards, and objectives for the process, its work products, and its services are defined and documented. The status of the work products and delivery of the services are visible to management at defined points (for example, at major milestones and completion of major tasks). [FM122.HDA102.HDB102.T105]

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Commitments are established among relevant stakeholders. Commitments are revised as needed and satisfied. Work products are reviewed with stakeholders and are controlled. The work products and services satisfy their specified requirements, standards, and objectives.

[FM122.HDA102.HDB102.T106]

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At maturity level 2, institutionalization is achieved by doing the following:

[FM122.HDA102.HDB102.T107]

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- Adhering to organizational policies

- 1518 • Following a documented plan and process description
- 1519 • Applying adequate and appropriate resources (including funding,
1520 people, and tools)
- 1521 • Maintaining appropriate assignment of responsibility and authority
- 1522 • Training the people performing and supporting the process
- 1523 • Placing work products under appropriate levels of configuration
1524 management
- 1525 • Monitoring and controlling the performance of the process and
1526 taking corrective actions
- 1527 • Objectively reviewing the process, its work products, and its
1528 services, and addressing noncompliance
- 1529 • Reviewing the activities, status, and results of the process with
1530 appropriate levels of management, and taking corrective action
- 1531 • Identifying and interacting with relevant stakeholders

1532 **Maturity Level 3: Defined**

1533 At maturity level 3, an organization has achieved all of the goals of the
1534 maturity level 2 and 3 process areas. Processes are tailored from the
1535 organization's set of standard processes and related organizational
1536 process assets to suit the circumstances in which they will be
1537 performed. At maturity level 3, processes are well characterized and
1538 understood, and are described in standards, procedures, tools, and
1539 methods. [FM122.HDA102.HDB103.T101]

1540 Maturity level 3 process areas are Requirements Development,
1541 Technical Solution, Product Integration, Verification, Validation,
1542 Organizational Process Focus, Organizational Process Definition,
1543 Organizational Training, Integrated Project Management (IPPD), Risk
1544 Management, and Decision Analysis and Resolution.
1545 [FM122.HDA102.HDB103.T103]

1546 The organization's set of standard processes, which are the basis for
1547 maturity level 3, are established and improved over time. These
1548 standard processes define the basic processes used for establishing
1549 consistent processes across the organization. [FM122.HDA102.HDB103.T104]

1550 Basic processes describe the fundamental process elements that are
1551 expected at maturity level 3. Basic processes also describe the
1552 relationships (for example, the ordering and interfaces) between these
1553 process elements. The organization level infrastructure to support the
1554 current and future use of the organization's set of standard processes is
1555 established and improved over time. [FM122.HDA102.HDB103.T105]

1556 The organization's management establishes process objectives based
1557 on the organization's set of standard processes. These process
1558 objectives are appropriately addressed at maturity level 3.

1559 [FM122.HDA102.HDB103.T106]

1560 At maturity level 3, the following process characteristics are clearly
1561 stated: [FM122.HDA102.HDB103.T107]

- 1562 • Purpose
- 1563 • Inputs
- 1564 • Entry criteria
- 1565 • Activities
- 1566 • Roles
- 1567 • Measures
- 1568 • Verification steps
- 1569 • Outputs
- 1570 • Exit criteria

1571 At maturity level 3, institutionalization is achieved by doing the following:

1572 [FM122.HDA102.HDB103.T108]

- 1573 • Satisfying the items that institutionalize a managed (maturity level
1574 2) process
- 1575 • Establishing the description of the defined process
- 1576 • Establishing a plan based on the description of the defined process
- 1577 • Performing the process according to the planned defined process
- 1578 • Collecting work products, measures, and improvement information
1579 derived from performing the process
- 1580 • Performing the process to support the future use and improvement
1581 of the organization's process assets

1582 A critical distinction between maturity level 2 and maturity level 3 is the
1583 scope of application of the standards, process descriptions, and
1584 procedures. At maturity level 2, the standards, process descriptions,
1585 and procedures may be in use in only a specific instance of the process
1586 (for example, on a particular project). At maturity level 3, the standards,
1587 process descriptions, and procedures for a project are tailored from
1588 organizational process assets. As a result, the processes that are
1589 performed across the organization are consistent. [FM122.HDA102.HDB103.T109]

- 1590 • Another critical distinction is that at maturity level 3, processes are
1591 described in more detail and more rigorously than at maturity level
1592 2. At maturity level 3, processes are managed more proactively
1593 using an understanding of the interrelationships of the process

1594 activities and detailed measures of the process, its work products,
1595 and its services.

1596 **Maturity Level 4: Quantitatively Managed**

1597 At maturity level 4, an organization has achieved all of the goals of the
1598 maturity level 2, 3, and 4 process areas. Processes are controlled using
1599 statistical and other quantitative techniques. Quantitative objectives for
1600 product quality, service quality, and process performance are
1601 established and used as criteria in managing processes. Product
1602 quality, service quality, and process performance are understood in
1603 statistical terms and are managed throughout the life of processes.

1604 [FM122.HDA102.HDB104.T101]

1605 Maturity level 4 process areas are Organizational Process Performance
1606 and Quantitative Project Management. [FM122.HDA102.HDB104.T102]

1607 Quantitative objectives are based on the needs of the customer, end-
1608 users, organization, and process implementors. Those performing the
1609 process are directly involved in quantitatively managing the process.

1610 [FM122.HDA102.HDB104.T103]

1611 Processes that significantly contribute to overall process performance
1612 are quantitatively managed. For these processes, detailed measures of
1613 process performance are collected and statistically analyzed. Special
1614 causes of process variation⁹ are identified and, where appropriate, the
1615 sources of special causes are corrected to prevent future occurrences.

1616 [FM122.HDA102.HDB104.T104]

1617 Product quality, service quality, and process performance measures are
1618 incorporated into the organization's measurement repository to support
1619 fact-based decision-making in the future. [FM122.HDA102.HDB104.T106]

1620 At maturity level 4, processes are institutionalized by doing the
1621 following: [FM122.HDA102.HDB104.T107]

- 1622 • Satisfying the items that institutionalize a defined (maturity level 3)
1623 process
- 1624 • Establishing and maintaining quantitative objectives for product
1625 quality, service quality, and process performance
- 1626 • Establishing and maintaining a statistically stable and predictable
1627 process performance
- 1628 • Establishing and maintaining a statistical understanding of the
1629 capability of the process to achieve the quantitative objectives for
1630 product quality, service quality, and process performance

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.

1631 A critical distinction between maturity level 3 and maturity level 4 is the
1632 predictability of process performance. The performance of a process at
1633 maturity level 4 is controlled using statistical and other quantitative
1634 techniques, and is statistically predictable. At maturity level 3,
1635 processes are only qualitatively predictable. [FM122.HDA102.HDB104.T108]

1636 At maturity level 4 the performance of processes include the following:
1637 [FM122.HDA102.HDB104.T109]

- 1638 • Identifying and measuring product and process attributes that are
1639 important contributors to product quality, service quality, and
1640 process performance
- 1641 • Identifying and addressing special causes of process variations
1642 (based on the selected product and process attributes)
- 1643 • Bringing the performance of the process within its natural bounds
1644 (that is, make the process performance statistically stable and
1645 predictable based on the selected product and process -attributes)
- 1646 • Determining the capability of the process to satisfy established
1647 quantitative product quality, service quality, and process
1648 performance objectives
- 1649 • Taking appropriate corrective actions when it is determined that the
1650 established quantitative product quality, service quality, and
1651 process performance objectives will not be satisfied

1652 These actions may be limited to merely changing objectives or ensuring
1653 that stakeholders have a quantitative understanding of, and agree to,
1654 the performance shortfall. [FM122.HDA102.HDB104.T110]

1655 **Maturity Level 5: Optimizing**

1656 At maturity level 5, an organization has achieved all of the goals of the
1657 maturity level 2, 3, 4, and 5 process areas. Processes are continually
1658 improved based on an understanding of the common causes of
1659 variation¹⁰ inherent in processes. [FM122.HDA102.HDB105.T101]

1660 Maturity level 5 process areas are Organizational Innovation and
1661 Deployment and Causal Analysis and Resolution. [FM122.HDA102.HDB105.T103]

1662 Maturity level 5 focuses on continually improving process performance
1663 through both incremental and innovative technological improvements.
1664 Quantitative process improvement objectives for the organization are
1665 established, continually revised to reflect changing business objectives,
1666 and used as criteria in managing process improvement. Both the
1667 processes and the organization's set of standard processes are targets
1668 of improvement activities. [FM122.HDA102.HDB105.T104]

¹⁰ 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.

1669 Process improvements to address common causes of process variation
1670 and measurably improve the organization's processes are identified,
1671 evaluated, and deployed. Improvements are selected based on a
1672 quantitative understanding of their expected contribution to achieving
1673 the organization's process improvement objectives versus the cost and
1674 impact to the organization. The performance of the organization's
1675 processes is continually improved. [FM122.HDA102.HDB105.T105]

1676 Optimizing processes that are agile and innovative depend on the
1677 participation of an empowered workforce aligned with the business
1678 values and objectives of the organization. The organization's ability to
1679 rapidly respond to changes and opportunities is enhanced by finding
1680 ways to accelerate and share learning. Improvement of the processes is
1681 inherently part of everybody's role, resulting in a cycle of continual
1682 improvement. [FM122.HDA102.HDB105.T106]

1683 Selected incremental and innovative technological process
1684 improvements are deployed into the organization systematically. The
1685 effects of the deployed process improvements are measured and
1686 evaluated against the quantitative process improvement objectives.
1687 [FM122.HDA102.HDB105.T107]

1688 At maturity level 5, processes are institutionalized by doing the
1689 following: [FM122.HDA102.HDB105.T108]

- 1690 • Satisfying the items that institutionalize a quantitatively managed
1691 (maturity level 4) process
- 1692 • Establishing and maintaining quantitative process improvement
1693 objectives
- 1694 • Identifying and deploying both incremental and innovative
1695 technological improvements that continually improves the range of
1696 process performance

1697 A critical distinction between maturity level 4 and maturity level 5 is the
1698 type of process variation addressed. At maturity level 4, processes are
1699 concerned with addressing special causes of process variation and
1700 providing statistical predictability for the results. Though processes may
1701 produce predictable results, the results may be insufficient to achieve
1702 the established objectives. At maturity level 5, processes are concerned
1703 with addressing common causes of process variation and changing the
1704 process (that is, shift the mean of the process performance) to improve
1705 process performance (while maintaining statistical predictability) to
1706 achieve the established quantitative process improvement objectives.
1707 [FM122.HDA102.HDB105.T109]

1708 Common Features

1709 Common features are predefined attributes that group generic goals
1710 and generic practices into categories. Common features are model
1711 components that are not rated in any way. They are only groupings that
1712 provide a way to present the generic practices. Generic goals signify
1713 whether the implementation and institutionalization of each process
1714 area are effective, repeatable, and lasting. [FM122.HDA103.T101]

1715 There are four common features used in CMMI models: Commitment to
1716 Perform, Ability to Perform, Directing Implementation, and Verifying
1717 Implementation. [FM122.HDA103.T102]

1718 In the following section, generic practices are listed by their common
1719 feature categories. This section also contains subpractices and other
1720 informative model components that clarify the generic practice
1721 statements found in the process areas. These details of the generic
1722 practices do not appear in the process areas. [FM122.HDA103.T103]

1723 Generic Practices Listed by Common Feature

1724 In the process areas, generic practices appear after the last goal,
1725 grouped by the common features. Generic practice elaborations also
1726 appear in each process area to provide guidance on how the generic
1727 practices should uniquely be applied to the process area. [FM122.HDA104.T101]

1728 Although this information is applied throughout the model in multiple
1729 process areas, the entire text of each generic practice is not repeated in
1730 every process area. Instead, the generic practice titles and statements
1731 appear alone in each process area. As you apply generic practices
1732 within each process area, refer to this section for the details of these
1733 practices, such as subpractices and work products.¹¹ [FM122.HDA104.T102]

1734 Within the common feature categories below, you will find generic
1735 practices with different numbering. Some begin with GP 2 and others
1736 begin with GP 3. The generic practices that begin with GP 2 apply to
1737 process areas at maturity levels 2 through 5. The generic practices that
1738 begin with GP 3 apply to process areas at maturity levels 3 through 5.
1739 [FM122.HDA104.T104]

¹¹ The generic practices that apply to the staged representation appear in this chapter. There are other generic practices that are used only by the continuous representation. These capability level 1, 4, and 5 generic practices are found in chapter four of the continuous representation.

1740 Commitment to Perform

1741 **GP 2.1 Establish an Organizational Policy**

1742 ***Establish and maintain an organizational policy for planning and***
1743 ***performing the process***

1744 The purpose of this practice is to define the organizational expectations
1745 for the process and make these expectations visible to those in the
1746 organization who are affected. [GP103]

1747 Not all direction from senior management will bear the label, "policy."
1748 The existence of appropriate organizational direction is the expectation
1749 of this practice, regardless of what it is called. [GP103.N101]

1750 Ability to Perform

1751 **GP 2.2 Plan the Process**

1752 ***Establish and maintain the requirements and objectives, and plan***
1753 ***for performing the process.***

1754 The purpose of this practice is to determine what is needed to perform
1755 the process and achieve the established objectives, prepare a plan for
1756 performing the process, and get agreement on the plan from relevant
1757 stakeholders. [GP104]

1758 Requirements are defined for the process's specified work products and
1759 for performing the work. [GP104.N101]

1760 The objectives for the process are established by those responsible for
1761 performing the process. Included are objectives for their specific
1762 situation, including quality, cost, and schedule objectives. For example,
1763 an objective might be to reduce the cost of performing a process for this
1764 implementation over the previous implementation. [GP104.N102]

1765 Establishing a plan includes documenting it. Maintaining the plan
1766 includes changing it, as necessary, as a result of corrective actions,
1767 changes to the process, and changes to the requirements and
1768 objectives for the process. [GP104.N103]

1769 In some CMMI process areas there are specific practices that also talk
1770 about developing strategies or plans. This generic practice addresses
1771 overall planning for the entire process area, whereas the specific
1772 practices address a topic for more detailed or focused planning.

1773 [GP104.N104]

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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
- Requirements for the work products and services of the process
- Specific objectives for the performance of the process (e.g., quality, time-scale, cycle time, and resource usage)
- Schedule (events and activity dependencies) for performing the process
- Dependencies among the activities, work products, and services of the process
- Resources (including funding, people, and tools) needed to perform the process
- Assignment of responsibility and authority
- Training needed for performing and supporting the process
- Work products to be placed under configuration management and the level of configuration management for each item
- Measurement requirements to provide insight into the performance of the process, its work products, and its services
- Activities for monitoring and controlling the process
- Objective verification activities for the process and the work products
- Management review activities for the process and the work products

4. Review the plan with relevant stakeholders and get their agreement. [GP104.SubP104]

This includes reviewing that the planned process satisfies the applicable policies, plans, requirements, and standards to provide assurance to relevant stakeholders. [GP104.SubP104.N101]

5. Revise the plan as necessary. [GP104.SubP105]

1810 **GP 2.3**

Provide Resources

1811 ***Provide adequate resources for performing the process,***
1812 ***developing the work products, and providing the services of the***
1813 ***process.***

1814 The purpose of this practice is to ensure that the resources necessary
1815 to perform the process as defined by the plan are available when they
1816 are needed. Resources include adequate funding, appropriate physical
1817 facilities, skilled people, and appropriate tools. [GP105]

1818 The interpretation of the term "adequate" depends on many factors and
1819 may change over time. Inadequate resources may be addressed by
1820 increasing resources or by removing requirements, constraints, and
1821 commitments. [GP105.N101]

1822 **GP 2.4**

Assign Responsibility

1823 ***Assign responsibility and authority for performing the process,***
1824 ***developing the work products, and providing the services of the***
1825 ***process***

1826 The purpose of this practice is to ensure that there is accountability,
1827 throughout the life of the process for performing the process and
1828 achieving the specified results. The people assigned must have the
1829 appropriate authority to perform the assigned responsibilities. [GP106]

1830 Responsibility can be assigned using detailed job descriptions or in
1831 living documents, such as a plan for the process. Dynamic assignment
1832 of responsibility is another legitimate way to perform this practice, as
1833 long as the assignment and acceptance of responsibility is assured
1834 throughout the life of the process. [GP106.N101]

1835 **Subpractices**

- 1836 1. Assign overall responsibility and authority for performing the
1837 process. [GP106.SubP101]
- 1838 2. Assign responsibility for performing the specific tasks of the
1839 process. [GP106.SubP102]
- 1840 3. Confirm that the people assigned to the responsibilities and
1841 authorities understand and accept them. [GP106.SubP103]

1842 **GP 2.5**

Train People

1843 ***Train the people performing or supporting the process as needed.***

1844 The purpose of this practice is to ensure that the people have the
1845 necessary skills and expertise to perform or support the process. [GP107]

1846 Appropriate training is provided to the people who will be performing the
1847 work. Overview training is provided to orient people who interact with
1848 those performing the work. [GP107.N101]

1849 Training supports the successful performing of the process by
1850 establishing a common understanding of the process and by imparting
1851 the skills and knowledge needed to perform the process. [GP107.N103]

1852 GP 3.1 Establish a Defined Process

1853 ***Establish and maintain the description of a defined process.***

1854 The purpose of this practice is to establish and maintain a description of
1855 the process that is tailored from the organization's set of standard
1856 processes to address the needs of a specific instantiation. With a
1857 defined process, variability in how the processes are performed across
1858 the organization is reduced; and process assets, data, and learning can
1859 be effectively shared. [GP114]

1860 *Refer to the Organizational Process Definition process area for more*
1861 *information about the organization's standard set of processes and*
1862 *tailoring guidelines.* [GP114.R101]

1863 The descriptions of the defined processes provide the basis for
1864 planning, performing, and managing the activities, work products, and
1865 services associated with the process. [GP114.N102]

1866 **Subpractices**

- 1867 1. Select the standard process that best fits the specific instantiation
1868 from the organization's set of standard processes. [GP114.SubP101]
- 1869 2. Establish the defined process by tailoring the selected standard
1870 processes and other process assets according to the
1871 organization's tailoring guidelines. [GP114.SubP102]
- 1872 3. Ensure that the organization's process objectives are appropriately
1873 addressed in the defined process. [GP114.SubP103]
- 1874 4. Document the defined process and the records of the tailoring.
1875 [GP114.SubP104]
- 1876 5. Revise the description of the defined process as necessary.
1877 [GP114.SubP106]

1879 **GP 2.6 Manage Configurations**

1880 ***Place designated work products of the process under appropriate***
1881 ***levels of configuration management.***

1882 The purpose of this practice is to establish and maintain the integrity of
1883 the designated work products of the process (or their descriptions)
1884 throughout their useful life. [GP109]

1885 *Refer to the Configuration Management process area for more*
1886 *information.* [GP109.R101]

1887 The designated work products are specifically identified in the plan for
1888 performing the process, along with a specification of the level of
1889 configuration management. [GP109.N101]

1890 Different levels of configuration management are appropriate for
1891 different work products and for different points in time. For some work
1892 products, it may be sufficient to maintain version control (i.e., the
1893 version of the work product in use at a given time, past or present, is
1894 known and changes are incorporated in a controlled manner). Version
1895 control is usually under the sole control of the work product owner
1896 (which may be an individual, a development group, or a team). [GP109.N102]

1897 Sometimes, it may be critical that work products be placed under formal
1898 or "baseline" configuration management. This type of configuration
1899 management includes defining and establishing baselines at
1900 predetermined points. These baselines are formally reviewed and
1901 agreed on, and serve as the basis for further development. [GP109.N104]

1902 Additional levels of configuration management between version control
1903 and formal configuration management are possible. An identified work
1904 product may be under various levels of configuration management at
1905 different points in time. [GP109.N103]

1906 **GP 2.7 Identify and Involve Relevant Stakeholders**

1907 ***Identify and involve the relevant stakeholders as planned.***

1908 The purpose of this practice is to establish and maintain the expected
1909 involvement of stakeholders during the execution of the process. [GP124]

1910 *Refer to Project Planning process area for information on the project*
1911 *planning for stakeholder involvement.* [GP124.R101]

1912 Involve stakeholders as described in an appropriate plan for
1913 stakeholder involvement (e.g., as developed in the Project Planning
1914 PA). Involve them appropriately in activities such as: [GP124.N101]

- 1915 • Planning
- 1916 • Decisions
- 1917 • Communications
- 1918 • Coordination
- 1919 • Assessments
- 1920 • Requirements definitions
- 1921 • Resolution of problems/issues

1922 The objective of planning the stakeholder involvement is to assure that
1923 interactions necessary to the process are accomplished, while not
1924 allowing excessive numbers of affected groups and individuals to
1925 impede process execution. [GP124.N102]

1926 **Subpractices**

- 1927 1. Identify stakeholders relevant to this process and decide what type
1928 of involvement should be practiced. [GP124.SubP101]

1929 Stakeholders are identified among the suppliers of inputs to, the users of outputs
1930 from, and the performers of the activities within the process. Once the relevant
1931 stakeholders are identified, the appropriate level of their involvement in process
1932 activities is planned. [GP124.SubP101.N101]

- 1933 2. Share these identifications with project planners or other planners
1934 as appropriate. [GP124.SubP102]
- 1935 3. Get stakeholders involved as planned. [GP124.SubP103]

1936 **GP 2.8 Monitor and Control the Process**

1937 ***Monitor and control the process against the plan and take***
1938 ***appropriate corrective action.***

1939 The purpose of this practice is to perform the direct day-to-day
1940 monitoring and controlling of the process. Appropriate visibility into the
1941 process is maintained so that appropriate corrective action can be taken
1942 when necessary. [GP110]

1943 *Refer to the Measurement and Analysis process area for more*
1944 *information about measurement.* [GP110.R101]

1945 **Subpractices**

- 1946 1. Measure actual performance against the plan. [GP110.SubP101]

- 1947 The measures are of the process, its work products, and its services.
1948 [GP110.SubP101.N101]
- 1949 2. Review accomplishments and results of the process against the
1950 plan. [GP110.SubP102]
- 1951 3. Review activities, status, and results of the process with the
1952 immediate level of management responsible for the process and
1953 identify issues. The reviews are intended to provide the immediate
1954 level of management with appropriate visibility into the process.
1955 The reviews can be both periodic and event-driven. [GP110.SubP108]
- 1956 4. Identify and evaluate the effects of significant deviations from the
1957 plan. [GP110.SubP104]
- 1958 5. Identify problems in the process and in the plan. [GP110.SubP105]
- 1959 6. Take corrective action when requirements and objectives are not
1960 being satisfied, when issues are identified, or when progress differs
1961 significantly from the plan. [GP110.SubP106]
- 1962 There are inherent risks that need to be considered before any of the corrective
1963 actions are taken. [GP110.SubP106.N102]
- 1964 Corrective action may include the following: [GP110.SubP106.N101]
- 1965 • Taking remedial action to repair defective work products or services
 - 1966 • Changing the plan
 - 1967 • Adjusting resources, including people, tools, and other resources
 - 1968 • Negotiating changes to the established commitments
 - 1969 • Securing change to the requirements and standards that have to be satisfied
 - 1970 • Terminating the effort
- 1971 7. Track corrective action to closure. [GP110.SubP107]

GP 3.2 Collect Improvement Information

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.

1977 The purpose of this practice is to collect information and artifacts
1978 derived from planning and performing the process. This practice is
1979 performed so that the information and artifacts can be included in the
1980 organization's process assets and made available to those who are (or
1981 who will be) planning and performing the same or similar processes.
1982 The information and artifacts are stored in the organizational
1983 measurement repository and the organizational library of process-
1984 related assets. [GP117]

1985 *Refer to the Organizational Process Definition process area for more*
1986 *information about the organizational measurement repository and*
1987 *library of process-related assets.* [GP117.R101]

1988 **Subpractices**

1989 1. Store process and product measures in the organizational
1990 measurement repository. [GP117.SubP102]

1991 The process and product measures are primarily those that are defined in the
1992 organization's common set of measures for the set of standard processes.

1993 [GP117.SubP102.N101]

1994 2. Submit documentation for inclusion in the organizational library of
1995 process-related assets. [GP117.SubP103]

1996 3. Document lessons learned from the process for inclusion in the
1997 organizational library of process-related assets. [GP117.SubP104]

1998 4. Propose improvements to the organization's process assets.

1999 [GP117.SubP101]

2000 Verifying Implementation

2001 **GP 2.9 Objectively Evaluate Adherence**

2002 ***Objectively evaluate adherence of the process and the work***
2003 ***products and services of the process to the applicable***
2004 ***requirements, objectives, and standards, and address***
2005 ***noncompliance.***

2006 The purpose of this practice is to provide credible assurance that the
2007 process is implemented as planned and satisfies the relevant policies,
2008 requirements, standards, and objectives. [GP113]

2009 *Refer to the Process and Product Quality Assurance process area for*
2010 *more information about the specific goal and practices needed to*
2011 *objectively evaluate adherence.* [GP113.R101]

2012 People not directly responsible for managing or performing the activities
2013 of the process typically evaluate adherence. As a result, credible
2014 assurance of adherence can be provided even during times when the
2015 process is under stress (e.g., when the effort is behind schedule or over
2016 budget). [GP113.N101]

2017 **GP 2.10 Review Status with Higher-Level Management**

2018 ***Review the activities, status, and results of the process with***
2019 ***higher-level management and resolve issues.***

2020 The purpose of this practice is to provide higher-level management with
2021 the appropriate visibility into the process. [GP112]

2022 Higher-level management includes those levels of management in the
2023 organization above the immediate level of management responsible for
2024 the process. In particular, higher-level management includes senior
2025 management. These reviews are for managers who provide
2026 sponsorship and overall guidance for the process, not for those who
2027 perform the direct day-to-day monitoring and controlling of the process.
2028 [GP112.N102]

2029 Different managers have different needs for information about the
2030 process. These reviews help ensure that informed decisions on the
2031 planning and performing of the process can be made. Therefore, these
2032 reviews are expected to be both periodic and event driven. [GP112.N101]

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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Besides categorizing process areas by maturity level, you can also group all process areas into four categories: [FM102.HDA101.T102]

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- Process Management Processes

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- Project Management Processes

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- Engineering Processes

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- Support Processes

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Although we are grouping process areas this way to discuss their interactions, process areas often interact and have an effect on one another regardless of their defined group. For example, the Decision Analysis and Resolution process area provides structured decision making practices that are 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.T104]

2064 The Engineering process areas are written in a general engineering
2065 terminology so any technical discipline involved in the product
2066 development process (for example, software engineering, mechanical
2067 engineering) can use them for process improvement. The Process
2068 Management, Project Management and Support process areas also
2069 apply to all such disciplines, as well as others. [FM102.HDA101.T106]

2070 Whether you use a model with a staged or continuous representation,
2071 you must be aware of the interactions that exist among the CMMI model
2072 components to apply the model in a useful and productive way. The
2073 following sections describe the interactions that occur among CMMI
2074 model components. [FM102.HDA101.T107]

2075 Process Management Processes

2076 **The Scope of Process Management Processes**

2077 Process management process areas contain the cross-project practices
2078 related to defining, planning, resourcing, deploying, implementing,
2079 monitoring, controlling, verifying, measuring, and improving processes.
2080 The process management process areas of CMMI are as follows:

2081 [FM102.HDA102.HDB101.T101]

- 2082 • Organizational Process Focus
- 2083 • Organizational Process Definition
- 2084 • Organizational Training
- 2085 • Organizational Process Performance
- 2086 • Organizational Innovation and Deployment

2087 To describe the interactions among the process management process
2088 areas, it is most useful to address them in two process area groups:

2089 [FM102.HDA102.HDB101.T102]

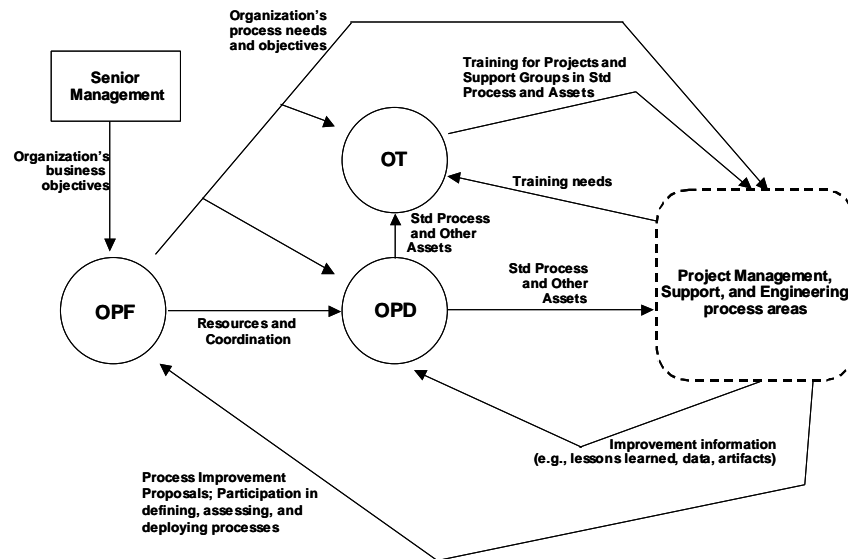
- 2090 • The “basic” process management process areas are
2091 Organizational Process Focus, Organizational Process Definition,
2092 and Organizational Training.
- 2093 • The “advanced” process management process areas are
2094 Organizational Process Performance and Organizational
2095 Innovation and Deployment.

2096 **Basic Process Management Process Areas**

2097 The basic process management process areas provide the organization
2098 with a basic capability to document and share best practices, process
2099 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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The Organizational Process Definition process area establishes and maintains the organization's set of standard processes and supporting assets based on the organizational process needs and objectives of the organization. These process and supporting assets include descriptions of processes and process elements, descriptions of life-cycle models, process tailoring guidelines, process related documentation, and data. The organization's set of standard processes is tailored by projects and support groups to create their defined processes. The other process and support assets support tailoring as well as implementation of the defined processes. Experiences and work products from performing these defined processes, including measurement data, process descriptions, process artifacts, and lessons learned are incorporated as appropriate into the organization's set of standard processes and supporting assets. [FM102.HDA102.HDB102.T105]

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2127 IPPD standard processes and guidelines are included in the
2128 organization's process asset library, which is established and
2129 maintained in the Process Management process areas. These IPPD
2130 processes and guidelines require integrated processes that ensure that
2131 product-related life-cycle processes (such as manufacturing, code
2132 development, testing, deployment, training, and other support needs)
2133 are identified and planned concurrently with the product design. These
2134 integrated processes should also address relevant stakeholder
2135 involvement, customer satisfaction, and a continuous focus on the
2136 product life cycle. [FM102.HDA102.HDB102.T106]

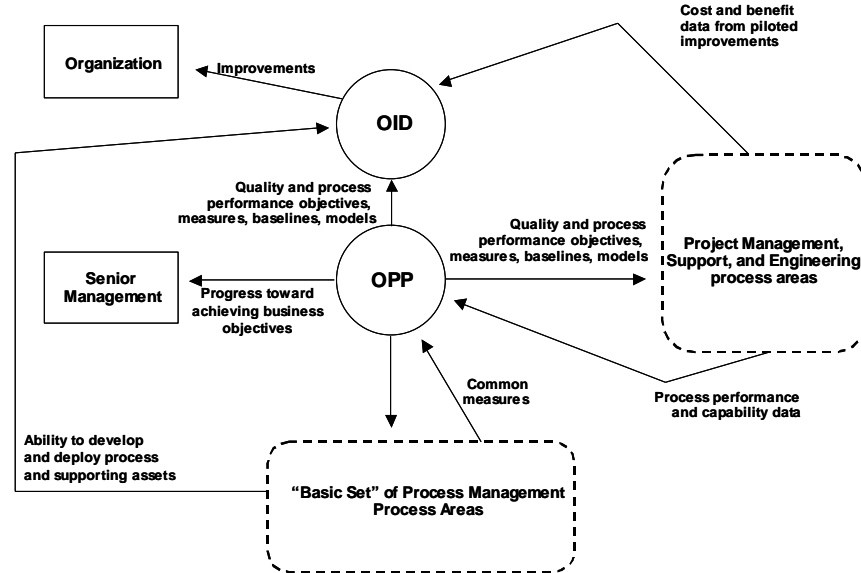
2137 In an IPPD environment, product development processes shift
2138 emphasis from serial development to parallel collaborative development
2139 and the integration of the product set that includes all the products,
2140 services, and processes for the life cycle of the product. The tailoring of
2141 the organization's set of standard processes to IPPD guidelines and the
2142 addition of IPPD standard processes establishes the extent of process
2143 development that occurs concurrently with the product development on
2144 projects. For example, if the organization has a standard process for
2145 manufacturing a certain type or family of product components, then that
2146 process does not need to be redeveloped, but rather is tailored as the
2147 product is designed. The recommended process development decision
2148 in that case is to reuse and modify an existing process.
2149 [FM102.HDA102.HDB102.T107]

2150 The Organizational Training process area identifies the strategic
2151 training needs of the organization as well as tactical training needs that
2152 are common across projects and support groups. In particular, training
2153 is developed or obtained that develops the skills required to perform the
2154 organization's set of standard processes. The main components of
2155 training include a managed training development program, documented
2156 plans, personnel with appropriate knowledge, and mechanisms for
2157 measuring the effectiveness of the training program. [FM102.HDA102.HDB102.T108]

2158 **Advanced Process Management Process Areas**

2159 The advanced process management process areas provide the
2160 organization with an advanced capability to achieve its quantitative
2161 objectives for quality and process performance. [FM102.HDA102.HDB103.T101]

2162 Figure 3 provides a bird's-eye view of the interactions among the
2163 advanced process management process areas. Each of the advanced
2164 process management process areas is strongly dependent on the ability
2165 to develop and deploy process and supporting assets. The basic
2166 process management process areas provide this ability.
2167 [FM102.HDA102.HDB103.T102]



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Figure 3: Advanced Process Management Process Areas

[FM102.HDA102.HDB103.T105]

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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]

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

2193 Project Management Processes

2194 **The Scope of Project Management Processes**

2195 Project management process areas cover the project management
2196 activities related to planning, monitoring, and controlling the project. The
2197 project management process areas of CMMI are as follows:

2198 [FM102.HDA103.HDB101.T102]

- 2199 • Project Planning
- 2200 • Project Monitoring and Control
- 2201 • Supplier Agreement Management
- 2202 • Integrated Project Management (IPPD)
- 2203 • Risk Management
- 2204 • Integrated Teaming
- 2205 • Quantitative Project Management

2206 To describe the interactions among the project management process
2207 areas, it is most useful to address them in two process area groups:

2208 [FM102.HDA103.HDB101.T104]

- 2209 • The “basic” project management process areas are Project
2210 Planning, Project Monitoring and Control, and Supplier Agreement
2211 Management.
- 2212 • The “advanced” project management process areas are Integrated
2213 Project Management (IPPD), Risk Management, Integrated
2214 Teaming, and Quantitative Project Management.

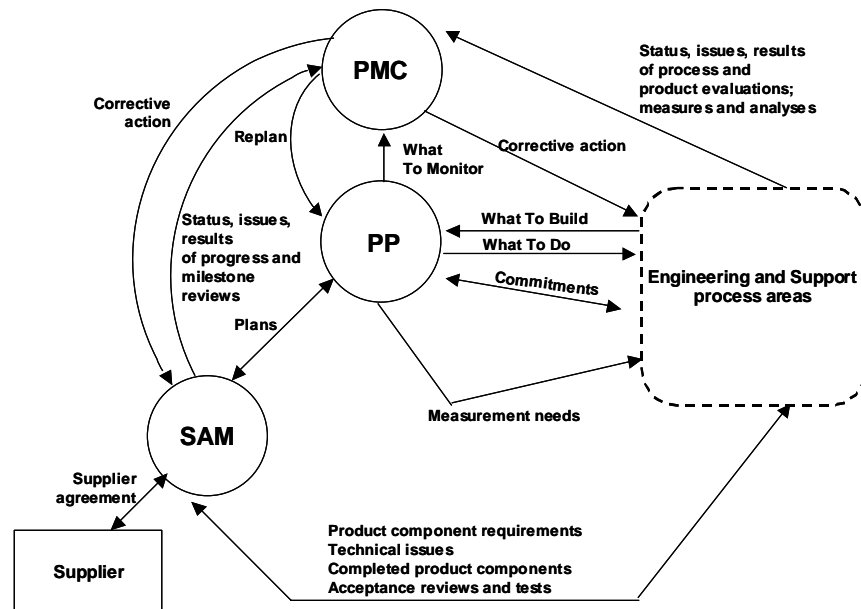
2215 **Basic Project Management Process Areas**

2216 The basic project management process areas address the basic
2217 activities related to establishing and maintaining the project plan,
2218 establishing and maintaining commitments, monitoring progress against
2219 the plan, taking corrective action, and managing supplier agreements.

2220 [FM102.HDA103.HDB102.T101]

2221 Figure 4 provides a bird’s-eye view of the interactions among the basic
2222 project management process areas and with other process areas.

2223 [FM102.HDA103.HDB102.T102]



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Figure 4: Basic Project Management Process Areas

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

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

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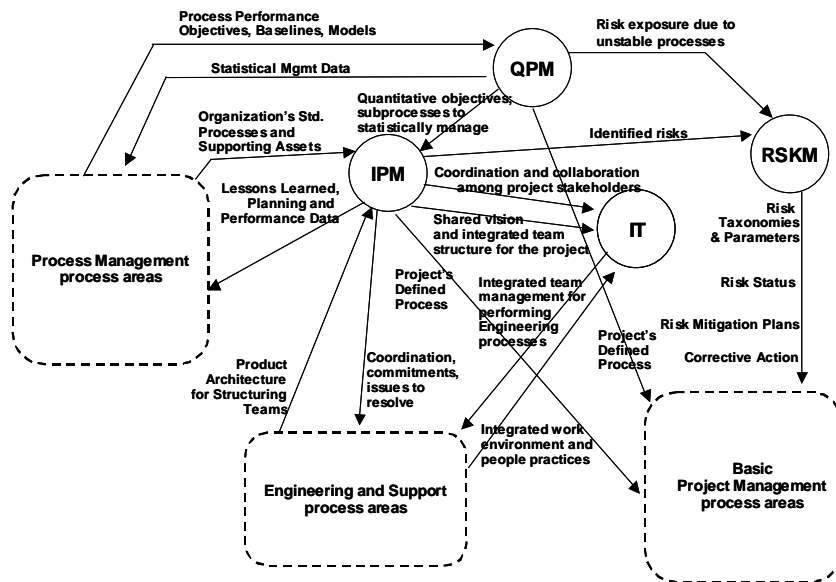
Advanced Project Management Process Areas

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

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



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Figure 5: Advanced Project Management Process Areas

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[FM102.HDA103.HDB103.T105]

2272 As illustrated in Figure 5, the Integrated Project Management (IPPD)
2273 process area establishes and maintains the project's defined process
2274 that is tailored from the organization's set of standard processes. The
2275 project is managed using the project's defined process. The project
2276 uses and contributes to the organization's process and supporting
2277 assets. It also ensures that the principles of IPPD are incorporated into
2278 project planning and the project's defined process, and that the useful
2279 measures and process fragments developed when using the IPPD
2280 approach are included in the organization's process assets.

2281 [FM102.HDA103.HDB103.T108]

2282 The project ensures that the relevant stakeholders associated with the
2283 project coordinate their efforts in a timely manner. It does this by
2284 providing for the management of stakeholder involvement; the
2285 identification, negotiation, and tracking of critical dependencies; and the
2286 resolution of coordination issues within the project with the
2287 stakeholders. These activities are all part of the cultural environment
2288 needed for implementation of IPPD. [FM102.HDA103.HDB103.T110]

2289 The Integrated Project Management (IPPD) process area also creates
2290 the shared vision for the project. This shared vision needs to align both
2291 horizontally and vertically with both the organization and integrated
2292 team shared vision, created in the Organizational Environment for
2293 Integration and Integrated Teaming process areas, respectively. These
2294 shared visions collectively support the coordination and collaboration
2295 among stakeholders. Lastly, the Integrated Project Management (IPPD)
2296 process area implements an integrated team structure to perform the
2297 work of the project in developing a product. This team structure is
2298 typically based on a decomposition of the product itself, much like a
2299 work breakdown structure. This activity is accomplished in conjunction
2300 with the Integrated Teaming process area. [FM102.HDA103.HDB103.T111]

2301 Although risk identification and monitoring are covered in the Project
2302 Planning and Project Monitoring and Control process areas, the Risk
2303 Management process area takes a more continuous, forward-looking
2304 approach to managing risks with activities that include identification of
2305 risk parameters and taxonomies; risk assessments; and risk handling.

2306 [FM102.HDA103.HDB103.T112]

2307 The Quantitative Project Management process area applies quantitative
 2308 and statistical techniques to manage process performance and product
 2309 quality. Quality and process performance objectives for the project are
 2310 based on those established by the organization. The project's defined
 2311 process established in the Integrated Project Management (IPPD) is
 2312 comprised, in part, of process elements and subprocesses whose
 2313 process performance can be predicted. At a minimum, the process
 2314 variation experienced by subprocesses that is critical to achieving the
 2315 project's quality and process performance objectives is understood.
 2316 Corrective action is taken when special causes of variation¹² are
 2317 identified. [FM102.HDA103.HDB103.T114]

2318 While the integrated team structure is established within the Integrated
 2319 Project Management (IPPD) process area, the practices in the
 2320 Integrated Teaming process area provide for the formation and
 2321 sustainment of each integrated team in this structure. Part of sustaining
 2322 the team is developing the integrated team's shared vision, which must
 2323 align with the project and organization shared vision, developed in
 2324 Integrated Project Management (IPPD) and Organizational Environment
 2325 for Integration process areas, respectively. The specific practices in the
 2326 Organizational Environment for Integration and Integrated Teaming
 2327 process areas then set the environment for effecting the integrated
 2328 teamwork for completing projects. In addition, the Integrated Teaming
 2329 process area interacts with other Project Management processes by
 2330 supplying team commitments, work plans, and other information that
 2331 forms the basis for managing the project and supporting risk
 2332 management. [FM102.HDA103.HDB103.T116]

2333 Engineering Processes

2334 **The Scope of Engineering Processes**

2335 Engineering process areas cover the development and maintenance
 2336 practices that are shared across engineering disciplines (for example,
 2337 systems engineering and software engineering). The six engineering
 2338 process areas have inherent interrelationships. These interrelationships
 2339 stem from applying a product development process rather than
 2340 discipline-specific processes such as software engineering or systems
 2341 engineering. [FM102.HDA104.HDB101.T101]

2342 The engineering process areas of CMMI are as follows:

2343 [FM102.HDA104.HDB101.T102]

- 2344 • Requirements Development
- 2345 • Requirements Management

¹² 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.

- 2346 • Technical Solution
- 2347 • Product Integration
- 2348 • Verification
- 2349 • Validation

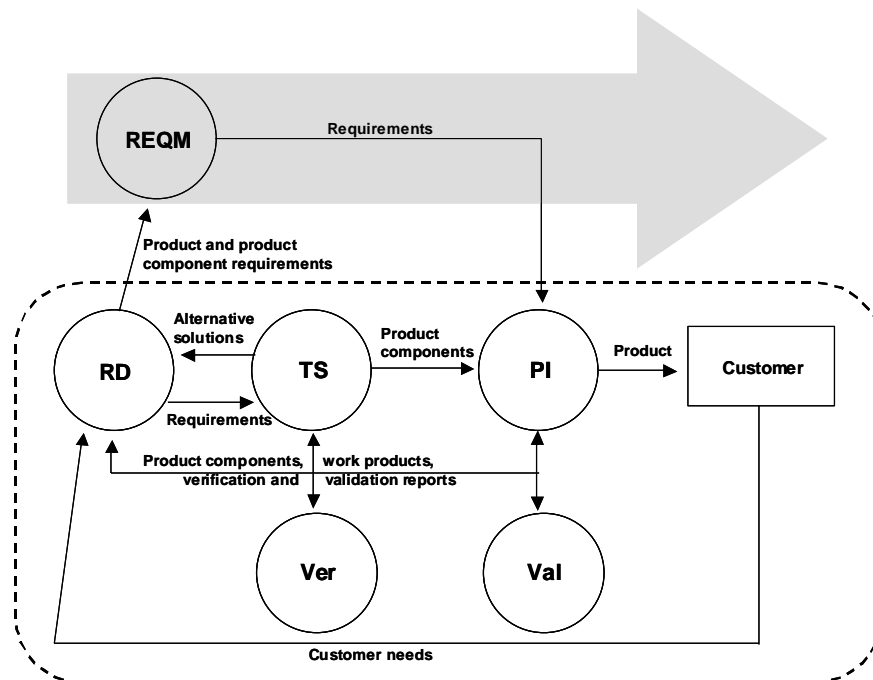
2350 **Interactions Among Engineering Process Areas**

2351 The engineering process areas integrate software engineering and
2352 systems engineering processes into a product-oriented process
2353 improvement scenario. Improving product development processes
2354 targets essential business objectives, rather than specific disciplines.
2355 This approach to processes effectively avoids the tendency toward an
2356 organizational “stove-pipe” mentality. [FM102.HDA104.HDB102.T101]

2357 The technical foundation for IPPD is grounded in a robust systems
2358 engineering approach that encompasses development in the context of
2359 the product life cycle, such as that provided in the engineering process
2360 areas of the CMMI-SE/SW model. Thus, the implementation of the
2361 IPPD environment provides amplifications to specific practices in the
2362 Engineering process areas that emphasize the concurrent development
2363 and life-cycle focus. [FM102.HDA104.HDB102.T102]

2364 These engineering process areas apply to the development of any
2365 product or service in the engineering development domain (for example,
2366 software products, hardware products, services, or processes).
2367 [FM102.HDA104.HDB102.T103]

2368 Figure 6 provides a bird’s-eye view of the interactions among all
2369 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 an appropriate level is reached at which point, discipline-specific product components are identified. [FM102.HDA104.HDB102.T107]

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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]

2391 The Requirements Development process area also supplies
2392 requirements to Technical Solution, where the requirements are
2393 converted into the product architecture, product component design, and
2394 the product component itself (for example, coding, fabrication). This
2395 information is fed to Product Integration, where product components are
2396 combined and interfaces are assured to meet the interface
2397 requirements supplied by Requirements Development.

2398 [FM102.HDA104.HDB102.T111]

2399 The Requirements Management process area maintains the
2400 requirements. It describes practices for obtaining and controlling
2401 requirement changes, and ensuring other relevant plans and data are
2402 kept current. It provides traceability of requirements from customer, to
2403 product, to product component. [FM102.HDA104.HDB102.T112]

2404 Requirements Management ensures that changes to requirements are
2405 reflected in project plans, activities, and work products. This cycle of
2406 changes may impact all the other engineering process areas, thus
2407 requirements management is a dynamic and often recursive sequence
2408 of events. Establishment and maintenance of the Requirements
2409 Management process area is fundamental to a controlled and
2410 disciplined engineering design process. [FM102.HDA104.HDB102.T113]

2411 The Technical Solution process area develops product component
2412 technical data packages and implements product components that will
2413 be used by the Product Integration process area. The examination of
2414 alternative solutions, with the intent of selecting the optimum design
2415 based upon established criteria, is expected. These criteria may be
2416 significantly different across products, depending on product type,
2417 operational environment, performance requirements, support
2418 requirements, and cost or delivery schedules. The task of selecting the
2419 final solution makes use of the practices in the Decision Analysis and
2420 Resolution process area. [FM102.HDA104.HDB102.T114]

2421 The Technical Solution process area relies on the practices in the
2422 Verification process area to perform design verification and peer
2423 reviews during design and prior to final build. [FM102.HDA104.HDB102.T115]

2424 The Verification process area ensures that selected work products meet
2425 the specified requirements. The Verification process area expects that a
2426 verification strategy is developed to ensure adequate verification. This
2427 verification strategy should be highly integrated with the Technical
2428 Solution process area and the Product Integration process area. It is
2429 generally an incremental process starting with product component
2430 verification and usually concludes with verification of fully assembled
2431 products. [FM102.HDA104.HDB102.T116]

2432 Verification also addresses peer reviews. Peer reviews are a proven
2433 method of defect reduction in product development and maintenance
2434 and provides valuable insight into the work products and product
2435 components being developed and maintained. [FM102.HDA104.HDB102.T117]

2436 The Validation process area validates products against the customer's
2437 needs. Validation may be performed in the operational environment or a
2438 simulated operational environment. Coordination with the customer on
2439 the validation requirements and the validation strategy is one of the
2440 most essential elements of this process area. [FM102.HDA104.HDB102.T118]

2441 The scope of the Validation process area includes validation of
2442 products, product components, and processes. The product, product
2443 component, or process may often require re-verification and re-
2444 validation and is therefore tightly coupled to the other engineering
2445 process areas. Issues discovered during validation are usually resolved
2446 in the Requirements Development or Technical Solution process areas.
2447 [FM102.HDA104.HDB102.T119]

2448 The Product Integration process area establishes the expected
2449 practices associated with generating the best possible integration
2450 strategy, integrating product components and delivering the product to
2451 the customer. [FM102.HDA104.HDB102.T120]

2452 Product Integration uses the practices of both Verification and
2453 Validation in implementing the product integration process. Verification
2454 verifies the interfaces and interface requirements between product
2455 components prior to product integration. This is an essential event in
2456 the integration process. During product integration in the operational
2457 environment, the practices of the Validation process area are used.
2458 [FM102.HDA104.HDB102.T121]

2459 Product Integration addresses the testing needed to ensure proper
2460 functional performance and acceptable physical attributes. After
2461 acceptance testing the product is properly packaged and shipped.
2462 [FM102.HDA104.HDB102.T122]

2463 **Engineering Process Areas and Recursion**

2464 All engineering process areas have been written to support recursion of
2465 the process(es) throughout the product architecture. There is no
2466 specific practice that forces recursive process application. Rather, the
2467 practices are written in a fashion that "expects" process application
2468 throughout the product architecture. You may be more comfortable
2469 viewing the approach as providing a sufficiently generic set of
2470 expectations that can be applied at any level of product detail rather
2471 than as "enabling recursive behavior of a process." Either view is
2472 appropriate. [FM102.HDA104.HDB103.T101]

2473 There are a number of advantages gained by this generality. For
2474 example, the engineering process areas can be applied to a product
2475 that has several layers of product components that address each layer.
2476 Thus, different segments of a very large project can be assessed using
2477 the same model. [FM102.HDA104.HDB103.T102]

2478 Support Processes

2479 The Scope of Support

2480 Support process areas cover the practices that support product
2481 development and maintenance and the establishment and maintenance
2482 of a work environment that facilitates and stimulates integration and
2483 manages people to enable and reward integrative behaviors. The
2484 support process areas of CMMI are as follows: [FM102.HDA105.HDB101.T102]

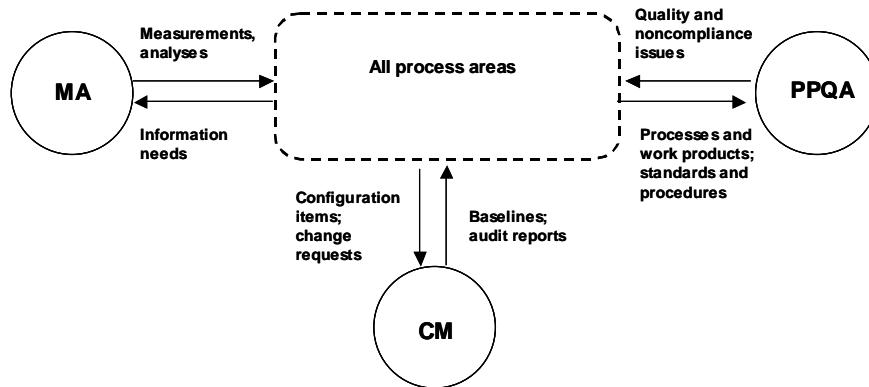
- 2485 • Configuration Management
- 2486 • Process and Product Quality Assurance
- 2487 • Measurement and Analysis
- 2488 • Organizational Environment for Integration
- 2489 • Decision Analysis and Resolution
- 2490 • Causal Analysis and Resolution

2491 The support process areas provide essential processes that are used
2492 by all of the CMMI process areas and are typically used in the context
2493 of performing other processes. In general the support process areas are
2494 targeted towards the project (except for Process and Product Quality
2495 Assurance and Organizational Environment for Integration) but can be
2496 applied more generally to the organization. For example, Process and
2497 Product Quality Assurance can be used with all the process areas to
2498 provide an objective review of the processes and work products
2499 described in all of the process areas. [FM102.HDA105.HDB101.T104]

2500 Basic Support Process Areas

2501 The basic support process areas address basic support functions that
2502 will be used by all of the process areas. Although all support process
2503 areas rely on the other process areas in the CMMI model for inputs, all
2504 of the basic support process areas provide support functions that are
2505 covered by generic practices. [FM102.HDA105.HDB102.T101]

2506 Figure 7 provides a bird's-eye view of the basic Support process areas'
2507 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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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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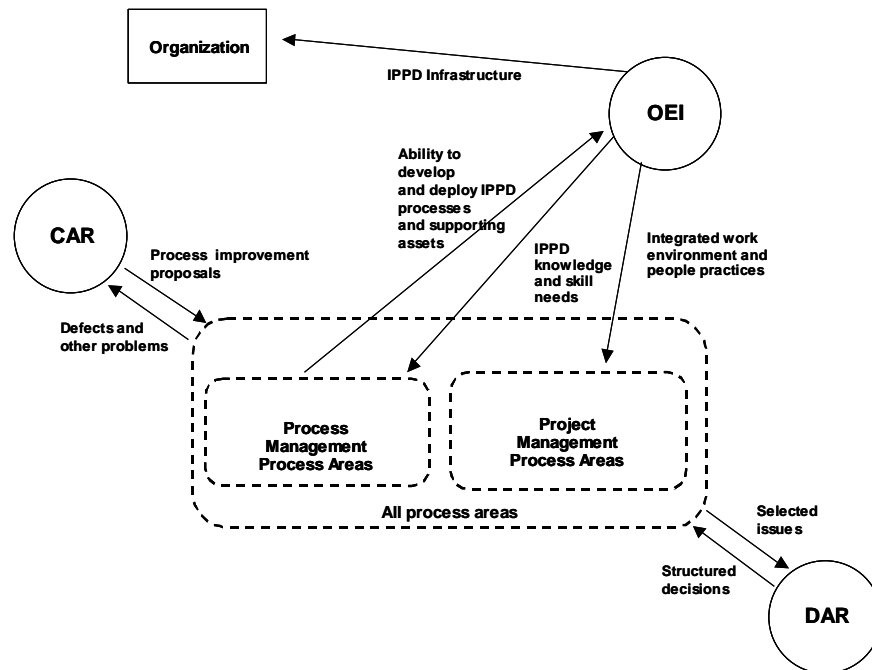
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Figure 8 provides a bird's-eye view of the advanced Support process areas' interactions. [FM102.HDA105.HDB103.T102]

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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]

2558 Using the Causal Analysis and Resolution process area, the project
2559 strives to understand the common causes of variation inherent in the
2560 process and remove them from the project's processes as well as using
2561 this knowledge to continually improve the organization's processes.
2562 Both the defined processes and the organization's set of standard
2563 processes are targets of these improvement activities.

2564 [FM102.HDA105.HDB103.T107]

2565 The Decision Analysis and Resolution process area supports all the
2566 process areas by providing a structured decision-making process that
2567 ensures that alternatives are compared and the best one is selected to
2568 accomplish the goals of the process areas. [FM102.HDA105.HDB103.T108]

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]

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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]

2605 A capable process is defined, documented, practiced, supported,
2606 maintained, controlled, verified, validated, measured, and able to be
2607 improved. [FM120.HDA101.T105]

2608 The CMMI models have resulted from studying the practices and needs
2609 of highly structured, large, and complex projects. While they are also
2610 appropriate for smaller organizations, some of the processes described
2611 in the model will not suit the needs of smaller companies or projects
2612 without tailoring or interpretation. For example, in a small organization
2613 the processes performed by a “group” in the model may instead be the
2614 responsibility of a single individual. [FM120.HDA101.T107]

2615 Assessing for Process Improvement and Benchmarking

2616 Process assessments focus on identifying improvement opportunities.
2617 The organization should set its priorities based on its business and
2618 process improvement objectives, as well as its collection of business
2619 and technical processes. Assessment teams use the CMMI models to
2620 guide them in identifying and prioritizing findings. These findings, with
2621 guidance provided by the practices in the CMMI models, are used (by
2622 an engineering process group, for example) to plan an improvement
2623 strategy for the organization. In addition, many organizations find value
2624 in benchmarking their progress in process improvement for both internal
2625 purposes and with external customers and suppliers. [FM120.HDA102.T101]

2626 For organizations that wish to assess multiple disciplines (for example,
2627 software engineering and system engineering), the unified CMMI
2628 approach permits some economy of scale in model training and
2629 assessment training. One assessment method can provide separate or
2630 combined results for multiple disciplines. [FM120.HDA102.T102]

2631 Alternatively, an organization may wish to use, for example, a limited
2632 Class B or C assessment method¹³ with the continuous representation
2633 to focus on individual process areas of most significant business value.
2634 It might then employ a Class A staged Standard CMMI Assessment
2635 Method for Process Improvement (SCAMPI) on a less frequent basis to
2636 benchmark the entire organization. [FM120.HDA102.T103]

2637 The CMMI assessment products will also allow the assessment of a
2638 single discipline, as in the past. CMMI assessment products provide
2639 consistent findings for staged and continuous representations with
2640 equivalent staging. [FM120.HDA102.T105]

2641 The assessment principles for the CMMI Product Suite remain the
2642 same as those used in past assessments using the SW-CMM and the
2643 Systems Engineering Capability Model (SECM): [FM120.HDA102.T106]

¹³ See Assessment Requirements for CMMI (ARC) and Standard CMMI Assessment Method for Process Improvement (SCAMPI) for more information about classes of assessment methods.

- 2644 • senior management sponsorship
- 2645 • a focus on the organization's business objectives
- 2646 • confidentiality for interviewees
- 2647 • use of a documented assessment method
- 2648 • use of a process reference model (for example, a CMMI model) as
- 2649 a base
- 2650 • a collaborative team approach
- 2651 • a focus on actions for process improvement

2652 Over time, a suite of assessment techniques is expected to be
 2653 available. New techniques will be developed and existing ones
 2654 improved to meet various needs for building internal improvement and
 2655 external confidence. The CMMI project has produced one method to
 2656 meet the need for a rigorous assessment tool for benchmarking and a
 2657 set of guidelines for future additions to the suite for other process
 2658 improvement assessments requiring less rigor and repeatability. This
 2659 first and most rigorous version has been named the Standard CMMI
 2660 Assessment Method for Process Improvement, or SCAMPI. Details on
 2661 this method are available on the Software Engineering Institute Web
 2662 site. [FM120.HDA102.T107]

2663 For benchmarking against other organizations, assessments must
 2664 ensure consistent ratings. The achievement of a specific maturity level
 2665 or the satisfaction of a specific process area must mean the same thing
 2666 for different assessed organizations. Rules for ensuring this consistency
 2667 are provided in the documents mentioned above. SCAMPI is the only
 2668 assessment method initially considered to be suitable for rendering
 2669 ratings for benchmarking the CMMI model. The SEI, as steward of the
 2670 CMMI Product Suite, will assure that any public comments or
 2671 statements about maturity levels or ratings resulting from a SCAMPI
 2672 meet quality and consistency criteria. [FM120.HDA102.T108]

2673 SCAMPI was written to conform to the emerging International
 2674 Organization for Standardization and the International/Electrotechnical
 2675 Commission (ISO/IEC) 15504 technical report. ISO/IEC 15504 is an
 2676 international collaboration to develop a standard set of technical reports
 2677 on software process assessment that has been underway since June
 2678 1993 under the auspices of the ISO/IEC. For those sponsors interested
 2679 in performing a ISO/IEC 15504-conformant assessment, SCAMPI will
 2680 support these needs. [FM120.HDA102.T109]

2681 **Assessment Requirements for CMMI**

2682 The Assessment Requirements for CMMI (ARC) is a set of criteria for
2683 developing, defining, and using assessment methods based on CMMI
2684 products. The ARC provides requirements for multiple types of
2685 assessment methods with guidelines for determining the suitability of a
2686 particular assessment method. Suitability addresses the accuracy and
2687 repeatability of assessment results. [FM120.HDA102.HDB101.T101]

2688 The ARC uses the CMMI models as its associated reference models.
2689 The CMM Appraisal Framework (CAF) v1.0 was originally produced to
2690 address assessment methods associated with the CMM for Software
2691 only. With the incorporation of CMMs into the CMMI architecture, the
2692 ARC has been created to address these new models and the resulting
2693 impacts of the staged and continuous representations of each model.
2694 [FM120.HDA102.HDB101.T102]

2695 The ARC was designed to help improve consistency across multiple
2696 disciplines and assessment methods, and to help assessment method
2697 developers, sponsors, and users understand the trade-offs associated
2698 with various methods. More information and a matrix detailing ARC
2699 requirements is available on the Software Engineering Institute Web
2700 site. [FM120.HDA102.HDB101.T103]

2701 Other CMMI-based assessment methods may be appropriate for a
2702 given set of sponsor needs, including self-assessments, initial
2703 assessments, quick-look or mini-assessments, incremental
2704 assessments, and external audit evaluations. Method developers are
2705 expected and encouraged to develop a variety of assessment methods
2706 to meet these needs. [FM120.HDA102.HDB101.T104]

2707 **Making the Transition to CMMI**

2708 This section briefly describes three transition scenarios. The first two
2709 assume the organization has already begun its improvement efforts
2710 using either the SECM or the Software CMM. The third scenario
2711 assumes that the organization has not used a particular reference
2712 model for current improvement efforts, or that there have been no
2713 improvement efforts to date. [FM120.HDA103.T101]

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Organizations with Software CMM Experience

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Most organizations initially making the transition to CMMI will likely be seeking to update their process improvement efforts to incorporate the Version 2.0 draft C improvements and to gain the additional breadth of organizational and life-cycle coverage afforded in the CMMI model. Many of these organizations will need to decide the best timing for transition to preserve the value of plans toward, for example, a particular maturity level achievement. [FM120.HDA103.HDB102.T105]

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

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

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

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

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

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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.HDB103.T101]

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The evolution from EIA/IS 731 involves both: (1) some reorganization of specific practices under goals and process areas and (2) the addition of informative material. Initial transition steps therefore might be to compare current specific practice improvement efforts against those now expected in the CMMI models. [FM120.HDA103.HDB103.T102]

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Organizations Without Experience in Either Model

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

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

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

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

2789 Given sufficient senior management sponsorship, establishing a
2790 specific, technically competent group to guide process improvement
2791 efforts has proven to be a best practice. For an organization whose
2792 mission is to develop software-intensive systems, the group might
2793 include systems engineers and software engineers from projects across
2794 the organization, and selected other membership based on the
2795 business needs driving improvement. For example, a systems
2796 administrator focused on Information Technology support and a
2797 marketing representative concerned with integrating customer needs
2798 could make powerful additions to the engineering process group (EPG).
2799 [FM120.HDA103.HDB104.T105]

2800 **Training**

2801 Training is a key element in the ability of organizations to adopt CMMI
2802 and is therefore a key part of the Product Suite. While an initial set of
2803 courses will be provided by the SEI and its transition partners, your
2804 organization may wish to supplement these courses with internal
2805 instruction. This approach allows the focus of organizational attention to
2806 be placed on the areas marked for greater attention due to the linkage
2807 to the product development value chain. [FM120.HDA103.HDB105.T101]

2808 Initial training will be available for both representations of CMMI models,
2809 with additional training provided to assist those who will need to guide
2810 improvement on the EPG, or those seeking to become lead assessors.
2811 [FM120.HDA103.HDB105.T102]

2812 **Tailoring Criteria**

2813 Tailoring the CMMI model is a process whereby only a subset of the
2814 model is used to make it suitable for a specific application.
2815 [FM120.HDA104.T101]

2816 Tailoring the CMMI assessment method is the selection of options for
2817 use in a specific assessment. In both cases, the intent of tailoring is to
2818 assist an organization or project in aligning the CMMI products with its
2819 business needs and objectives, and thus focus on those aspects of the
2820 products and services that are most beneficial to the organization.
2821 [FM120.HDA104.T102]

2822 The tailoring discussed in this section does not address adaptation of
2823 an organization's set of standard processes for use on a specific
2824 project. Such tailoring is driven by tailoring guidelines defined by an
2825 organization and is further addressed in the Integrated Project
2826 Management (IPPD) process area. [FM120.HDA104.T104]

2827 Tailoring should be done knowing that it can result in significant gaps in
2828 efforts to improve or assess an organization's or project's capabilities.
2829 [FM120.HDA104.T105]

2830 **Model Tailoring Perspectives**

2831 Tailoring of the CMMI model can be viewed from two perspectives:
2832 [FM120.HDA104.HDB101.T101]

- 2833 • Tailoring related to use of the model for process improvement
- 2834 • Tailoring related to use of the model for benchmarking

2835 Many organizations will use the model for benchmarking as well as
2836 process improvement, so the appropriate tailoring will be constrained by
2837 the intersection of criteria outlined below. [FM120.HDA104.HDB101.T102]

2838 **Model Tailoring Criteria for Internal Process Improvement**

2839 For internal process improvement, it is appropriate to restrict or expand
2840 the scope of an organization's or project's improvement effort (including
2841 assessments). The tailoring may address individual disciplines, process
2842 areas, maturity levels, and/or capability levels. Tailoring of the model
2843 should focus on identifying the process areas and practices that support
2844 the business needs and objectives. [FM120.HDA104.HDB102.T101]

2845 Care must be taken when considering tailoring out portions of the
2846 model. Given the model's focus on the essential characteristics of an
2847 effective process, the majority of the process areas and practices in the
2848 model typically would be addressed. In fact, the folly of wholesale
2849 exclusion of fundamental processes and/or practices (in particular at
2850 maturity levels 2 and 3) is clear given the prevalence of data indicating
2851 that following CMM-based improvement efforts will significantly improve
2852 attainment of business objectives. Cited improvements in the literature
2853 include the increased likelihood that an organization or project will
2854 achieve its cost and/or schedule objectives. [FM120.HDA104.HDB102.T102]

2855 Organizations and/or projects implementing less than a full set of
2856 process areas, goals, or practices can still achieve significant value
2857 from the CMMI model. However, due to the significant interrelationship
2858 of model components, exclusion of a significant number of process
2859 areas, goals, and/or practices may constrain the benefits achieved. In
2860 addition, the degree of comparability of assessment results is directly
2861 related to the extent to which the model and assessment method have
2862 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 those that are outside the scope of an assessment. For example, process areas at maturity levels 4 and 5 may be omitted for an assessment focused on maturity level 3, where all process areas for levels 2 and 3 would typically be selected.

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- Process areas, in some unique circumstances, may be determined to be "not applicable" if the process area is, in fact, outside of the organization's scope of work. Typically, very few process areas are eligible for exclusion in this manner. An example of a process area that might be excluded would be Supplier Agreement Management, a process area that may be inapplicable in the absence of suppliers of products and services external to the organization that are critical to the development effort. A maturity level rating could still be determined, with the identification of the "not applicable" process area.

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- A process area is designated as "not rated" if it is outside of the assessment scope or if insufficient data is available to satisfy the data coverage criteria. A maturity level cannot be determined if process areas at that level (or below) are "not rated."

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- Goals, are required and thus are not excluded from those process areas included in the scope of a process improvement or assessment effort. Goals reflect the minimum requirements for satisfying a process area at their defined capability levels. If a process area is applicable, each of its goals is applicable at defined capability levels. Goals work together to support a process area and may not be individually designated as "not applicable."

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- Specific practices and generic practices are expected to be implemented as typical activities necessary to implement and

2908 institutionalize the goals or capability levels. However, appropriate
2909 alternative practices may be substituted for specific practices
2910 and/or generic practices if the alternatives are effective in
2911 implementing and institutionalizing the goals. Infrequently, a
2912 specific practice may be determined during an assessment to be
2913 “not applicable” and thus excluded from coverage.

- 2914 • All other model components (subpractices, examples,
2915 amplifications, elaborations and/or references) contained in CMMI
2916 models are informative and are provided solely for guidance in
2917 implementation.

2918 **Model Tailoring for Smaller Projects**

2919 The CMMI models were written for use by all types of organizations;
2920 however, for small organizations a CMMI model must be interpreted. In
2921 the case of small 3- to 6-month projects, a high-level plan is typically
2922 available that has been developed for a group of projects. This high-
2923 level plan defines the organization, resources, training, management
2924 participation, and quality assurance reporting descriptions for all
2925 member projects. [FM120.HDA104.HDB104.T101]

2926 Conversely, in the project plan, the details of what the project is
2927 developing, the development process, the schedule, and staff assigned
2928 to each task are defined. Often this plan also captures the development
2929 plan, quality assurance plan, and configuration management plan. A
2930 four-person project development group might expect to develop a five-
2931 page project plan. Dynamic parts of the plan, such as the schedule and
2932 list of deliverables are in the plan’s appendix. [FM120.HDA104.HDB104.T102]

2933 Project specifics, such as special customer requirements, may be
2934 covered in the project plan. Usually, the bulk of the project plan is a
2935 detailed schedule in which resources are assigned and tracked. The
2936 global development and test environment, quality assurance review
2937 process, configuration management, delivery processes, and customer
2938 and internal review processes are in the higher-level management plan.
2939 [FM120.HDA104.HDB104.T103]

2940 In small projects, meetings take place more frequently, take less time,
2941 and cover more details. The schedule may contain daily activities, and
2942 may be monitored in weekly meetings. The schedule may change
2943 weekly. A configuration management function keeps every version of
2944 the schedule in the project library. [FM120.HDA104.HDB104.T104]

2945 In a small team, the customer usually knows the entire team and feels
2946 comfortable calling any member of the team to propose or discuss a
2947 change. The team must decide up front how to handle these informal
2948 calls from the customer. Once they have decided on an approach, it
2949 should be captured in the project plan details, and communicated to the
2950 customer. [FM120.HDA104.HDB104.T105]

2951 The work of a small team may be highly collaborative; thus, a formal
2952 peer review may not provide a high return on investment. The checklist
2953 for the review by a peer is just as comprehensive in this small team
2954 approach as it would be for a larger team. All of the standards are
2955 enforced by all of the members of the team. [FM120.HDA104.HDB104.T106]

2956 Periodically, reviews of the project plans and lessons learned may be
2957 funneled to a higher-level of the organization. This review ensures that
2958 the higher level documentation and direction is continually improved.
2959 Best business practices are identified and fed back into the
2960 organization's process asset library, and the organizational processes,
2961 plans, and templates are modified to reflect the improvements used by
2962 the project. The next time the project begins work with a new set of
2963 requirements, it tailors the updated organizational assets.
2964 [FM120.HDA104.HDB104.T107]

2965 **Assessment Tailoring Criteria**

2966 The major tailoring options for a CMMI assessment include:
2967 [FM120.HDA104.HDB105.T101]

- 2968 • Establishing the assessment scope, including the organizational
2969 entity to be assessed, the CMMI process areas to be investigated,
2970 and the capability level to be assessed
- 2971 • Selecting the assessment method
- 2972 • Selecting the assessment team members
- 2973 • Selecting assessment participants from the assessment entity to
2974 be interviewed
- 2975 • Establishing assessment outputs (for example, ratings, project-
2976 specific findings)
- 2977 • Establishing assessment constraints (for example, time spent on
2978 site)

2979 In addition to these tailoring options, the CMMI assessment method
2980 description details a number of specific tailoring options driven by
2981 considering the objectives of a particular assessment and the business
2982 objectives of the organization and/or project. Documentation of CMMI
2983 assessment plans and results must always include a description of the
2984 tailoring options selected, as well as any model tailoring. Such
2985 documentation will enable a determination to be made of the
2986 comparability of assessment results across organizations.
2987 [FM120.HDA104.HDB105.T102]

7 Process Areas

2989 MATURITY LEVEL: 2 MANAGED

2990 The following section contains all of the process areas that belong to
2991 maturity level 2. The maturity level 2 process areas of CMMI are as
2992 follows: [FM109.T101]

- 2993 • Requirements Management
- 2994 • Project Planning
- 2995 • Project Monitoring and Control
- 2996 • Supplier Agreement Management
- 2997 • Measurement and Analysis
- 2998 • Process and Product Quality Assurance
- 2999 • Configuration Management

3000 *Refer to the Model Components section of the Structure of the Model*
3001 *chapter of the Overview for more information about CMMI maturity*
3002 *levels.* [FM109.T101.R101]

3003 REQUIREMENTS MANAGEMENT

3004 Maturity Level 2

3005 Purpose

3006 The purpose of Requirements Management is to manage the
3007 requirements of the project's products and product components and to
3008 identify inconsistencies between those requirements and the project's
3009 plans and work products. [PA146]

3010 Introductory Notes

3011 The term "requirements" refers to product and product component
3012 requirements that are received by or generated by the project, including
3013 those requirements levied on the project by the organization. The
3014 requirements are both technical and non-technical. The practices in the
3015 Requirements Management process area are the source for the current,
3016 approved set of requirements upon which all of the practices in the
3017 other project process areas act. [PA146.N101]

3018 The project takes appropriate steps to ensure that the agreed-upon set
3019 of requirements is managed to support the planning and execution
3020 needs of the project. When a project receives requirements from an
3021 approved requirements provider, the requirements are reviewed with
3022 the requirements provider to resolve issues and prevent
3023 misunderstanding before the requirements are incorporated into the
3024 project's plans. After agreement between the requirements provider and
3025 the requirements receiver, commitment to the requirements is obtained
3026 from the project participants who have to do project activities and
3027 implement the requirements. The project manages changes to the
3028 requirements as they evolve during the project and identifies any
3029 inconsistencies that occur between the plans and work products and
3030 the requirements. [PA146.N102]

3031 Part of the management of requirements is to capture requirements
3032 changes and rationale and maintain bi-directional traceability among
3033 source requirements and all product and product component
3034 requirements. [PA146.N103]

3035 This process area is tightly coupled with the Requirements
3036 Development and the Technical Solution process areas, which address
3037 the processes for transforming stakeholder needs into product
3038 requirements and deciding how to allocate or distribute requirements
3039 among the product components. The practices in the Requirements
3040 Management process area should be done concurrently with the
3041 practices in the Requirements Development process area and the
3042 Technical Solution process area when those practices are
3043 implemented. [PA146.N104]

3044 Related Process Areas

3045 *Refer to the Requirements Development process area for more*
3046 *information regarding transforming stakeholder needs into product*
3047 *requirements and deciding how to allocate or distribute requirements*
3048 *among the product components.* [PA146.R101]

3049 *Refer to the Technical Solution process area for more information about*
3050 *transforming requirements into technical solutions.* [PA146.R102]

3051 *Refer to the Project Planning process area for more information about*
3052 *how project plans reflect requirements and need to be revised as*
3053 *requirements change.* [PA146.R103]

3054 *Refer to the Configuration Management process area for more*
3055 *information about baselining and controlling changes to configuration*
3056 *documentation for requirements* [PA146.R104]

3057 *Refer to the Project Monitoring and Control process area for more*
3058 *information about tracking and controlling the activities and work*
3059 *products that are based on the requirements.* [PA146.R105]

3060 Specific and Generic Goals

3061 **SG 1 Manage Requirements** [PA146.IG101]

3062 ***Requirements are managed and inconsistencies with project plans and work***
3063 ***products are identified.***

3064 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

3065 ***The process is institutionalized as a managed process.***

3066 Practice to Goal Relationship Table

3067	SG 1 Manage Requirements [PA146.IG101]		
3068	SP 1.1		Obtain an Understanding of Requirements
3069	SP 1.2		Obtain Commitment to Requirements
3070	SP 1.3		Manage Requirements Changes
3071	SP 1.4		Maintain Bi-directional Traceability of Requirements
3072	SP 1.5		Identify Inconsistencies between Project Work and Requirements
3073	GG 2 Institutionalize a Managed Process		
3074	GP 2.1	(CO 1)	Establish an Organizational Policy
3075	GP 2.2	(AB 1)	Plan the Process
3076	GP 2.3	(AB 2)	Provide Resources
3077	GP 2.4	(AB 3)	Assign Responsibility
3078	GP 2.5	(AB 4)	Train People
3079	GP 2.6	(DI 1)	Manage Configurations
3080	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
3081	GP 2.8	(DI 3)	Monitor and Control the Process
3082	GP 2.9	(VE 1)	Objectively Evaluate Adherence
3083	GP 2.10	(VE 2)	Review Status with Higher-Level Management

3084 Specific Practices by Goal

3085 **SG 1** **Manage Requirements** [PA146.IG101]

3086 ***Requirements are managed and inconsistencies with project plans and work***
 3087 ***products are identified.***

3088 The goal is to provide the project with a current, approved set of
 3089 requirements over the life of the project, manage all changes to the
 3090 requirements, make sure the relationships between the requirements
 3091 and other entities affected by the requirements are captured bi-
 3092 directionally and identify inconsistencies between the set of
 3093 requirements and the project plans and work products. Identified
 3094 inconsistencies then generate corrective actions. [PA146.IG101.N101]

3095 *Refer to the Technical Solution process area for more information about*
 3096 *determining the feasibility of the requirements.* [PA146.IG101.N101.R101]

3097 *Refer to the Requirements Development process area for more*
 3098 *information about ensuring that the requirements reflect the needs and*
 3099 *expectations of the customer.* [PA146.IG101.N101.R102]

3100 ***For Software Engineering***
 3101 *The requirements may be a subset of the overall product*
 3102 *requirements, or they may constitute the entire product*
 3103 *requirements* [PA146.IG101.AMP101]

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For Systems Engineering

Each level of product component design (e.g., segment, subsystem) receives the requirements from the higher level.

[PA146.IG101.AMP102]

SP 1.1 Obtain an Understanding of Requirements

Develop an understanding with the requirements providers on the meaning of the requirements. [PA146.IG101.SP101]

As the project matures and requirements are derived, all activities or disciplines will receive requirements. To avoid requirements creep or “leakage,” criteria are established to designate appropriate channels, or official sources, from which to receive requirements. The receiving activities conduct analyses of the requirements with the requirements provider to ensure that a compatible, shared understanding is reached on the meaning of the requirements. The result of this analysis and dialog is an agreed-to set of requirements. [PA146.IG101.SP101.N101]

Typical Work Products

1. Lists of criteria for distinguishing appropriate requirements providers [PA146.IG101.SP101.W101]
2. Lists of criteria for establishing an understanding [PA146.IG101.SP101.W102]
3. Results of analyses against criteria [PA146.IG101.SP101.W103]
4. An agreed-to set of requirements [PA146.IG101.SP101.W104]

Subpractices

1. Establish criteria for distinguishing appropriate requirements providers. [PA146.IG101.SP101.SubP101]
2. Establish objective criteria for the acceptance of requirements. [PA146.IG101.SP101.SubP102]

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

- 3139 3. Analyze requirements to assure the established criteria are met.
3140 [PA146.IG101.SP101.SubP103]
- 3141 4. Reach an understanding of the requirements with the requirements
3142 provider sufficient so the project participants can commit to them.
3143 [PA146.IG101.SP101.SubP104]

3144 **SP 1.2 Obtain Commitment to Requirements**

3145 ***Obtain commitment to the requirements from the project***
3146 ***participants.*** [PA146.IG101.SP102]

3147 *Refer to the Project Monitoring and Control process area for more*
3148 *information about monitoring the commitments made.* [PA146.IG101.SP102.R101]

3149 ***For Integrated Product and Process Development***

3150 *When integrated teams are formed, the project participants*
3151 *are the integrated teams and their members. Commitment to*
3152 *the requirement for interacting with other integrated teams is*
3153 *as important for each integrated team as its commitments to*
3154 *product and other project requirements.* [PA146.IG101.SP102.AMP101]

3155 Whereas the previous practice dealt with reaching an understanding
3156 with the requirements provider, this practice deals with agreements and
3157 commitments among those who have to carry out the activities
3158 necessary to implement the requirements. Requirements evolve
3159 throughout the project, especially during the activities of the
3160 Requirements Development process area and the Technical Solution
3161 process area. As the requirements evolve, a commitment to the
3162 current, approved requirements and the subsequent changes in project
3163 plans, activities, and work products are required among all relevant
3164 stakeholders. [PA146.IG101.SP102.N101]

3165 **Subpractices**

- 3166 1. Assess the impact of requirements on existing commitments.
3167 [PA146.IG101.SP102.SubP101]

3168 The impact on the project participants should be evaluated when the requirements
3169 change or at the start of a new requirement. [PA146.IG101.SP102.SubP101.N101]

- 3170 2. Record the commitment. [PA146.IG101.SP102.SubP102]

3171 **SP 1.3 Manage Requirements Changes**

3172 ***Manage changes to the requirements as they evolve during the***
3173 ***project.*** [PA146.IG101.SP103]

3174 *Refer to the Configuration Management process area for more*
3175 *information about maintaining and controlling the requirements baseline*
3176 *and on making the requirements and change data available to the*
3177 *project.* [PA146.IG101.SP103.R101]

3178 During the project, requirements change for a variety of reasons. As
3179 needs change and as work proceeds, additional requirements are
3180 derived and changes may have to be made to the existing
3181 requirements. It is essential to manage these additions and changes
3182 efficiently and effectively. To effectively analyze the impact of the
3183 changes, it is necessary that the source of each requirement is known
3184 and the rationale for any change is documented. The project manager
3185 may, however, want to track appropriate measures of requirements
3186 volatility to judge whether new or revised controls are necessary.
3187 [PA146.IG101.SP103.N101]

3188 **Typical Work Products**

- 3189 1. Requirements status [PA146.IG101.SP103.W101]
3190 2. Requirements database [PA146.IG101.SP103.W102]
3191 3. Requirements decision database [PA146.IG101.SP103.W103]

3192 **Subpractices**

- 3193 1. Capture all requirements and requirements changes that are given
3194 to or generated by the project. [PA146.IG101.SP103.SubP101]
3195 2. Maintain the requirements change history with the rationale for the
3196 changes. [PA146.IG101.SP103.SubP102]

3197 Maintaining the change history helps track requirements volatility.

3198 [PA146.IG101.SP103.SubP102.N101]

- 3199 3. Evaluate the impact of requirement changes from the standpoint of
3200 relevant stakeholders. [PA146.IG101.SP103.SubP103]
3201 4. Make the requirements and change data available to the project.
3202 [PA146.IG101.SP103.SubP104]

3203 **SP 1.4 Maintain Bi-directional Traceability of Requirements**

3204 ***Maintain bi-directional traceability among the requirements and***
3205 ***the project plans and work products.*** [PA146.IG101.SP104]

3206 The intent of this specific practice is to maintain the bi-directional
 3207 traceability of requirements for each level of product decomposition.
 3208 When the requirements are managed well, traceability can be
 3209 established from the source requirement to its lower-level requirements
 3210 and from the lower-level requirements back to their source. Such bi-
 3211 directional traceability helps determine that all source requirements
 3212 have been completely addressed and that all lower-level requirements
 3213 can be traced to a valid source. Requirements traceability can also
 3214 cover the relationships to other entities such as the product, changes in
 3215 design documentation, test plans, verifications, validations, and work
 3216 tasks. The traceability should cover the horizontal as well as the vertical
 3217 relationships, such as across interfaces. Traceability is particularly
 3218 needed in conducting the impact assessment of requirements changes
 3219 on the project plans, activities, and work products. [PA146.IG101.SP104.N101]

3220 **Typical Work Products**

- 3221 1. Requirements traceability matrix [PA146.IG101.SP104.W101]
- 3222 2. Requirements tracking system [PA146.IG101.SP104.W102]

3223 **Subpractices**

- 3224 1. Maintain requirements traceability to ensure that the source of
 3225 lower-level (derived) requirements is captured. [PA146.IG101.SP104.SubP101]
- 3226 2. Maintain requirements traceability from a requirement to its derived
 3227 requirements and the allocation to functions, objects, people, and
 3228 processes. [PA146.IG101.SP104.SubP102]
- 3229 3. Maintain horizontal traceability from function to function and across
 3230 interfaces. [PA146.IG101.SP104.SubP103]
- 3231 4. Generate the requirements traceability matrix. [PA146.IG101.SP104.SubP104]

3232 **SP 1.5 Identify Inconsistencies between Project Work and Requirements**

3233 ***Identify inconsistencies between the project plans and work***
 3234 ***products and the requirements.*** [PA146.IG101.SP105]

3235 *Refer to the Project Monitoring and Control process area for more*
 3236 *information about monitoring and controlling the project plans and work*
 3237 *products for consistency with requirements.* [PA146.IG101.SP105.R101]

3238 Although some work products resulting from this activity would be
 3239 updated project plans, activities, and work products, these are products
 3240 of the Project Planning process area, not Requirements Management.
 3241 This practice finds the inconsistencies between the requirements and
 3242 the project plans and work products and initiates the corrective action to
 3243 fix them. [PA146.IG101.SP105.N101]

- 3244 **Typical Work Products**
- 3245 1. Documentation of inconsistencies including sources, conditions,
- 3246 rationales [PA146.IG101.SP105.W101]
- 3247 2. Corrective action requirements [PA146.IG101.SP105.W102]
- 3248 3. Corrective action [PA146.IG101.SP105.W103]

- 3249 **Subpractices**
- 3250 1. Review the project's plans, activities, and work products for
- 3251 consistency with the requirements and the changes made to them.
- 3252 [PA146.IG101.SP105.SubP101]
- 3253 2. Identify the source of the inconsistency and the rationale.
- 3254 [PA146.IG101.SP105.SubP102]
- 3255 3. Identify changes that need to be made to the plans and work
- 3256 products resulting from changes to the requirements baseline.
- 3257 [PA146.IG101.SP105.SubP103]
- 3258 4. Initiate corrective actions. [PA146.IG101.SP105.SubP104]

3259 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

3260 ***The process is institutionalized as a managed process.***

3261 Commitment to Perform

3262 **GP 2.1 (CO 1) Establish an Organizational Policy**

3263 ***Establish and maintain an organizational policy for planning and***

3264 ***performing the requirements management process.*** [GP103]

3265 Elaboration:

3266 This policy establishes organizational expectations for managing

3267 requirements and identifying inconsistencies between the requirements

3268 and the project plans and work products. [PA146.EL101]

3269 Ability to Perform

3270 **GP 2.2 (AB 1) Plan the Process**

3271 ***Establish and maintain the requirements and objectives, and plans***

3272 ***for performing the requirements management process.*** [GP104]

3273 Elaboration:

3274 These requirements, objectives, and plans are typically described in the
3275 project plan as described in the Project Planning process area.

3276 [PA146.EL102]

3277 **GP 2.3 (AB 2) Provide Resources**

3278 ***Provide adequate resources for performing the requirements***
3279 ***management process, developing the work products and***
3280 ***providing the services of the process.*** [GP105]

3281 Elaboration:

3282 Examples of tools used in performing the activities of the Requirements
3283 Management process area include the following: [PA146.EL113]

- 3284 • Requirements tracking tools
- 3285 • Traceability tools

3286

3287 **GP 2.4 (AB 3) Assign Responsibility**

3288 ***Assign responsibility and authority for performing the process,***
3289 ***developing the work products, and providing the services of the***
3290 ***requirements management process.*** [GP106]

3291 **GP 2.5 (AB 4) Train People**

3292 ***Train the people performing or supporting the requirements***
3293 ***management process as needed.*** [GP107]

3294 Elaboration:

3295 Examples of training topics include the following: [PA146.EL105]

- 3296 • Application domain
- 3297 • Requirements definition, analysis, review, and management
- 3298 • Requirements management tools
- 3299 • Configuration management
- 3300 • Negotiation and conflict resolution

3301

3302 Directing Implementation

3303 **GP 2.6 (DI 1) Manage Configurations**

3304 ***Place designated work products of the requirements management***
3305 ***process under appropriate levels of configuration management.***

3306 [GP109]

3307 Elaboration:

3308 Examples of work products placed under configuration management
3309 include the following: [PA146.EL108]

- 3310
- Requirements
 - Requirements traceability matrix
- 3311

3312

3313 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

3314 ***Identify and involve the relevant stakeholders of the requirements***
3315 ***management process as planned.*** [GP124]

3316 Elaboration:

3317 For engineering processes, consider stakeholders among customers,
3318 end-users, developers, producers, testers, suppliers, marketers,
3319 maintainers, disposal personnel, and others who may be affected by, or
3320 may affect, the product as well as the process. [PA146.EL115]

3321 Examples of activities for stakeholder involvement include: [PA146.EL116]

- 3322
- 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
- 3323
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3327 **GP 2.8 (DI 3) Monitor and Control the Process**

3328 ***Monitor and control the requirements management process***
3329 ***against the plan and take appropriate corrective action.*** [GP110]

3330 Elaboration:

3331 Examples of measures used in monitoring and controlling the activities
3332 of the Requirements Management process area include the following:

3333 [PA146.EL111]

- 3334 • Requirements volatility (percentage of requirements changed)

3335

3336 Verifying Implementation

3337 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

3338 ***Objectively evaluate adherence of the requirements management***
3339 ***process and the work products and services of the process to the***
3340 ***applicable requirements, objectives, and standards, and address***
3341 ***noncompliance.*** [GP113]

3342 Elaboration:

3343 Examples of activities reviewed include the following: [PA146.EL112]

- 3344 • Managing requirements
- 3345 • Identifying inconsistencies between the project plans and work
- 3346 products and the requirements

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3348 Examples of work products reviewed include the following: [PA146.EL114]

- 3349 • Requirements
- 3350 • Requirements traceability matrix

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3352 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

3353 ***Review the activities, status, and results of the requirements***
3354 ***management process with higher-level management and resolve***
3355 ***issues.*** [GP112]

3356 PROJECT PLANNING

3357 Maturity Level 2

3358 Purpose

3359 The purpose of Project Planning is to establish and maintain plans that
3360 define project activities. [PA163]

3361 Introductory Notes

3362 Project Planning includes developing the project plan, interacting with
3363 stakeholders appropriately and getting commitment to the plan, and
3364 maintaining the plan. [PA163.N101]

3365 Planning begins with requirements that define the product and project.
3366 [PA163.N102]

3367 Planning includes estimating the attributes of the work products and
3368 tasks, the resources needed, negotiating commitments, producing a
3369 schedule, and identifying and analyzing project risks. Iterating through
3370 these activities may be necessary to establish the project plan. The
3371 project plan provides the basis for performing and controlling the
3372 project's activities that address the commitments with the project's
3373 customer. [PA163.N103]

3374 The project plan will usually need to be revised as the project
3375 progresses to address changes in requirements and commitments,
3376 inaccurate estimates, corrective actions, and process changes.
3377 Activities describing both planning and re-planning are contained in this
3378 process area. [PA163.N104]

3379 The term "project plan" is used throughout these practices to refer to
3380 the overall plan for controlling the project. [PA163.N105]

3381 Related Process Areas

3382 *Refer to the Requirements Development process area for more*
3383 *information about developing requirements that define the product and*
3384 *product components. Product and product component requirements*
3385 *and changes to those requirements serve as a basis for planning and*
3386 *re-planning.* [PA163.R101]

3387 *Refer to the Requirements Management process area for more*
3388 *information about managing requirements needed for planning and re-*
3389 *planning. [PA163.R102]*

3390 *Refer to the Risk Management process area for more information about*
3391 *identifying and managing risks. [PA163.R103]*

3392 *Refer to the Technical Solution process area for more information about*
3393 *transforming requirements into product and product component*
3394 *solutions. [PA163.R104]*

3395 *Refer to the Measurement and Analysis process area for more*
3396 *information about the planning required for project progress and*
3397 *performance measurement. [PA163.R105]*

3398 *Refer to the Supplier Selection and Monitoring for more information*
3399 *about the planning needs for managing an acquisition. [PA163.R106]*

3400 Specific and Generic Goals

3401 **SG 1 Establish Estimates** [PA163.IG101]

3402 ***Estimates of project planning parameters are established and maintained.***

3403 **SG 2 Develop a Project Plan** [PA163.IG102]

3404 ***A project plan is established and maintained as the basis for managing the***
3405 ***project.***

3406 **SG 3 Obtain Commitment to the Plan** [PA163.IG103]

3407 ***Commitments to the project plan are established and maintained.***

3408 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

3409 ***The process is institutionalized as a managed process.***

3410 Practice to Goal Relationship Table

3411 SG 1 Establish Estimates [PA163.IG101]

- 3412 SP 1.1 Estimate the Scope of the Project
- 3413 SP 1.2 Establish Estimates of Project Attributes
- 3414 SP 1.3 Define Project Life Cycle
- 3415 SP 1.4 Determine Estimates of Effort and Cost

3416 SG 2 Develop a Project Plan [PA163.IG102]

- 3417 SP 2.1 Establish the Budget and Schedule
- 3418 SP 2.2 Identify Project Risks
- 3419 SP 2.3 Plan for Data Management
- 3420 SP 2.4 Plan for Project Resources
- 3421 SP 2.5 Plan for Needed Knowledge and Skills
- 3422 SP 2.6 Plan Stakeholder Involvement
- 3423 SP 2.7 Establish the Project Plan

3424 SG 3 Obtain Commitment to the Plan [PA163.IG103]

- 3425 SP 3.1 Review Subordinate Plans
- 3426 SP 3.2 Reconcile Work and Resource Levels
- 3427 SP 3.3 Obtain Plan Commitment

3428 GG 2 Institutionalize a Managed Process

- 3429 GP 2.1 (CO 1) Establish an Organizational Policy
- 3430 GP 2.2 (AB 1) Plan the Process
- 3431 GP 2.3 (AB 2) Provide Resources
- 3432 GP 2.4 (AB 3) Assign Responsibility
- 3433 GP 2.5 (AB 4) Train People
- 3434 GP 2.6 (DI 1) Manage Configurations
- 3435 GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders
- 3436 GP 2.8 (DI 3) Monitor and Control the Process
- 3437 GP 2.9 (VE 1) Objectively Evaluate Adherence
- 3438 GP 2.10 (VE 2) Review Status with Higher-Level Management

3439 Specific Practices by Goal

3440 **SG 1 Establish Estimates** [PA163.IG101]

3441 ***Estimates of project planning parameters are established and maintained.***

3442 Project planning parameters include all information needed by the
3443 project to perform the necessary planning, organizing, staffing,
3444 directing, coordinating, reporting and budgeting. [PA163.IG101.N101]

3445 Estimates of planning parameters should have a sound basis to provide
3446 confidence that any plans, based on these estimates, are capable of
3447 supporting project objectives. [PA163.IG101.N102]

3448 Factors that are typically considered when estimating these parameters
3449 include the following: [PA163.IG101.N103]

- 3450 • Project requirements, including the product requirements, the
- 3451 requirements imposed by the organization, the requirements
- 3452 imposed by the customer, and other requirements that impact
- 3453 expectations from the project
- 3454 • Identified tasks and work products
- 3455 • Technical approach
- 3456 • Attributes of the work products and tasks (e.g., size or complexity)
- 3457 • Models or historical data for converting the attributes of the work
- 3458 products and tasks into labor hours and cost
- 3459 • Methodology (models, data, algorithms) used to determine needed
- 3460 material, skills, labor hours, and cost

3461 Documenting the estimating rationale and supporting data is needed for
 3462 the review and commitment of stakeholders to the plan and for
 3463 maintenance of the plan as the project progresses. [PA163.IG101.N104]

3464 SP 1.1 Estimate the Scope of the Project

3465 ***Establish and maintain a top-level work breakdown structure***
 3466 ***(WBS) to estimate of the scope of the project.*** [PA163.IG101.SP101]

3467 The WBS evolves with the project. Initially a top-level WBS can serve
 3468 to structure the initial estimating. The development of a WBS divides
 3469 the overall project into an interconnected set of manageable
 3470 components. The WBS is typically a product-oriented structure that
 3471 provides a scheme for identifying and organizing the logical units of
 3472 work to be managed. The WBS provides a reference and
 3473 organizational mechanism for assigning effort, schedule, and
 3474 responsibility and is used as the underlying framework to plan,
 3475 organize, and control the work done on the project. [PA163.IG101.SP101.N101]

3476 Typical Work Products

- 3477 1. Task descriptions [PA163.IG101.SP101.W101]
- 3478 2. Work product descriptions [PA163.IG101.SP101.W102]
- 3479 3. Work Breakdown Structure [PA163.IG101.SP101.W103]

3480 Subpractices

- 3481 1. Develop a WBS structure based on the product architecture.
 3482 [PA163.IG101.SP101.SubP101]

3483 The WBS provides a scheme for organizing the project's work around the
 3484 products that the work supports. The WBS should permit the identification of the
 3485 following items: [PA163.IG101.SP101.SubP101.N101]

- 3486 • Identified risks and their mitigation tasks

- 3487 • Tasks for deliverables and supporting activities
 - 3488 • Tasks for skill and knowledge acquisition
 - 3489 • Tasks for development of needed support plans, such as configuration
 - 3490 management, quality assurance, and verification plans
 - 3491 • Tasks for integration and life-cycle management of non-developmental items
- 3492 2. Identify the work products in sufficient detail to specify estimates of
- 3493 the project tasks, responsibilities, and schedule.
- 3494 [PA163.IG101.SP101.SubP102]
- 3495 The top-level WBS is intended to help in gauging the project work effort in terms
- 3496 of tasks and organizational roles and responsibilities. The level of understanding
- 3497 of the WBS at this point in time will help in developing realistic schedules thereby
- 3498 minimizing the need for management reserve. [PA163.IG101.SP101.SubP102.N101]
- 3499 Ensure that estimates of effort required for creating and reviewing of work
- 3500 products (including re-reviews) are made. It is very common during planning to
- 3501 estimate only the effort involved in developing and testing components but not in
- 3502 reviewing them. This is also true for other work products such as documents.
- 3503 Failing to estimate the effort that is required in conducting reviews could force
- 3504 project teams to skip reviews or present unrealistic schedules (since moving a
- 3505 committed date may not be acceptable). [PA163.IG101.SP101.SubP102.N102]
- 3506 3. Identify work products (or components of work products) that will
- 3507 be externally acquired. [PA163.IG101.SP101.SubP103]
- 3508 *Refer to the Supplier Agreement Management process area for more*
- 3509 *information acquiring work products from sources external to the*
- 3510 *project.* [PA163.IG101.SP101.SubP103.R101]
- 3511 4. Identify work products that will be reused. [PA163.IG101.SP101.SubP104]

SP 1.2 Establish Estimates of Project Attributes

Establish and document estimates of the attributes of the work products and tasks. [PA163.IG101.SP102]

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]

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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]

Typical Work Products

1. **Technical approach** [PA163.IG101.SP102.W101]
2. **Size and complexity of tasks and work products** [PA163.IG101.SP102.W102]
3. **Estimating models** [PA163.IG101.SP102.W103]

3555 4. Attribute estimates [PA163.IG101.SP102.W104]

3556 **Subpractices**

3557 1. Determine the technical approach for the project.

3558 [PA163.IG101.SP102.SubP101]

3559 The technical approach defines a top-level strategy for development of the
3560 products. It includes decisions on architectural features, such as distributed or
3561 client server; state-of-the-art or established technologies to be applied, such as
3562 robotics, composite materials, or artificial intelligence; and breadth of the
3563 functionality expected in the final products, such as safety, security and
3564 ergonomics. [PA163.IG101.SP102.SubP101.N101]

3565 2. Use appropriate methods to determine the attributes of the work
3566 products and tasks that will be used to estimate the resource
3567 requirements. [PA163.IG101.SP102.SubP102]

3568 Methods for determining size and complexity should be based on validated
3569 models or historical data. [PA163.IG101.SP102.SubP102.N101]

3570 The methods for determining attributes evolve as our understanding of the
3571 relationship of product characteristics to the attributes increases.

3572 [PA163.IG101.SP102.SubP102.N102]

3573 For example, current methods include the following: number of logic gates for
3574 integrated circuit design, lines of code or function points for software,
3575 number/complexity of requirements for systems engineering, and number of
3576 square feet for standard-specified residential homes. [PA163.IG101.SP102.SubP102.N103]

3577

3578 3. Estimate the attributes of the work products and tasks.

3579 [PA163.IG101.SP102.SubP103]

3580 4. Estimate, as appropriate, the labor, machinery, materials, and
3581 methods that will be required by the project. [PA163.IG101.SP102.SubP104]

3582 **SP 1.3 Define Project Life Cycle**

3583 ***Define the project life-cycle phases upon which to scope the***
3584 ***planning effort.*** [PA163.IG101.SP103]

3585 The determination of a project's life-cycle phases provides for planned
3586 periods of evaluation and decision making. These are normally defined
3587 to support logical decision points at which significant commitments are
3588 made from resource and technical approach perspectives. Such points
3589 provide planned events at which project course corrections and
3590 determinations of future scope and cost can be made.

3591 [PA163.IG101.SP103.N101]

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For Software Engineering

The determination of project phases for software typically includes selection and refinement of a software development model to address interdependencies and appropriate sequencing of software project activities.

[PA163.IG101.SP103.N101.AMP101]

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3600

For Software Engineering

Examples of software development models include the following: [PA163.IG101.SP103.N101.AMP103]

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3605

- *Evolutionary*
- *Incremental*
- *Iterative*
- *Spiral*
- *Waterfall*

3606
3607

For Systems Engineering

Identify the major product phase (e.g., concept exploration, development, etc.) for the current state of the product, expected future phases, and the relationships and effects among phases. Adjust planning parameters to account for relationships and effects among phases.

[PA163.IG101.SP103.N101.AMP102]

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The project life cycle consists of phases that need to be defined depending on the scope of requirements, the estimates for project resources, and nature of the project. Larger projects may contain multiple phases, such as concept exploration, development, production, operations, and disposal. Within these phases, sub-phases may be needed. A development phase may include sub-phases such as requirements analysis, design, fabrication, integration, and verification. Depending on the strategy for development, there may be intermediate phases for the creation of prototypes, increments of capability, or spiral model cycles. [PA163.IG101.SP103.N102]

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Understanding the project life cycle is crucial in determining the scope of the planning effort, the timing of the initial planning, as well as the timing and criteria (critical milestones) for replanning. [PA163.IG101.SP103.N103]

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Typical Work Products

1. Project life-cycle phases [PA163.IG101.SP103.W101]
2. Product life-cycle phases [PA163.IG101.SP103.W102]

SP 1.4 Determine Estimates of Effort and Cost

Estimate the project effort and cost for the attributes of the work products and tasks based on estimation rationale. [PA163.IG101.SP104]

Estimates of effort and cost are generally based on the results of analysis using models or historical data applied to the size, activities, and other planning parameters. Confidence in these estimates is based on the rationale for selected model and the nature of the data. There may be occasions where the available historical data does not apply, e.g., where efforts are unprecedented and when the type of task does not fit available models. An effort is unprecedented (to some degree) if a similar product or component has never been built. An effort may also be unprecedented if the development group has never built such a product or component. [PA163.IG101.SP104.N101]

Unprecedented efforts are more risky, require more research to develop reasonable bases of estimate, and require more management reserve. The uniqueness of the project must be documented when using these models to ensure a common understanding of any assumptions made in the initial planning stages. [PA163.IG101.SP104.N102]

Typical Work Products

1. Estimation rationale [PA163.IG101.SP104.W101]
2. Project effort estimates [PA163.IG101.SP104.W102]
3. Project schedule estimates [PA163.IG101.SP104.W103]
4. Project cost estimates [PA163.IG101.SP104.W104]

Subpractices

1. Collect the models or historical data that will be used to transform the attributes of the work products and tasks into estimates of the labor hours, schedule, and cost. [PA163.IG101.SP104.SubP101]

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]

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]

3669 2. Include supporting infrastructure needs when estimating schedule
3670 and cost. [PA163.IG101.SP104.SubP102]

3671 The support infrastructure includes items needed from a life-cycle development
3672 and sustainment perspective for the product. [PA163.IG101.SP104.SubP102.N101]

3673 *For Software Engineering*

3674 *Consider critical computer resources in the host environment,*
3675 *in the test environment, in the target environment, or in any*
3676 *combination of these. Computer resource estimation typically*
3677 *includes the following: identifying the critical computer*
3678 *resources for the software project*
3679 *basing estimates of critical computer resources on allocated*
3680 *requirements [PA163.IG101.SP104.SubP102.N101.AMP101]*

3681 *For Software Engineering*

3682 *Examples of critical computer resources include the following:*
3683 *[PA163.IG101.SP104.SubP102.N101.AMP102]*

- 3684 • *Memory, disk, and network capacity*
- 3685 • *Processor power*
- 3686 • *Communications channel capacity*
- 3687 • *Workstation power*
- 3688 • *Peripheral capacity*

3690 *For Software Engineering*

3691 *Examples of software engineering facilities include the*
3692 *following: [PA163.IG101.SP104.SubP102.N101.AMP103]*

- 3693 • *Host computers, peripherals, and networks*
- 3694 • *Software test computers and peripherals*
- 3695 • *Target computer environment software*
- 3696 • *Software engineering environment (i.e., software tools)*

3697
3698 3. Estimate the effort and cost using models and/or historical data.
3699 [PA163.IG101.SP104.SubP103]

3700 Effort and cost inputs used for estimating typically include the following:
3701 [PA163.IG101.SP104.SubP103.N101]

- 3702 • Judgmental estimates provided by an expert or group of experts (e.g. Delphi
3703 Method)
- 3704 • Risks, including the extent to which the effort is unprecedented
- 3705 • Critical competencies and roles needed to perform the work

- 3706 • Product and product component requirements
- 3707 • Technical approach
- 3708 • Work breakdown structure
- 3709 • Size estimates of work products and anticipated changes
- 3710 • Cost of externally acquired work products
- 3711 • Selected project life-cycle model and processes
- 3712 • Life cycle cost estimates
- 3713 • Capability of tools provided in engineering environment
- 3714 • Skill levels of managers and staff needed to perform the work
- 3715 • Knowledge, skill, and training needs
- 3716 • Facilities needed (e.g., office and meeting space and workstations)
- 3717 • Engineering facilities needed
- 3718 • Capability of manufacturing process(es)
- 3719 • Travel
- 3720 • Level of security required for tasks, work products, hardware, software, personnel,
3721 and work environment
- 3722 • Service level agreements for call centers and warranty work
- 3723 • Direct labor and overhead
- 3724 4. Confirm that effort and cost estimates are based on credible
3725 prediction factors (rationale) that take into account: work product
3726 size and complexity, requirements, risk, technical feasibility,
3727 security issues, precedence, historical performance, and
3728 availability of personnel skill. [PA163.IG101.SP104.SubP104]
- 3729 Confirmation of resource estimates can be accomplished with structured reviews
3730 that check the adequacy and reasonableness of the estimating rationale.
3731 [PA163.IG101.SP104.SubP104.N101]

3732 **SG 2 Develop a Project Plan** [PA163.IG102]

3733 ***A project plan is established and maintained as the basis for managing the***
3734 ***project.***

3735 A project plan is a formal, approved document used to manage and
3736 control the execution of the project and is based on the project
3737 requirements and the established estimates. [PA163.IG102.N101]

3738 The project plan should consider all phases of the project life cycle and
3739 planning should ensure that subordinate plans are consistent with each
3740 other and with the overall project plan. [PA163.IG102.N102]

SP 2.1 Establish the Budget and Schedule

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Establish and maintain the project's budget and schedule.
[PA163.IG102.SP101]

The project's budget and schedule are based on the developed estimates ensuring that budget allocation, task complexity, and task dependencies are appropriately addressed. [PA163.IG102.SP101.N101]

Event-driven schedules have proven to be effective in dealing with project risk. Identifying accomplishments to be demonstrated before initiation of the event provides some flexibility in the timing of the event, a common understanding of what is expected, a better vision of the state of the project, and a more accurate status of the project's tasks.
[PA163.IG102.SP101.N102]

Typical Work Products

1. Project schedules [PA163.IG102.SP101.W101]
2. Schedule dependencies [PA163.IG102.SP101.W102]
3. Project Budget [PA163.IG102.SP101.W103]

Subpractices

1. Identify major milestones. [PA163.IG102.SP101.SubP101]

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]

3775 Typically, the tasks for a project can be accomplished in some ordered sequence
3776 that will minimize the duration of the project. This involves the identification of
3777 predecessor and successor tasks to determine the optimal ordering.
3778 [PA163.IG102.SP101.SubP104.N101]

3779 Examples of tools that can help determine an optimal ordering of task activities
3780 include the following: [PA163.IG102.SP101.SubP104.N102]

- Critical Path Method (CPM)
- Program Evaluation and Review Technique (PERT)
- Resource based scheduling

3784
3785 **5. Define the budget and schedule.** [PA163.IG102.SP101.SubP105]

3786 Establishing and maintaining the project's budget and schedule typically includes
3787 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
- Defining milestones of appropriate time separation
- Defining a management reserve based on the confidence level in meeting the schedule
- Using appropriate historical data to verify the schedule
- Defining incremental funding requirements

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3801
3802 **6. Establish corrective action criteria.** [PA163.IG102.SP101.SubP106]

3803 Criteria are established for determining what constitutes a significant deviation
3804 from the project plan. A basis for gauging issues and problems is essential to
3805 formulate a rigorous and objective standard for determining when a corrective
3806 action should be taken. [PA163.IG102.SP101.SubP106.N101]

3807 **SP 2.2 Identify Project Risks**

3808 ***Identify and analyze project risks.*** [PA163.IG102.SP103]

3809 *Refer to the Risk Management process area for more information about*
3810 *risk management activities.* [PA163.IG102.SP103.R101]

3811 *Refer to the Monitor Project Risks specific practice in the Project*
3812 *Monitoring and Control process area for more information about risk*
3813 *monitoring activities.* [PA163.IG102.SP103.R102]

3814 Risks are identified or discovered and analyzed to support project
3815 planning. This practice should be extended down to all the subordinate
3816 plans to ensure that the appropriate interfacing is taking place between
3817 all relevant stakeholders on identified risks. Project planning risk
3818 identification and analysis typically includes the following:

3819 [PA163.IG102.SP103.N101]

- 3820 • Identifying risks
- 3821 • Analyzing the risks to determine the impact, probability of
3822 occurrence, and time-frame in which problems are likely to occur
- 3823 • Prioritizing risks

3824 **Typical Work Products**

- 3825 1. Identified risks [PA163.IG102.SP103.W101]
- 3826 2. Risk impacts and probability of occurrence [PA163.IG102.SP103.W102]
- 3827 3. Risk priorities [PA163.IG102.SP103.W103]

3828 **Subpractices**

- 3829 1. Identify risks. [PA163.IG102.SP103.SubP101]

3830 The identification of risks involves the identification of potential issues, hazards,
3831 threats, vulnerabilities, etc. that could negatively affect work efforts and plans.
3832 Risks must be identified and described in an understandable way before they can
3833 be analyzed. When identifying risks, it is good practice to use a standard method
3834 for defining risks. Risk identification and analysis tools may be used to help
3835 identify possible problems. [PA163.IG102.SP103.SubP101.N101]

3836 Examples of risk identification and analysis tools include the following:

3837 [PA163.IG102.SP103.SubP101.N102]

- 3838 • Risk taxonomies
- 3839 • Risk assessments
- 3840 • Checklists
- 3841 • Structured interviews
- 3842 • Brainstorming
- 3843 • Performance models
- 3844 • Cost models
- 3845 • Network analysis
- 3846 • Quality factor analysis

3847

- 3848 2. Document the risks. [PA163.IG102.SP103.SubP102]
- 3849 3. Review and obtain agreement with relevant stakeholders on the
- 3850 completeness and correctness of the documented risks.
- 3851 [PA163.IG102.SP103.SubP103]
- 3852 4. Revise the risks as appropriate. [PA163.IG102.SP103.SubP104]

3853 Examples of when identified risks may need to be revised include the following:

3854 [PA163.IG102.SP103.SubP104.N101]

- 3855 • When new risk is identified
 - 3856 • When risks are retired
 - 3857 • When project circumstances change significantly
- 3858

3859 SP 2.3 Plan for Data Management

3860 ***Plan for the management of project data.*** [PA163.IG102.SP102]

3861 *For Integrated Product and Process Development*

3862 *When integrated teams are formed, project data includes data*

3863 *developed and used solely within a particular team as well as*

3864 *data applicable across integrated team boundaries if there are*

3865 *multiple integrated teams.* [PA163.IG102.SP102.AMP101]

3866 Data are the various forms of documentation required to support a

3867 program in all of its areas (e.g., administration, engineering,

3868 configuration, financial, logistics, quality, safety, manufacturing, and

3869 procurement). The data may take any form (e.g., reports, manuals,

3870 notebooks, charts, drawings, specifications, files, or correspondence).

3871 The data may exist in any medium (e.g., printed or drawn on various

3872 materials, photographs, electronic, or multi-media). Data may be

3873 deliverable (e.g., items identified by a program's contract data

3874 requirements) or data may be non-deliverable (e.g., informal data, trade

3875 studies and analyses, internal meeting minutes, internal design review

3876 documentation, lessons learned and action items). Distribution may

3877 take many forms including electronic transmission. [PA163.IG102.SP102.N101]

3878 The data requirements for the project should be established for both the

3879 data items to be created and their content and form, based on a

3880 common or standard set of data requirements. Uniform content and

3881 format requirements for data items facilitate understanding of data

3882 content and help with consistent management of the data resources.

3883 [PA163.IG102.SP102.N102]

3884 The reason for collecting each document should be clear. This task
3885 includes the analysis and validation of project deliverables and non-
3886 deliverables, contract and non-contract data requirements and
3887 customer-supplied data. All too often, data is collected with no clear
3888 understanding of how it will be used. Data is costly and should be
3889 collected only when needed. [PA163.IG102.SP102.N103]

3890 **Typical Work Products**

- 3891 1. Data management plan [PA163.IG102.SP102.W101]
- 3892 2. Master list of managed data [PA163.IG102.SP102.W102]
- 3893 3. Data content and format description [PA163.IG102.SP102.W103]
- 3894 4. Data requirements lists for acquirers and for suppliers
3895 [PA163.IG102.SP102.W104]
- 3896 5. Privacy requirements [PA163.IG102.SP102.W105]
- 3897 6. Security requirements [PA163.IG102.SP102.W106]
- 3898 7. Security procedures [PA163.IG102.SP102.W107]
- 3899 8. Mechanism for data retrieval, reproduction, and distribution
3900 [PA163.IG102.SP102.W108]
- 3901 9. Schedule for collection of project data [PA163.IG102.SP102.W109]
- 3902 10. Listing of project data to be collected [PA163.IG102.SP102.W110]

3903 **Subpractices**

- 3904 1. Establish requirements and procedures to ensure privacy and
3905 security of the data. [PA163.IG102.SP102.SubP101]

3906 Not everyone will have the need or clearance necessary to access the project
3907 data. Procedures must be established to identify who has access to what data as
3908 well as when they have access to the data. [PA163.IG102.SP102.SubP101.N101]

- 3909 2. Establish a mechanism to access archived data. [PA163.IG102.SP102.SubP102]

3910 Accessed information should be in an understandable form (e.g., electronic or
3911 computer output from a database) or represented as originally generated.

3912 [PA163.IG102.SP102.SubP102.N101]

- 3913 3. Plan for the definition, collection, and analysis of project data.

3914 [PA163.IG102.SP102.SubP103]

3915 *Refer to the Measurement and Analysis process area for planning for*
3916 *the definition, collection, and analysis of project progress and*
3917 *performance data.* [PA163.IG102.SP102.SubP103.R101]

3918 Progress and performance data (e.g., effort, cost, schedule, and technical
3919 performance) are essential for project tracking, re-planning, and estimating new
3920 tasks. [PA163.IG102.SP102.SubP103.N101]

3921 *Refer to the Define Measures specific practice of the Measurement and*
3922 *Analysis process area for examples of project management metrics.*

3923 [PA163.IG102.SP102.SubP103.N101.R101]

3924 **SP 2.4 Plan for Project Resources**

3925 ***Plan for necessary resources to perform the project.*** [PA163.IG102.SP104]

3926 *For Integrated Product and Process Development*

3927 *When integrated teams are formed, planning for project*
3928 *resources has to consider staffing of the integrated teams.*

3929 [PA163.IG102.SP104.AMP101]

3930 Defining project resources (labor, machinery/equipment, materials, and
3931 methods) and what quantities of each should be used to perform project
3932 activities builds on the estimates and provides additional information for
3933 the expansion of the WBS for the managing the project.

3934 [PA163.IG102.SP104.N101]

3935 The top level WBS developed earlier as an estimation mechanism is
3936 typically expanded by decomposing these top-levels into work
3937 packages that represent singular work units that can be separately
3938 assigned, performed, and tracked. This subdivision is done to distribute
3939 management responsibility and provide better management control.
3940 This is the level at which organizational functions are assigned to
3941 perform the WBS tasks. This intersection of product and function is
3942 typically called a cost account. Each task or work product at this lower-
3943 level in the WBS should be assigned a unique identifier (e.g., number)
3944 to permit tracking. A WBS may be based on requirements, activities,
3945 work products, or a combination of these items. A task dictionary that
3946 describes the work for each task in the WBS should accompany the
3947 work breakdown structure. [PA163.IG102.SP104.N102]

3948 **Typical Work Products**

3949 1. WBS work packages [PA163.IG102.SP104.W101]

3950 2. WBS task dictionary [PA163.IG102.SP104.W102]

3951 3. Staffing requirements based on project size and scope

3952 [PA163.IG102.SP104.W103]

3953 4. Critical facilities/equipment list [PA163.IG102.SP104.W104]

3954 5. Process/workflow definitions and diagrams [PA163.IG102.SP104.W105]

- 3955 6. Program administration requirements list [PA163.IG102.SP104.W106]
- 3956 **Subpractices**
- 3957 1. Determine process requirements. [PA163.IG102.SP104.SubP101]
- 3958 The processes used to manage a project must be identified, defined, and
3959 coordinated with all the relevant stakeholders to ensure efficient operations during
3960 project execution. [PA163.IG102.SP104.SubP101.N101]
- 3961 2. Determine staffing requirements. [PA163.IG102.SP104.SubP102]
- 3962 The staffing of a project depends on the decomposition of the project
3963 requirements into tasks, roles, and responsibilities for accomplishing the project
3964 requirements as laid out within the work packages of the WBS.
3965 [PA163.IG102.SP104.SubP102.N101]
- 3966 Staffing requirements must consider the knowledge and skills required for each of
3967 the identified positions, as defined in the Plan for Needed Knowledge and Skills
3968 specific practice. [PA163.IG102.SP104.SubP102.N102]
- 3969 3. Determine facilities, equipment, and component requirements.
3970 [PA163.IG102.SP104.SubP103]
- 3971 Most projects are unique in some sense and require some set of unique assets to
3972 accomplish the objectives of the project. The determination and acquisition of
3973 these assets in a timely manner is crucial to project success.
3974 [PA163.IG102.SP104.SubP103.N101]
- 3975 Even when the required assets are not unique, comprising a list of all of the
3976 facilities, equipment and parts (e.g., number of computers for the personnel
3977 working on the project, software applications, office space, etc.) provides insight
3978 into one aspect of the scope of an effort that is often overlooked.
3979 [PA163.IG102.SP104.SubP103.N102]

3980 **SP 2.5 Plan for Needed Knowledge and Skills**

3981 ***Plan for knowledge and skills needed to perform the project.***

3982 [PA163.IG102.SP105]

3983 *Refer to the Organizational Training process area for more information*
3984 *about knowledge and skills information to be incorporated into the*
3985 *project plan.* [PA163.IG102.SP105.R101]

3986 Knowledge delivery to projects involves both training of project
3987 personnel and acquisition of knowledge from outside sources.

3988 [PA163.IG102.SP105.N101]

3989 Staffing requirements are dependent on the knowledge and skills
3990 available to support the execution of the project. [PA163.IG102.SP105.N102]

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Typical Work Products

3992

1. Inventory of skill needs [PA163.IG102.SP105.W101]

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2. Inventory of skill needs [PA163.IG102.SP105.W102]

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3. New hire plans [PA163.IG102.SP105.W103]

3995

4. Databases (e.g., skills and training) [PA163.IG102.SP105.W104]

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Subpractices

3997

1. Identify the knowledge and skills needed to perform the project.

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[PA163.IG102.SP105.SubP101]

3999

2. Assess the knowledge and skills available. [PA163.IG102.SP105.SubP102]

4000

3. Select mechanisms for providing needed knowledge and skills.

4001

[PA163.IG102.SP105.SubP103]

4002

Example mechanisms include the following: [PA163.IG102.SP105.SubP103.N101]

4003

- In-house training (both organizational or project)

4004

- External training

4005

- New hires

4006

- External skill acquisition

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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]

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4. Incorporate selected mechanisms in the project plan.

4012

[PA163.IG102.SP105.SubP104]

4013

SP 2.6 Plan Stakeholder Involvement

4014

Plan the involvement with identified stakeholders. [PA163.IG102.SP106]

4015

For Integrated Product and Process Development

4016

When integrated teams are formed, stakeholder involvement needs to be planned down to the integrated team level.

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[PA163.IG102.SP106.AMP101]

4019 Stakeholders are identified from all phases of the product life cycle by
4020 identifying the type of people and functions needing representation in
4021 the project and describing their relevance and the degree of interaction
4022 for specific project activities. A two-dimensional matrix with
4023 stakeholders along one axis and project activities along the other axis is
4024 a convenient format for accomplishing this identification. Relevance of
4025 the stakeholder to the activity in a particular project phase and the
4026 amount of interaction expected would be shown at the intersection of
4027 the project phase activity axis and the stakeholder axis.

4028 [PA163.IG102.SP106.N101]

4029 For the inputs of stakeholders to be useful, careful selection of those to
4030 be engaged is necessary. For each major activity, identify the
4031 stakeholders that are affected by the activity and those who have
4032 expertise that is needed to conduct the activity. This list of stakeholders
4033 will probably change as the project moves through the product life
4034 cycle. It is important however to assure that stakeholders in the later
4035 phases of the life cycle have early inputs to requirements and design
4036 decisions that affect them. [PA163.IG102.SP106.N102]

4037 Examples of the type of material that should be included in a plan for
4038 stakeholder interaction include the following: [PA163.IG102.SP106.N103]

- 4039 • List of all relevant stakeholders
- 4040 • Rationale for stakeholder involvement
- 4041 • Roles and responsibilities of the stakeholders with respect to the
4042 project by project life-cycle phase
- 4043 • Relationships between stakeholders
- 4044 • Relative importance of the stakeholder to project success by
4045 project phase
- 4046 • Resources (e.g., training, materials, time, funding) needed to
4047 ensure stakeholder interaction
- 4048 • Schedule for phasing of stakeholder interaction

4049
4050 Conduct of this practice relies on shared, or exchanged, information
4051 with the previous Plan for Needed Knowledge and Skills specific
4052 practice. [PA163.IG102.SP106.N104]

4053 SP 2.7 Establish the Project Plan

4054 ***Establish and maintain the overall project plan content.***

4055 [PA163.IG102.SP107]

4056

For Systems Engineering

4057

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

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Examples of plans that have been used in the U.S. Department of Defense community include the following:

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[PA163.IG102.SP107.AMP103]

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4064

- *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.*

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- *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.*

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- *System Engineering Management Plan – a plan that details the integrated technical effort across the project.*

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- *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.*

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- *Systems Engineering Detailed Schedule – a detailed, time dependent, task-oriented schedule that associates specific dates and milestones with the Systems Engineering Master Schedule.*

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For Software Engineering

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For software, the planning document is often referred to as one of the following: [PA163.IG102.SP107.AMP102]

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- *A software development plan*

4088

- *A software project plan*

4089

- *A software plan*

4090 A documented plan that address all relevant planning items is
4091 necessary to achieve the mutual understanding, commitment, and
4092 performance of individuals, groups, and organizations that must
4093 execute or support the plans. The plan generated for the project defines
4094 all aspects of the effort, tying together in a logical manner: product life-
4095 cycle considerations; technical and management tasks; budgets and
4096 schedules; milestones; data management, risk identification, resource
4097 and skill requirements; and stakeholder identification and interaction.
4098 Infrastructure descriptions include responsibility and authority
4099 relationships for project staff, management, and support organizations.
4100 [PA163.IG102.SP107.N101]

4101 **Typical Work Products**

- 4102 1. Overall project plan [PA163.IG102.SP107.W101]

4103 **SG 3 Obtain Commitment to the Plan** [PA163.IG103]

4104 ***Commitments to the project plan are established and maintained.***

4105 To be effective, plans require commitment by those responsible for
4106 implementing and supporting the plan. [PA163.IG103.N101]

4107 **SP 3.1 Review Subordinate Plans**

4108 ***Review subordinate plans to understand project commitments.***

4109 [PA163.IG103.SP103]

4110 ***For Integrated Product and Process Development***

4111 *When integrated teams are formed, their integrated work*
4112 *plans are among the subordinate plans to review.*

4113 [PA163.IG103.SP103.AMP101]

4114 Subordinate plans and strategies developed within other process areas
4115 will typically contain the same type of information as called out for the
4116 overall project plan but tailored to the scope of that particular area. The
4117 subordinate plans should be compatible with and support the overall
4118 project plan to know who has the authority, responsibility, accountability
4119 and control. These subordinate plans should be reviewed to ensure a
4120 common understanding of the scope, goals, roles, and relationships
4121 that are required for the project to be successful. [PA163.IG103.SP103.N101]

4122 **Typical Work Products**

- 4123 1. Record of subordinate plan reviews [PA163.IG103.SP103.W101]

4124 **SP 3.2 Reconcile Work and Resource Levels**

4125 **Reconcile the project plan to reflect available and projected**
4126 **resources.** [PA163.IG103.SP101]

4127 *For Integrated Product and Process Development*

4128 *When integrated teams are formed, special attention needs to*
4129 *be paid to resource commitments in circumstances of*
4130 *distributed integrated teams and when people are on multiple*
4131 *integrated teams in one or many projects.* [PA163.IG103.SP101.AMP101]

4132 To obtain commitment from relevant stakeholders, it is important to
4133 reconcile any differences between the estimates and the available
4134 resources. Reconciliation is typically accomplished by lowering or
4135 deferring technical performance requirements, negotiating more
4136 resources, finding ways to increase productivity, outsourcing, adjusting
4137 the staff skill mix, or revising subordinate plans or schedules.

4138 [PA163.IG103.SP101.N101]

4139 **Typical Work Products**

- 4140 1. Revised methods and corresponding estimating parameters (e.g.,
4141 better tools, use of off-the-shelf components) [PA163.IG103.SP101.W101]
- 4142 2. Re-negotiated budgets [PA163.IG103.SP101.W102]
- 4143 3. Revised schedules [PA163.IG103.SP101.W103]
- 4144 4. Revised requirements list [PA163.IG103.SP101.W104]
- 4145 5. Renegotiated stakeholder agreements [PA163.IG103.SP101.W105]

4146 **SP 3.3 Obtain Plan Commitment**

4147 **Obtain commitment from relevant stakeholders responsible for**
4148 **performing and supporting plan execution.** [PA163.IG103.SP102]

4149 *For Integrated Product and Process Development*

4150 *When integrated teams are formed, the integrated team plans*
4151 *will need buy-in from the team members, the interfacing*
4152 *teams, the project, and the process owners of the standard*
4153 *processes that team has selected for tailored application.*

4154 [PA163.IG103.SP102.AMP101]

4155 Obtaining commitment involves interaction among all relevant
4156 stakeholders both internal and external to the project. The individual or
4157 group making a commitment should have confidence that the work can
4158 be performed within cost, schedule, and performance constraints. Often
4159 a provisional commitment is adequate to allow the effort to begin and to
4160 permit research to be performed to increase the confidence to the
4161 appropriate level needed to obtain a full commitment. [PA163.IG103.SP102.N101]

4162 **Typical Work Products**

- 4163 1. Documented requests for commitments [PA163.IG103.SP102.W101]
- 4164 2. Documented commitments [PA163.IG103.SP102.W102]

4165 **Subpractices**

- 4166 1. Identify needed support and negotiate commitments with relevant
4167 stakeholders. [PA163.IG103.SP102.SubP101]

4168 The WBS can be used as a checklist for assuring that commitments are obtained
4169 for all tasks. [PA163.IG103.SP102.SubP101.N101]

4170 The plan for stakeholder interaction should identify all parties from whom
4171 commitment should be obtained. [PA163.IG103.SP102.SubP101.N102]

- 4172 2. Document all organizational commitments, both full and
4173 provisional, ensuring appropriate level of signatories.
4174 [PA163.IG103.SP102.SubP102]

4175 Commitments must be documented to assure a consistent mutual understanding
4176 as well as for tracking and maintenance. Provisional commitments should be
4177 accompanied by a description of the risks associated with this relationship.
4178 [PA163.IG103.SP102.SubP102.N101]

- 4179 3. Review internal commitments with senior management as
4180 appropriate. [PA163.IG103.SP102.SubP103]

- 4181 4. Review external commitments with senior management as
4182 appropriate. [PA163.IG103.SP102.SubP104]

4183 Management may have the necessary insight and authority to reduce risks
4184 associated with external commitments. [PA163.IG103.SP102.SubP104.N101]

- 4185 5. Identify commitments on interfaces between elements in the
4186 project, and with other projects and organizational units, for
4187 monitoring. [PA163.IG103.SP102.SubP105]

4188 Well-defined interface specifications form the basis for commitments.
4189 [PA163.IG103.SP102.SubP105.N101]

4190 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

4191 ***The process is institutionalized as a managed process.***

4192 Commitment to Perform

4193 **GP 2.1 (CO 1) Establish an Organizational Policy**

4194 ***Establish and maintain an organizational policy for planning and***
4195 ***performing the project planning process.*** [GP103]

4196 Elaboration:

4197 This policy establishes organizational expectations for estimating the
4198 planning parameters, making internal and external commitments, and
4199 developing the plan for managing the project. [PA163.EL101]

4200 Ability to Perform

4201 **GP 2.2 (AB 1) Plan the Process**

4202 ***Establish and maintain the requirements and objectives, and plans***
4203 ***for performing the project planning process.*** [GP104]

4204 Elaboration:

4205 These requirements, objectives, and plans are described in the plan for
4206 project planning. This plan for project planning differs from the project
4207 plan described in the specific practices in this process area. The
4208 project plan addresses the specific needs and objectives for the project;
4209 whereas the plan for project planning addresses the overall planning of
4210 this process area and how the specific practices will be performed.

4211 [PA163.EL103]

4212 **GP 2.3 (AB 2) Provide Resources**

4213 ***Provide adequate resources for performing the project planning***
4214 ***process, developing the work products and providing the services***
4215 ***of the process.*** [GP105]

4216 Elaboration:

4217 Special expertise, equipment, and facilities in project planning may be
4218 required. Special expertise in project planning may include the
4219 following: [PA163.EL104]

- 4220
- Experienced estimators
 - Schedulers
 - Technical experts in applicable areas (e.g., product domain and technology)
- 4221
4222
4223

4224 Examples of tools used in performing the activities of the Project
4225 Planning process area include the following: [PA163.EL106]

- 4226
- Spreadsheet programs
 - Estimating models
 - Project planning and scheduling packages
- 4227
4228
4229

4230 **GP 2.4 (AB 3) Assign Responsibility**

4231 *Assign responsibility and authority for performing the process,*
4232 *developing the work products, and providing the services of the*
4233 *project planning process.* [GP106]

4234 **GP 2.5 (AB 4) Train People**

4235 *Train the people performing or supporting the project planning*
4236 *process as needed.* [GP107]

4237 Elaboration:

4238 Examples of training topics include the following: [PA163.EL108]

- 4239
- Estimating
 - Budgeting
 - Negotiating
 - Risk identification and analysis
 - Data management
 - Planning
 - Scheduling
- 4240
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4247 Directing Implementation

4248 **GP 2.6 (DI 1) Manage Configurations**

4249 ***Place designated work products of the project planning process***
4250 ***under appropriate levels of configuration management.*** [GP109]

4251 Elaboration:

4252 Examples of work products placed under configuration management
4253 include the following: [PA163.EL110]

- 4254 • Work breakdown structure
 - 4255 • Project plan
 - 4256 • Data management plan
 - 4257 • Stakeholder involvement plan
- 4258

4259 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

4260 ***Identify and involve the relevant stakeholders of the project***
4261 ***planning process as planned.*** [GP124]

4262 Elaboration:

4263 This generic practice is different from developing the plan for
4264 stakeholder involvement for the project itself, which is covered in a
4265 specific practice of this process area. [PA163.EL111]

4266 At the project level, consider stakeholders from among senior
4267 managers, project managers, project functional managers (e.g.,
4268 systems engineering, software engineering, other disciplines), software
4269 engineers, systems engineers, manufacturing engineers, logisticians,
4270 suppliers, customers, and others who may be affected by, or may
4271 affect, the project. [PA163.EL118]

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Examples of activities for stakeholder involvement include: [PA163.EL119]

- Establishing estimates
- Reviewing and resolving issues on the completeness and correctness of the project risks
- Reviewing data management plans
- Establishing project plans
- Reviewing project plans and resolving issues on work and resource issues

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GP 2.8 (DI 3) Monitor and Control the Process

Monitor and control the project planning process against the plan and take appropriate corrective action. [GP110]

4284

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

4290

Verifying Implementation

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GP 2.9 (VE 1) Objectively Evaluate Adherence

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]

4296

Elaboration:

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4301

Examples of activities reviewed include the following: [PA163.EL115]

- Establishing estimates
- Developing a project plan
- Obtaining commitments to the project plan

4302

Examples of work products reviewed include the following: [PA163.EL117]

4303

- Work breakdown structure

4304

- Project plan

4305

- Data management plan

4306

- Stakeholder involvement plan

4307

4308

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

4309

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

4310

4311 PROJECT MONITORING AND CONTROL

4312 Maturity Level 2

4313 Purpose

4314 The purpose of Project Monitoring and Control is to provide
4315 understanding into the project's progress so that appropriate corrective
4316 actions can be taken when the project's performance deviates
4317 significantly from the plan. [PA162]

4318 Introductory Notes

4319 A project's documented plan is the basis for monitoring activities,
4320 communicating status, and taking corrective action. Progress is
4321 primarily determined by comparing actual work product and task
4322 attributes, effort, cost, and schedule to the plan at prescribed
4323 milestones or control levels within the project schedule or work
4324 breakdown structure. Appropriate visibility enables timely corrective
4325 action to be taken when performance deviates significantly from the
4326 plan. A deviation is significant if it precludes meeting project objectives
4327 if left unresolved. [PA162.N101]

4328 The term "project plan" is used throughout these practices to refer to
4329 the overall plan for controlling the project. [PA162.N102]

4330 When actual status deviates significantly from the expected values,
4331 corrective actions are taken as appropriate. These actions may require
4332 re-planning, which may include revising the original plan, establishing
4333 new agreements, or including additional mitigation activities within the
4334 current plan. [PA162.N103]

4335 Related Process Areas

4336 *Refer to the Project Planning process area for more information about*
4337 *the project plan, including how it specifies the appropriate level of*
4338 *project monitoring, the measures used to monitor progress, and known*
4339 *risks. [PA162.R101]*

4340 *Refer to the Measurement and Analysis process area for information*
4341 *about measures, including measuring, analyzing, and recording.*
4342 *[PA162.R102]*

4343 Specific and Generic Goals

4344 **SG 1** **Monitor Project Against Plan** [PA162.IG101]

4345 *Actual performance and progress of the project is monitored against the*
4346 *project plan.*

4347 **SG 2** **Manage Corrective Action to Closure** [PA162.IG102]

4348 *Corrective actions are managed to closure when the project's performance or*
4349 *results deviate significantly from the plan.*

4350 **GG 2** **Institutionalize a Managed Process** [CL103.GL101]

4351 *The process is institutionalized as a managed process.*

4352 Practice to Goal Relationship Table

4353	SG 1 Monitor Project Against Plan [PA162.IG101]		
4354	SP 1.1	Monitor Project Planning Parameters	
4355	SP 1.2	Monitor Commitments	
4356	SP 1.3	Monitor Project Risks	
4357	SP 1.4	Monitor Data Management	
4358	SP 1.5	Monitor Stakeholder Involvement	
4359	SP 1.6	Conduct Progress Reviews	
4360	SP 1.7	Conduct Milestone Reviews	
4361	SG 2 Manage Corrective Action to Closure [PA162.IG102]		
4362	SP 2.1	Analyze Issues	
4363	SP 2.2	Take Correction Action	
4364	SP 2.3	Manage Corrective Action	
4365	GG 2 Institutionalize a Managed Process		
4366	GP 2.1	(CO 1)	Establish an Organizational Policy
4367	GP 2.2	(AB 1)	Plan the Process
4368	GP 2.3	(AB 2)	Provide Resources
4369	GP 2.4	(AB 3)	Assign Responsibility
4370	GP 2.5	(AB 4)	Train People
4371	GP 2.6	(DI 1)	Manage Configurations
4372	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
4373	GP 2.8	(DI 3)	Monitor and Control the Process
4374	GP 2.9	(VE 1)	Objectively Evaluate Adherence
4375	GP 2.10	(VE 2)	Review Status with Higher-Level Management

4376 Specific Practices by Goal

4377 **SG 1 Monitor Project Against Plan** [PA162.IG101]

4378 ***Actual performance and progress of the project is monitored against the***
 4379 ***project plan.***

4380 **SP 1.1 Monitor Project Planning Parameters**

4381 ***Monitor the actual values of the project planning parameters***
 4382 ***against the project plan.*** [PA162.IG101.SP101]

4383 Project planning parameters constitute typical indicators of project
 4384 progress and performance and include attributes of work products and
 4385 tasks, cost, effort, and schedule. Attributes of the work products and
 4386 tasks include such items as size, complexity, weight, form, fit, or
 4387 function. [PA162.IG101.SP101.N101]

4388 *Refer to the Measurement and Analysis process area for periodically*
 4389 *measuring, analyzing, and recording the actual attributes of the work*
 4390 *products and tasks and other planning parameters and comparing them*
 4391 *to their associated estimates.* [PA162.IG101.SP101.N101.R101]

4392 Monitoring typically involves measuring the actual values of project
4393 planning parameters, comparing actual values to the estimates in the
4394 plan, and identifying significant deviations. Recording actual values of
4395 the project planning parameters includes recording associated
4396 contextual information to help understand the measures. Analysis of the
4397 impact of significant deviations to determine what corrective action to
4398 take is handled in the second specific goal and its specific practices in
4399 this process area. [PA162.IG101.SP101.N102]

4400 **Typical Work Products**

- 4401 1. Records of project performance [PA162.IG101.SP101.W101]
- 4402 2. Records of significant deviations [PA162.IG101.SP101.W102]

4403 **Subpractices**

- 4404 1. Monitor progress against the schedule. [PA162.IG101.SP101.SubP101]

4405 Progress monitoring typically includes the following: [PA162.IG101.SP101.SubP101.N101]

- 4406 • Periodically measuring the actual completion of activities and milestones
- 4407 • Comparing actual completion of activities and milestones against the schedule
- 4408 • Identifying significant deviations from the schedule estimates in the project plan

- 4409
- 4410 2. Monitor the project's cost and expended effort. [PA162.IG101.SP101.SubP102]

4411 Effort and cost monitoring typically includes the following: [PA162.IG101.SP101.SubP102.N101]

- 4412 • Periodically measuring the actual effort and cost expended and staff assigned
- 4413 • Comparing actual effort, costs, staffing, and training to the estimates documented
- 4414 • Identifying significant deviations from the estimates in the project plan

- 4415
- 4416 3. Monitor the attributes of the work products and tasks.

4417 [PA162.IG101.SP101.SubP103]

4418 *Refer to the Project Planning process area for information about the*
4419 *attributes of work products and tasks.* [PA162.IG101.SP101.SubP103.R101]

4420 Monitoring of the attributes of the work products and tasks typically includes the
4421 following: [PA162.IG101.SP101.SubP103.N101]

- 4422 • Periodically measuring the actual attributes of the work products and tasks, e.g.
- 4423 • Comparing the actual attributes of the work products and tasks (and the changes
- 4424 • Identifying significant deviations from the estimates in the project plan

- 4425
- 4426
- 4427 4. Monitor resources provided and used. [PA162.IG101.SP101.SubP104]

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4429

Refer to the Project Planning process area for information about planned resources. [PA162.IG101.SP101.SubP104.R101]

4430

For Software Engineering

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4432

Examples of software engineering resources include the following: [PA162.IG101.SP101.SubP104.AMP101]

4433

- *Host computers and peripherals*

4434

- *Networks*

4435

- *Software test computers and peripherals*

4436

- *Target computer environment software*

4437

- *Software engineering environment (e.g., software tools)*

4438

4439

Examples of resources include: [PA162.IG101.SP101.SubP104.N101]

4440

- Physical facilities

4441

- Computers, peripherals, and software used in design, manufacturing, test and operation

4442

4443

- Networks

4444

- Security environment

4445

- Manpower

4446

- Processes

4447

4448

5. Monitor the knowledge and skills of project personnel.

4449

[PA162.IG101.SP101.SubP105]

4450

Refer to Project Planning process area for information about planning for knowledge and skills needed to perform the project.

4451

4452

[PA162.IG101.SP101.SubP105.R101]

4453

Monitoring of the knowledge and skills of the project personnel typically includes the following: [PA162.IG101.SP101.SubP105.N101]

4454

4455

- Periodically measuring the acquisition of knowledge and skills by project personnel

4456

4457

- Comparing the actual training obtained to that documented in the project plan

4458

- Identifying significant deviations from the estimates in the project plan

4459

6. Document the significant deviations in the project planning parameters. [PA162.IG101.SP101.SubP106]

4460

4461

SP 1.2 Monitor Commitments

4462

Monitor commitments against those identified in the project plan.

4463

[PA162.IG101.SP102]

4464

Typical Work Products

4465

1. Records of commitment reviews [PA162.IG101.SP102.W101]

4466

Subpractices

4467

1. Regularly review commitments (both external and internal).

4468

[PA162.IG101.SP102.SubP101]

4469

2. Identify commitments that have not been satisfied or which are at significant risk of not being satisfied. [PA162.IG101.SP102.SubP102]

4470

4471

3. Document the results of the commitment reviews.

4472

[PA162.IG101.SP102.SubP103]

4473

SP 1.3 Monitor Project Risks

4474

Monitor risks against those identified in the project plan.

4475

[PA162.IG101.SP103]

4476

Refer to the Project Planning process area for more information about identifying project risks. [PA162.IG101.SP103.R101]

4477

4478

Refer to the Risk Management process area for more information about risk management activities. [PA162.IG101.SP103.R102]

4479

4480

Typical Work Products

4481

1. Records of project risk monitoring [PA162.IG101.SP103.W101]

4482

Subpractices

4483

1. Periodically review the documentation of the risks in the context of the project's current status and circumstances. [PA162.IG101.SP103.SubP101]

4484

4485

2. Revise the documentation of the risks, as additional information becomes available, to incorporate changes. [PA162.IG101.SP103.SubP102]

4486

4487

3. Communicate risk status to those affected. [PA162.IG101.SP103.SubP103]

4488

Examples of risk status include the following: [PA162.IG101.SP103.SubP103.N101]

4489

- A change in the probability that the risk occurs

4490

- A change in risk priority

4491

4492 **SP 1.4 Monitor Data Management**

4493 ***Monitor the management of project data.*** [PA162.IG101.SP106]

4494 *Refer to the Plan for Data Management specific practice in the Project*
4495 *Planning process area for more information about identifying the types*
4496 *of data that should be managed and how to plan for their management.*
4497 [PA162.IG101.SP106.R101]

4498 Once the plans for the management of project data are made, the
4499 management of that data must be monitored to ensure that those plans
4500 are accomplished. [PA162.IG101.SP106.N101]

4501 **Typical Work Products**

- 4502 1. Records of data management [PA162.IG101.SP106.W101]

4503 **Subpractices**

- 4504 1. Periodically review data management activities against their
4505 description in the project plan. [PA162.IG101.SP106.SubP101]
- 4506 2. Identify and document significant issues and their impacts.
4507 [PA162.IG101.SP106.SubP102]
- 4508 3. Document the results of data management activity reviews.
4509 [PA162.IG101.SP106.SubP103]

4510 **SP 1.5 Monitor Stakeholder Involvement**

4511 ***Monitor stakeholder involvement against the project plan.***
4512 [PA162.IG101.SP107]

4513 *Refer to the Plan Stakeholder Involvement specific practice in the*
4514 *Project Planning process area for more information on identifying*
4515 *relevant stakeholders and planning the appropriate involvement with*
4516 *them.* [PA162.IG101.SP107.R101]

4517 Once the stakeholders are identified and the extent of their involvement
4518 within the project are specified in project planning, that involvement
4519 must be monitored to ensure that the appropriate interactions are
4520 occurring with the appropriate stakeholders. [PA162.IG101.SP107.N101]

4521 **Typical Work Products**

- 4522 1. Records of stakeholder involvement [PA162.IG101.SP107.W101]

4523 **Subpractices**

- 4524 1. Periodically review the status of stakeholder involvement.
4525 [PA162.IG101.SP107.SubP101]

- 4526 2. Identify and document significant issues and their impacts.
4527 [PA162.IG101.SP107.SubP102]
- 4528 3. Document the results of the stakeholder involvement status
4529 reviews. [PA162.IG101.SP107.SubP103]

SP 1.6 Conduct Progress Reviews

Periodically review the project's progress, performance, and issues. [PA162.IG101.SP104]

Progress reviews are reviews on the project to keep stakeholders informed. These project reviews can be informal reviews and may not be specified explicitly in the project plans. [PA162.IG101.SP104.N101]

Examples of these reviews include the following: [PA162.IG101.SP104.N102]

- Reviews with staff
- Reviews with project engineers and support
- Reviews with management

Typical Work Products

- 4541 1. Documented project review results. [PA162.IG101.SP104.W101]

Subpractices

- 4543 1. Regularly communicate status on assigned activities and work
4544 products to relevant stakeholders. [PA162.IG101.SP104.SubP101]
4545

Managers, staff members, customers, end users, suppliers, and other stakeholders affected within the organization are included in the reviews as appropriate. [PA162.IG101.SP104.SubP101.N101]

- 4546 2. Review the results of collecting and analyzing measures for
4547 controlling the project. [PA162.IG101.SP104.SubP102]
4548
- 4549 3. Identify and document significant issues and deviations from the
4550 plan. [PA162.IG101.SP104.SubP103]
- 4551 4. Document change requests and problems identified in any of the
4552 work products and processes. [PA162.IG101.SP104.SubP104]
- 4553 5. Document the results of the reviews. [PA162.IG101.SP104.SubP105]
- 4554 6. Track change requests and problem reports to closure.
4555 [PA162.IG101.SP104.SubP106]
4556
4557

4558 **SP 1.7 Conduct Milestone Reviews**

4559 ***Review the accomplishments and results of the project at selected***
4560 ***project milestones.*** [PA162.IG101.SP105]

4561 *Refer to the Project Planning process area for more information about*
4562 *milestone planning.* [PA162.IG101.SP105.R101]

4563 Milestone reviews are planned during project planning and are typically
4564 formal reviews. [PA162.IG101.SP105.N101]

4565 **Typical Work Products**

- 4566 1. Documented milestone review results [PA162.IG101.SP105.W101]

4567 **Subpractices**

- 4568 1. Conduct the reviews at meaningful points in the project's schedule,
4569 such as the completion of selected stages, with relevant
4570 stakeholders. [PA162.IG101.SP105.SubP101]

4571 Managers, staff members, customers, end users, suppliers, and other
4572 stakeholders affected within the organization are included in the milestone
4573 reviews as appropriate. [PA162.IG101.SP105.SubP101.N101]

- 4574 2. Review the commitments, plan, status, and risks of the project.
4575 [PA162.IG101.SP105.SubP102]

- 4576 3. Identify and document significant issues and their impacts.
4577 [PA162.IG101.SP105.SubP103]

- 4578 4. Document the results of the review, action items, and decisions.
4579 [PA162.IG101.SP105.SubP104]

- 4580 5. Track action items to closure. [PA162.IG101.SP105.SubP105]

4581 **SG 2 Manage Corrective Action to Closure** [PA162.IG102]

4582 ***Corrective actions are managed to closure when the project's performance or***
4583 ***results deviate significantly from the plan.***

4584 **SP 2.1 Analyze Issues**

4585 ***Collect and analyze the issues and determine the corrective***
4586 ***actions necessary to address the issues.*** [PA162.IG102.SP101]

4587 **Typical Work Products**

- 4588 1. List of issues needing corrective actions [PA162.IG102.SP101.W101]

4589 **Subpractices**

- 4590 1. Gather issues for analysis. [PA162.IG102.SP101.SubP101]

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Refer to the Verification and Validation process areas for more information about how discovered issues are handled

[PA162.IG102.SP101.SubP101.R101]

Issues are collected from reviews and the execution of other processes.

[PA162.IG102.SP101.SubP101.N101]

Examples of issues to be gathered include: [PA162.IG102.SP101.SubP101.N102]

- Issues discovered through performing verification and validation activities
- Significant deviations in the project planning parameters from the estimates in the project plan
- Commitments (either internal or external) that have not been satisfied
- Significant changes in risk status
- Data access, collection, privacy, or security issues
- Stakeholder representation or involvement issues

2. Analyze issues to determine need for corrective action.

[PA162.IG102.SP101.SubP102]

Refer to Project Planning process area for information about corrective action criteria. [PA162.IG102.SP101.SubP102.R101]

Corrective action is required when the issue may prevent the project from meeting its objectives if left unresolved. [PA162.IG102.SP101.SubP102.N101]

SP 2.2 Take Correction Action

Take corrective action on identified issues. [PA162.IG102.SP102]

Typical Work Products

1. Corrective action plan [PA162.IG102.SP102.W101]

Subpractices

1. Determine and document the appropriate actions needed to address the identified issues. [PA162.IG102.SP102.SubP101]

Refer to the Project Planning process area for more information about the project plan when re-planning is needed [PA162.IG102.SP102.SubP101.R101]

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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

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]

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SP 2.3 Manage Corrective Action

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Manage corrective actions to closure. [PA162.IG102.SP103]

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Typical Work Products

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1. Corrective action results [PA162.IG102.SP103.W101]

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Subpractices

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1. Monitor corrective actions for completion. [PA162.IG102.SP103.SubP101]

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2. Analyze results of corrective actions to determine the effectiveness of the correction action. [PA162.IG102.SP103.SubP102]

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3. Determine and document appropriate actions to correct deviations from planned results for corrective actions. [PA162.IG102.SP103.SubP103]

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GG 2 Institutionalize a Managed Process [CL103.GL101]

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The process is institutionalized as a managed process.

4645

Commitment to Perform

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GP 2.1 (CO 1) Establish an Organizational Policy

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Establish and maintain an organizational policy for planning and performing the project monitoring and control process. [GP103]

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Elaboration:

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This policy establishes organizational expectations for monitoring performance against the project plan and managing corrective action to closure when actual performance or results deviate significantly from the plan. [PA162.EL101]

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Ability to Perform

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GP 2.2 (AB 1) Plan the Process

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Establish and maintain the requirements and objectives, and plans for performing the project monitoring and control process. [GP104]

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Elaboration:

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These requirements, objectives, and plans are typically described in the project plan as described in the Project Planning process area.

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4661

[PA162.EL102]

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GP 2.3 (AB 2) Provide Resources

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Provide adequate resources for performing the project monitoring and control 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 Project Monitoring and Control process area include the following: [PA162.EL103]

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- Cost tracking systems
- Effort reporting systems
- Action item tracking systems
- Project management and scheduling programs

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GP 2.4 (AB 3) 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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4678 **GP 2.5 (AB 4) Train People**

4679 ***Train the people performing or supporting the project monitoring***
4680 ***and control process as needed.*** [GP107]

4681 Elaboration:

4682 Examples of training topics include the following: [PA162.EL104]

- 4683 • Monitoring and control of projects
- 4684 • Risk management
- 4685 • Data management
- 4686

4687 **Directing Implementation**

4688 **GP 2.6 (DI 1) Manage Configurations**

4689 ***Place designated work products of the project monitoring and***
4690 ***control process under appropriate levels of configuration***
4691 ***management.*** [GP109]

4692 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

4693 ***Identify and involve the relevant stakeholders of the project***
4694 ***monitoring and control process as planned.*** [GP124]

4695 Elaboration:

4696 This generic practice is different from monitoring stakeholder interaction
4697 for the project, which is covered by a specific practice in this process
4698 area. [PA162.EL107]

4699 Examples of activities for stakeholder involvement include: [PA162.EL108]

- 4700 • Assessing the project against the plan
- 4701 • Reviewing commitments and resolving issues
- 4702 • Reviewing project risks
- 4703 • Reviewing data management activities
- 4704 • Reviewing project progress
- 4705 • Managing corrective actions to closure
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GP 2.8 (DI 3) Monitor and Control the Process

Monitor and control the project monitoring and control process against the plan and take appropriate corrective action. [GP110]

Elaboration:

Examples of measures used in monitoring and controlling the activities of the Project Monitoring and Control include the following: [PA162.EL105]

- Number of open and closed corrective actions
- Project milestone dates (e.g., planned versus actual and slipped milestones)

4717 Verifying Implementation

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GP 2.9 (VE 1) Objectively Evaluate Adherence

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

4723 Elaboration:

4724 Examples of activities reviewed include the following: [PA162.EL106]

- Monitoring the project against the project plan
- Managing corrective actions to closure

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4728 Examples of work products reviewed include the following: [PA162.EL109]

- Records of project performance
- Project review results

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

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

4736 SUPPLIER AGREEMENT MANAGEMENT

4737 Maturity Level 2

4738 Purpose

4739 The purpose of Supplier Agreement Management is to manage the
4740 acquisition of products and services from suppliers external to the
4741 project for which there exists a formal agreement. [PA166]

4742 Introductory Notes

4743 A formal agreement is any legal agreement between the organization
4744 (representing the project) and the supplier. This agreement may be a
4745 contract, a license, or a memorandum of agreement. The acquired
4746 product is delivered to the project from the supplier and becomes part of
4747 the products delivered to the customer. [PA166.N101]

4748 The acquired product may be a product component in the overall
4749 product under development. In this process area, "product" will be used
4750 to refer to both products and product components acquired from a
4751 supplier. [PA166.N102]

4752 The Supplier Agreement Management process area addresses the
4753 need of the project to effectively select and manage those portions of
4754 work that are produced by suppliers. The term "supplier" is used to
4755 identify an internal or external organization that develops,
4756 manufactures, or supports products being developed or maintained that
4757 will be delivered to the customer. Suppliers may take many forms
4758 depending on business needs including in-house vendors (i.e.,
4759 organizations within a company but which are external to the project),
4760 fabrication capabilities and laboratories, and commercial vendors.
4761 [PA166.N103]

4762 The Supplier Agreement Management process area involves the
4763 following activities: [PA166.N104]

- 4764
- 4765 • Identifying the products to be acquired
 - 4766 • Selecting suppliers
 - 4767 • Establishing and maintaining agreements with suppliers
 - 4768 • Overseeing supplier performance
 - 4769 • Accepting delivery of products
 - Arranging for maintenance and support of the products

4770 This process area does not directly cover the acquisition of products
4771 that are not delivered to the project's customer (for example,
4772 development tools). When development tools are not delivered to the
4773 customer, a project may choose to use the practices in this process
4774 area to minimize the risk to the project. However, if the project
4775 establishes an environment that includes development tools and this
4776 environment is part of the products that are delivered to the customer,
4777 this process area is applicable. [PA166.N105]

4778 This process area also does not directly cover arrangements where the
4779 supplier is integrated into the project team (for example, integrated
4780 product teams, virtual organizations, or employees from a supplier
4781 supplementing the project's staff). Although these situations typically
4782 require formal agreements, they are often handled by other functions
4783 outside of the project. Again, the practices of this process area may be
4784 useful to the project in these situations. [PA166.N106]

4785 Related Process Areas

4786 *Refer to the Project Monitoring and Control process area for more*
4787 *information about monitoring projects and taking corrective action.*
4788 [PA166.R101]

4789 *Refer to the Requirements Development process area for more*
4790 *information about defining requirements.* [PA166.R102]

4791 *Refer to the Requirements Management process area for more*
4792 *information about managing requirements, including the traceability of*
4793 *requirements for products acquired from suppliers.* [PA166.R103]

4794 *Refer to the Technical Solution process area for more information about*
4795 *determining the products and product components that may be*
4796 *acquired from suppliers.* [PA166.R104]

4797 Specific and Generic Goals

4798 **SG 1 Establish Supplier Agreements** [PA166.IG101]

4799 ***Agreements with the suppliers are established and maintained.***

4800 **SG 2 Satisfy Supplier Agreements** [PA166.IG102]

4801 ***Agreements with the suppliers are satisfied by both the project and the***
4802 ***supplier.***

4803 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

4804 ***The process is institutionalized as a managed process.***

4805 Practice to Goal Relationship Table

4806 **SG 1 Establish Supplier Agreements** [PA166.IG101]

4807 SP 1.1 Analyze Needs and Requirements Determined by the Project

4808 SP 1.2 Select Suppliers

4809 SP 1.3 Establish Supplier Agreements

4810 **SG 2 Satisfy Supplier Agreements** [PA166.IG102]

4811 SP 2.1 Acquire COTS Products

4812 SP 2.2 Execute the Supplier Agreement

4813 SP 2.3 Conduct Acceptance Testing

4814 SP 2.4 Transition Products

4815 **GG 2 Institutionalize a Managed Process**

4816 GP 2.1 (CO 1) Establish an Organizational Policy

4817 GP 2.2 (AB 1) Plan the Process

4818 GP 2.3 (AB 2) Provide Resources

4819 GP 2.4 (AB 3) Assign Responsibility

4820 GP 2.5 (AB 4) Train People

4821 GP 2.6 (DI 1) Manage Configurations

4822 GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders

4823 GP 2.8 (DI 3) Monitor and Control the Process

4824 GP 2.9 (VE 1) Objectively Evaluate Adherence

4825 GP 2.10 (VE 2) Review Status with Higher-Level Management

4826 Specific Practices by Goal

4827 **SG 1 Establish Supplier Agreements** [PA166.IG101]

4828 ***Agreements with the suppliers are established and maintained.***

4829 **SP 1.1 Analyze Needs and Requirements Determined by the Project**

4830 ***Analyze the project's needs and requirements that will be fulfilled***
 4831 ***by sources outside the project to determine how the needs and***
 4832 ***requirements will be satisfied.*** [PA166.IG101.SP101]

4833 *For Integrated Product and Process Development*

4834 *When integrated teams are formed, the risk to the acquirer*
 4835 *may be unacceptable if the suppliers for one, or more, of the*
 4836 *products needed are not employing IPPD approaches. In*
 4837 *analyzing needs, the project should consider whether or not to*
 4838 *use a non-IPPD supplier.* [PA166.IG101.SP101.AMP101]

4839 The determination of what products or product components will be
4840 acquired is frequently referred to as a "make-or-buy analysis." It is
4841 based on an analysis of the needs of the project. This make-or-buy
4842 analysis begins early in the project when the requirements are being
4843 developed, continues during the design process, and is completed with
4844 the decision to acquire the product. [PA166.IG101.SP101.N101]

4845 *Refer to the Requirements Development process area for more*
4846 *information about determining the product and product component*
4847 *requirements.* [PA166.IG101.SP101.N101.R101]

4848 *Refer to the Requirements Management process area for more*
4849 *information about managing requirements.* [PA166.IG101.SP101.N101.R102]

4850 *Refer to the Technical Solution process area for more information about*
4851 *design decisions for the make-or-buy analysis.* [PA166.IG101.SP101.N101.R103]

4852 Factors affecting the make-or-buy decision include the following:
4853 [PA166.IG101.SP101.N102]

- 4854 • Functions the products or services will provide and how these
- 4855 functions will fit into the project
- 4856 • Available project resources and skills
- 4857 • Costs of acquiring versus developing internally
- 4858 • Critical delivery and integration dates
- 4859 • Strategic business alliances including high level business
- 4860 requirements
- 4861 • Market research of available products, including commercial-off-
- 4862 the-shelf (COTS) products
- 4863 • Functionality and quality of available products
- 4864 • Skills and capabilities of potential suppliers
- 4865 • Impact on core competencies
- 4866 • Licenses, warranties, responsibilities, and limitations associated
- 4867 with products being acquired
- 4868 • Product availability
- 4869 • Proprietary issues
- 4870 • Risk reduction

4871 Many of these factors are addressed by the project and are covered by
4872 the practices described in the Requirements Development, Technical
4873 Solution, and Project Planning process areas. [PA166.IG101.SP101.N105]

4874 The make-or-buy decision can be conducted using a structured
4875 decision-making approach [PA166.IG101.SP101.N103]

4876 *Refer to the Decision Analysis and Resolution process area for more*
4877 *information about structured decision-making.* [PA166.IG101.SP101.N103.R101]

4878 **Typical Work Products**

- 4879 1. List of products to be acquired [PA166.IG101.SP101.W101]
4880 2. Outsourcing needs and requirements [PA166.IG101.SP101.W102]

4881 **Subpractices**

- 4882 1. Select acquisition options for the candidate products to be acquired
4883 to satisfy the project's needs and requirements.

4884 [PA166.IG101.SP101.SubP101]

4885 These options include the following: [PA166.IG101.SP101.SubP101.N101]

- 4886 • Purchasing COTS products or services
4887 • Obtaining products or services through a contractual agreement
4888 • Obtaining products or services from another part of the business enterprise (i.e.,
4889 another part of the corporation, government agency, etc.)
4890 • Obtaining products from the customer
4891 • Combining some of the above (e.g., contracting for a modification to a COTS
4892 product or having another part of the business enterprise co-develop products
4893 with an external supplier)

4894 **SP 1.2 Select Suppliers**

4895 ***Select suppliers based on an evaluation of their ability to meet the***
4896 ***specified requirements and established criteria.*** [PA166.IG101.SP102]

4897 *Refer to the Decision Analysis and Resolution process area for more*
4898 *information about decision-making approaches that can be used to*
4899 *select suppliers.* [PA166.IG101.SP102.R101]

4900 *Refer to the Requirements Management process area for more*
4901 *information about specified requirements.* [PA166.IG101.SP102.R102]

4902 Criteria should be established to address factors that are important to
4903 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 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]

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2. Document what the project will provide to the supplier.

[PA166.IG101.SP103.SubP102]

Include the following: [PA166.IG101.SP103.SubP102.N101]

- Project-furnished facilities
- Documentation
- Services

3. Document the supplier agreement. [PA166.IG101.SP103.SubP103]

The supplier agreement should include a statement of work, specification, terms and conditions, a list of deliverables, a schedule, budget, and a defined acceptance process. [PA166.IG101.SP103.SubP103.N101]

This subpractice typically includes the following: [PA166.IG101.SP103.SubP103.N102]

- Establishing the statement of work, specification, terms and conditions, list of deliverables, schedule, budget, and acceptance process
- Identifying who from the project and supplier are responsible and authorized to make changes to the supplier agreement
- Identifying how requirements changes and changes to the supplier agreement are determined, communicated, and addressed
- Identifying standards and procedures that will be followed
- Identifying critical dependencies between the project and the supplier
- Identifying the type and depth of project oversight of the supplier, procedures, and evaluation criteria to be used in monitoring supplier performance
- Identifying the supplier's responsibilities for ongoing maintenance and support of the acquired products
- Identifying warranty, ownership, and usage rights for the acquired products
- Identifying acceptance criteria

4. Ensure all parties to the agreement understand and agree to all requirements before implementing the agreement.

[PA166.IG101.SP103.SubP104]

5. Revise the supplier agreement as necessary. [PA166.IG101.SP103.SubP105]

6. Revise the project's plans and commitments as necessary to reflect the supplier agreement. [PA166.IG101.SP103.SubP106]

Refer to the Project Monitoring and Control process area for more information about revising the project plan. [PA166.IG101.SP103.SubP106.R101]

SG 2 Satisfy Supplier Agreements [PA166.IG102]

Agreements with the suppliers are satisfied by both the project and the supplier.

5003 **SP 2.1**

Acquire COTS Products

5004 ***Acquire COTS products to satisfy the specified requirements that***
5005 ***are covered under a supplier agreement.*** [PA166.IG102.SP101]

5006 In the event that COTS products are desired, care in evaluating and
5007 selecting these products and the vendor may be critical to the project.
5008 [PA166.IG102.SP101.N101]

5009 The identification of product components that will be satisfied by COTS
5010 is done in the Technical Solution process area. [PA166.IG102.SP101.N102]

5011 *Refer to the Technical Solution process area for more information about*
5012 *the identification of product components that will be satisfied with COTS*
5013 *products.* [PA166.IG102.SP101.N102.R101]

5014 **Typical Work Products**

- 5015 1. Trade studies [PA166.IG102.SP101.W101]
- 5016 2. Price lists [PA166.IG102.SP101.W102]
- 5017 3. Evaluation criteria [PA166.IG102.SP101.W103]
- 5018 4. Supplier performance reports [PA166.IG102.SP101.W104]

5019 **Subpractices**

- 5020 1. Develop criteria for evaluating COTS products. [PA166.IG102.SP101.SubP101]
- 5021 2. Evaluate candidate products against the associated requirements
5022 and criteria. [PA166.IG102.SP101.SubP102]

5023 *Refer to the Requirements Management and the Requirements*
5024 *Development process areas for more information about the*
5025 *requirements that will be used to evaluate candidate products.*
5026 [PA166.IG102.SP101.SubP102.R101]

5027 These requirements include the following: [PA166.IG102.SP101.SubP102.N101]

- 5028 • Functionality, performance, quality, and reliability
- 5029 • Terms and conditions of warranties for the products
- 5030 • Risk
- 5031 • Suppliers' responsibilities for ongoing maintenance and support of the products
- 5032 3. Evaluate the impact of candidate products on the project's plans
5033 and commitments. [PA166.IG102.SP101.SubP103]

5034 Evaluate according to the following: [PA166.IG102.SP101.SubP103.N101]

- 5035 • Cost of the products
- 5036 • Cost and effort to incorporate the products into the project

- 5037
- Security requirements
- 5038
- Benefits and impacts that may result from future product releases
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4. Assess the suppliers' performance and ability to deliver.

[PA166.IG102.SP101.SubP103.N102]

[PA166.IG102.SP101.SubP104]

[PA166.IG102.SP101.SubP105]

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Refer to the Project Planning and the Risk Management process areas for more information about identifying project risks.

[PA166.IG102.SP101.SubP105.R101]

- 5050
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

- 5065
7. Plan for the maintenance of the COTS product. [PA166.IG102.SP101.SubP107]

SP 2.2 Execute the Supplier Agreement

Perform activities with the supplier as specified in the supplier agreement. [PA166.IG102.SP102]

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Refer to the Project Monitoring and Control process area for more information about monitoring projects and taking corrective action.

[PA166.IG102.SP102.R101]

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Typical Work Products

1. Supplier progress reports [PA166.IG102.SP102.W101]
2. Results of audit reviews [PA166.IG102.SP102.W102]
3. Review reports [PA166.IG102.SP102.W103]
4. Action items [PA166.IG102.SP102.W104]
5. Documentation of work product and document deliveries [PA166.IG102.SP102.W105]

Subpractices

1. Monitor supplier progress and performance (schedule, effort, cost and technical performance) as defined in the supplier agreement. [PA166.IG102.SP102.SubP101]
2. Monitor selected supplier process activities and take corrective action when necessary. [PA166.IG102.SP102.SubP102]

Examples of processes to be monitored are quality assurance and configuration management. [PA166.IG102.SP102.SubP102.N101]

3. Conduct reviews with the supplier as specified in the supplier agreement. [PA166.IG102.SP102.SubP103]

Refer to the Project Monitoring and Control process area for more information about conducting reviews. [PA166.IG102.SP102.SubP103.R101]

Reviews cover both formal and informal reviews and include the following steps: [PA166.IG102.SP102.SubP103.N101]

- Preparing for the review
- Ensuring that relevant stakeholders participate
- Conducting the review
- Identifying, documenting, and tracking to closure all action items
- Preparing and distributing to the affected people a summary report of the review

4. Conduct technical reviews with the supplier as defined in the supplier agreement. [PA166.IG102.SP102.SubP104]

Technical reviews typically include the following: [PA166.IG102.SP102.SubP104.N101]

- Providing the supplier with visibility into the needs and desires of the project's customers and end users, as appropriate
- Reviewing the suppliers technical activities and verifying that the supplier's interpretation and implementation of the requirements are consistent with the project's interpretation, technical commitments are being met, and technical issues are communicated and resolved in a timely manner

- 5108
- Obtaining technical information about the supplier's work products
- 5109
- Providing appropriate technical information and support to the supplier
- 5110
- 5111
5. Conduct management reviews with the supplier as defined in the supplier agreement. [PA166.IG102.SP102.SubP105]
- 5112
- Management reviews typically include the following: [PA166.IG102.SP102.SubP105.N101]
- 5113
- Reviewing critical dependencies
- 5114
- Reviewing project risks involving the supplier
- 5115
- Reviewing schedule and budget
- 5116
- Technical and management reviews may be coordinated and held jointly.
- 5117
- [PA166.IG102.SP102.SubP105.N102]
- 5118
6. Use results to improve the supplier's performance and for establishing and nurturing long-term relationships with preferred suppliers. [PA166.IG102.SP102.SubP106]
- 5119
- 5120
- 5121
7. Monitor risks involving the supplier and take corrective action as necessary. [PA166.IG102.SP102.SubP107]
- 5122
- 5123
- Refer to the Project Monitoring and Control process area for more information about monitoring project risks. [PA166.IG102.SP102.SubP107.R101]*
- 5124
- 5125
8. Revise the supplier agreement and project plans and schedules as necessary. [PA166.IG102.SP102.SubP108]
- 5126

SP 2.3 Conduct Acceptance Testing

Ensure that the supplier agreement is satisfied before accepting the acquired product. [PA166.IG102.SP103]

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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]

5133 Typical Work Products

- 5134
1. Acceptance test procedures [PA166.IG102.SP103.W101]
- 5135
2. Acceptance test reports [PA166.IG102.SP103.W102]

5136 Subpractices

- 5137
1. Define the acceptance procedures. [PA166.IG102.SP103.SubP101]
- 5138
2. Review and obtain agreement with relevant stakeholders on the acceptance procedures before the acceptance review or test.
- 5139
- 5140
- [PA166.IG102.SP103.SubP102]

- 5141 3. Verify that the acquired products satisfy their requirements.
5142 [PA166.IG102.SP103.SubP103]
- 5143 *Refer to the Verification process area for more information about*
5144 *verifying products.* [PA166.IG102.SP103.SubP103.R101]
- 5145 4. Verify that the non-technical commitments associated with the
5146 acquired work product are satisfied. [PA166.IG102.SP103.SubP104]
- 5147 This may include verifying that the appropriate license, warranty, ownership,
5148 usage, and support or maintenance agreements are in place and that all
5149 supporting materials are received. [PA166.IG102.SP103.SubP104.N101]
- 5150 5. Document the results of the acceptance review or test.
5151 [PA166.IG102.SP103.SubP105]
- 5152 6. Establish and obtain supplier agreement on an action plan for any
5153 acquired work products that do not pass their acceptance review or
5154 test. [PA166.IG102.SP103.SubP106]
- 5155 7. Identify, document, and track action items to closure.
5156 [PA166.IG102.SP103.SubP107]
- 5157 *Refer to the Project Monitoring and Control process area for more*
5158 *information about tracking action items.* [PA166.IG102.SP103.SubP107.R101]

SP 2.4 Transition Products

Transition the acquired products from the supplier to the project.

[PA166.IG102.SP104]

Typical Work Products

- 5162 1. Transition plans [PA166.IG102.SP104.W101]
5163 2. Training plans [PA166.IG102.SP104.W102]
5164 3. Support and maintenance plans [PA166.IG102.SP104.W103]

Subpractices

- 5166 1. Ensure there are appropriate facilities to receive, store, use, and
5167 maintain the acquired products. [PA166.IG102.SP104.SubP101]
5168
- 5169 2. Ensure that appropriate training is provided for the people involved
5170 in receiving, storing, using, and maintaining the acquired products.
5171 [PA166.IG102.SP104.SubP102]
- 5172 3. Ensure that storing, distributing, and using the acquired products is
5173 performed according to the terms and conditions specified in the
5174 supplier agreement or license. [PA166.IG102.SP104.SubP103]

5175 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

5176 ***The process is institutionalized as a managed process.***

5177 Commitment to Perform

5178 **GP 2.1 (CO 1) Establish an Organizational Policy**

5179 ***Establish and maintain an organizational policy for planning and***
5180 ***performing the supplier agreement management process.*** [GP103]

5181 Elaboration:

5182 This policy establishes organizational expectations for establishing,
5183 maintaining, and satisfying supplier agreements. [PA166.EL101]

5184 Ability to Perform

5185 **GP 2.2 (AB 1) Plan the Process**

5186 ***Establish and maintain the requirements and objectives, and plans***
5187 ***for performing the supplier agreement management process.*** [GP104]

5188 **GP 2.3 (AB 2) Provide Resources**

5189 ***Provide adequate resources for performing the supplier agreement***
5190 ***management process, developing the work products and***
5191 ***providing the services of the process.*** [GP105]

5192 Elaboration:

5193 Examples of tools used in performing the activities of the Supplier
5194 Agreement Management process area include the following: [PA166.EL102]

- 5195
- Preferred supplier lists
 - Requirements tracking programs
 - Project management and scheduling programs
- 5196
- 5197
- 5198

5199 **GP 2.4 (AB 3) Assign Responsibility**

5200 *Assign responsibility and authority for performing the process,*
5201 *developing the work products, and providing the services of the*
5202 *supplier agreement management process. [GP106]*

5203 **GP 2.5 (AB 4) Train People**

5204 *Train the people performing or supporting the supplier agreement*
5205 *management process as needed. [GP107]*

5206 Elaboration:

5207 Examples of training topics include the following: [PA166.EL103]

- 5208 • Regulations and business practices related to negotiating and
- 5209 working with suppliers
- 5210 • Acquisition planning and preparation
- 5211 • COTS products acquisition
- 5212 • Supplier evaluation and selection
- 5213 • Negotiation and conflict resolution
- 5214 • Supplier management
- 5215 • Testing and transitioning of acquired products
- 5216 • Receiving, storing, using, and maintaining the acquired products
- 5217

5218 Directing Implementation

5219 **GP 2.6 (DI 1) Manage Configurations**

5220 *Place designated work products of the supplier agreement*
5221 *management process under appropriate levels of configuration*
5222 *management. [GP109]*

5223

Elaboration:

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Examples of work products placed under configuration management include the following: [PA166.EL104]

- Statements of work
- Supplier agreements
- Memoranda of agreement
- Subcontracts
- Preferred supplier list

5232

GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders

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Identify and involve the relevant stakeholders of the supplier agreement management process as planned. [GP124]

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Elaboration:

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Examples of activities for stakeholder involvement include: [PA166.EL109]

- Establishing criteria for evaluation of potential suppliers
- Reviewing potential suppliers
- Establishing supplier agreements
- Resolving issues with suppliers
- Reviewing supplier performance

5243

GP 2.8 (DI 3) Monitor and Control the Process

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Monitor and control the supplier agreement 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 Supplier Agreement Management process area include the following: [PA166.EL105]

- Number of changes made to the requirements for the supplier
- Cost and schedule variance per supplier agreement

5253 Verifying Implementation

5254 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

5255 ***Objectively evaluate adherence of the supplier agreement***
5256 ***management process and the work products and services of the***
5257 ***process to the applicable requirements, objectives, and standards,***
5258 ***and address noncompliance.*** [GP113]

5259 Elaboration:

5260 Examples of activities reviewed include the following: [PA166.EL106]

- 5261
- Establishing and maintaining supplier agreements
 - Satisfying supplier agreements
- 5262

5263

5264 Examples of work products reviewed include the following: [PA166.EL108]

- 5265
- Plan for Supplier Agreement Management
 - Supplier agreements
- 5266

5267

5268 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

5269 ***Review the activities, status, and results of the supplier agreement***
5270 ***management process with higher-level management and resolve***
5271 ***issues.*** [GP112]

5272 MEASUREMENT AND ANALYSIS

5273 Maturity Level 2

5274 Purpose

5275 The purpose of Measurement and Analysis is to develop and sustain a
5276 measurement capability that is used to support management
5277 information needs. [PA154]

5278 Introductory Notes

5279 Measurement involves the following: [PA154.N101]

- 5280 • Specifying the objectives of measurement and analysis such that
5281 they are aligned with identified information needs and objectives
- 5282 • Specifying the measures, data collection and storage mechanisms,
5283 analysis techniques, reporting and feedback mechanisms
- 5284 • Implementing the collection, storage, analysis, and reporting of the
5285 data
- 5286 • Providing objective results that can be used in making informed
5287 decisions, and taking appropriate corrective actions

5288 The integration of measurement and analysis activities into project
5289 processes supports the following: [PA154.N102]

- 5290 • Objective planning and estimating
- 5291 • Tracking actual performance against established plans and
5292 objectives
- 5293 • Identifying and resolving process-related issues
- 5294 • Providing a basis for incorporating measurement into additional
5295 processes in the future

5296 The people required to implement a measurement capability may or
5297 may not be employed in a separate organization wide program.
5298 Measurement capability may be integrated into individual projects or
5299 other organizational functions (e.g., Quality Assurance). [PA154.N103]

5300 The initial focus for measurement activities is at the project level.
5301 However, a measurement capability may prove useful for addressing
5302 organizational and/or enterprise wide information needs. [PA154.N104]

5303 Related Process Areas

5304 *Refer to the Project Planning process area for more information about*
5305 *estimating project attributes and other planning information needs.*

5306 [PA154.R101]

5307 *Refer to the Project Monitoring & Control process area for more*
5308 *information about monitoring project performance information needs.*

5309 [PA154.R102]

5310 *Refer to the Configuration Management process area for more*
5311 *information about managing measurement work products.* [PA154.R103]

5312 *Refer to the Requirements Development process area for more*
5313 *information about meeting customer requirements and related*
5314 *information needs.* [PA154.R104]

5315 *Refer to the Requirements Management process area for more*
5316 *information about maintaining requirements traceability and related*
5317 *information needs.* [PA154.R105]

5318 *Refer to the Organizational Process Definition process area for more*
5319 *information about establishing an Organizational Measurement*
5320 *Repository.* [PA154.R106]

5321 *Refer to the Quantitative Project Management process area for more*
5322 *information about understanding variation and the appropriate use of*
5323 *statistical analysis techniques.* [PA154.R107]

5324 Specific and Generic Goals

5325 **SG 1** **Align Measurement and Analysis Activities** [PA154.IG101]

5326 ***Measurement objectives and practices are aligned with identified information***
5327 ***needs and objectives.***

5328 **SG 2** **Provide Measurement Results** [PA154.IG102]

5329 ***Measurement results that address identified information needs and objectives***
5330 ***are provided.***

5331 **GG 2** **Institutionalize a Managed Process** [CL103.GL101]

5332 ***The process is institutionalized as a managed process.***

5333 Practice to Goal Relationship Table

5334 SG 1 Align Measurement and Analysis Activities [PA154.IG101]

- 5335 SP 1.1 Establish Measurement Objectives
- 5336 SP 1.2 Specify Measures
- 5337 SP 1.3 Specify Data Collection and Storage Procedures
- 5338 SP 1.4 Specify Analysis Procedures

5339 SG 2 Provide Measurement Results [PA154.IG102]

- 5340 SP 2.1 Collect Measurement Data
- 5341 SP 2.2 Analyze Measurement Data
- 5342 SP 2.3 Store Data and Results
- 5343 SP 2.4 Communicate Results

5344 GG 2 Institutionalize a Managed Process

- 5345 GP 2.1 (CO 1) Establish an Organizational Policy
- 5346 GP 2.2 (AB 1) Plan the Process
- 5347 GP 2.3 (AB 2) Provide Resources
- 5348 GP 2.4 (AB 3) Assign Responsibility
- 5349 GP 2.5 (AB 4) Train People
- 5350 GP 2.6 (DI 1) Manage Configurations
- 5351 GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders
- 5352 GP 2.8 (DI 3) Monitor and Control the Process
- 5353 GP 2.9 (VE 1) Objectively Evaluate Adherence
- 5354 GP 2.10 (VE 2) Review Status with Higher-Level Management

5355 Specific Practices by Goal

5356 **SG 1 Align Measurement and Analysis Activities** [PA154.IG101]

5357 ***Measurement objectives and practices are aligned with identified information***
 5358 ***needs and objectives.***

5359 The specific practices covered under this specific goal may be
 5360 addressed concurrently or in differing order: [PA154.IG101.N101]

- 5361 • When establishing measurement objectives, experts often think
- 5362 ahead about necessary criteria for specifying measures and
- 5363 analysis procedures. They also think concurrently about the
- 5364 constraints imposed by data collection and storage procedures.
- 5365 • It often is important to specify the essential analyses that will be
- 5366 conducted, before attending prematurely to details of measurement
- 5367 specification, data collection, or storage.

5368 **SP 1.1 Establish Measurement Objectives**

5369 ***Establish and maintain measurement objectives that are derived***
 5370 ***from identified information needs and objectives.*** [PA154.IG101.SP101]

5371 Measurement objectives document the purposes for which
5372 measurement and analysis are done, and specify the kinds of actions
5373 that may be taken based on the results of data analyses.
5374 [PA154.IG101.SP101.N101]

5375 The sources for measurement objectives may be management,
5376 technical, project, or process implementation needs. [PA154.IG101.SP101.N102]

5377 The measurement objectives may also be constrained by existing
5378 developmental processes, available resources, or other measurement
5379 considerations. Judgments may need to be made about whether the
5380 value of the results will be commensurate with the resources devoted to
5381 doing the work. [PA154.IG101.SP101.N103]

5382 Modifications to identified information needs and objectives may, in
5383 turn, be indicated as a consequence of the process and results of
5384 measurement and analysis. [PA154.IG101.SP101.N104]

5385 Sources of information needs and objectives may include the following:
5386 [PA154.IG101.SP101.N105]

- 5387 • Project plans
- 5388 • Monitoring of project performance
- 5389 • Interviews with managers and others who have information needs
- 5390 • Established management objectives
- 5391 • Strategic plans
- 5392 • Formal requirements or contractual obligations
- 5393 • Recurring or other troublesome management or technical problems
- 5394 • Experiences of other projects or organizational entities
- 5395 • External Industry Benchmarks
- 5396 • Process Improvement Plans

5397 *Refer to the Project Planning process area for more information about*
5398 *estimating project attributes and other planning information needs.*
5399 [PA154.IG101.SP101.N105.R101]

5400 *Refer to the Project Monitoring and Control process area for more*
5401 *information about project performance information needs.*
5402 [PA154.IG101.SP101.N105.R102]

5403 *Refer to the Requirements Development process area for more*
5404 *information about meeting customer requirements and related*
5405 *information needs.* [PA154.IG101.SP101.N105.R103]

5406 *Refer to the Requirements Management process area for more*
5407 *information about maintaining requirements traceability and related*
5408 *information needs.* [PA154.IG101.SP101.N105.R104]

5409 **Typical Work Products**

5410 1. Documented measurement objectives [PA154.IG101.SP101.W101]

5411 **Subpractices**

5412 1. Document information needs and objectives. [PA154.IG101.SP101.SubP101]

5413 Information needs and objectives are documented to allow traceability to
5414 subsequent measurement and analysis activities. [PA154.IG101.SP101.SubP101.N101]

5415 2. Prioritize information needs and objectives. [PA154.IG101.SP101.SubP102]

5416 It may be neither possible nor desirable to subject all initially identified information
5417 needs to measurement and analysis. Priorities may also need to be set within the
5418 limits of available resources. [PA154.IG101.SP101.SubP102.N101]

5419 3. Document, review, and revise measurement objectives.

5420 [PA154.IG101.SP101.SubP103]

5421 It is important to carefully consider the purposes and intended uses of
5422 measurement and analysis. [PA154.IG101.SP101.SubP103.N101]

5423 The measurement objectives are documented, reviewed by management and
5424 other affected stakeholder groups, and revised as necessary. Doing so enables
5425 traceability to subsequent measurement and analysis activities, and helps ensure
5426 that the analyses will properly address identified information needs and
5427 objectives. [PA154.IG101.SP101.SubP103.N102]

5428 It is important that users of measurement and analysis results be involved in
5429 setting measurement objectives and deciding on plans of action. It may also be
5430 appropriate to involve those who provide the measurement data.

5431 [PA154.IG101.SP101.SubP103.N103]

5432 4. Provide feedback for refining and clarifying information needs and

5433 objectives as necessary. [PA154.IG101.SP101.SubP104]

5434 Identified information needs and objectives may need to be refined and clarified
5435 as a result of setting measurement objectives. Initial descriptions of information
5436 needs may be unclear or ambiguous. Conflicts may arise between existing needs
5437 and objectives. Precise targets on an already existing measure may be
5438 unrealistic. [PA154.IG101.SP101.SubP104.N101]

5439 5. Maintain traceability of the measurement objectives to the identified
5440 information needs and objectives. [PA154.IG101.SP101.SubP105]

5441 There must always be a good answer to the question, "Why are we measuring
5442 this?" [PA154.IG101.SP101.SubP105.N101]

5443 Of course, the measurement objectives may also change to reflect evolving
5444 information needs and objectives. [PA154.IG101.SP101.SubP105.N102]

5445 SP 1.2 Specify Measures

5446 *Specify measures to address the measurement objectives.*

5447 [PA154.IG101.SP102]

5448 Measurement objectives are refined into precise, quantifiable
5449 measures. [PA154.IG101.SP102.N101]

5450 Measures may be either 'base' or 'derived'. Data for 'Base Measures'
5451 are obtained by direct measurement. Data for 'Derived Measures'
5452 come from other data, typically by combining two or more base
5453 measures. [PA154.IG101.SP102.N102]

5454 Examples of commonly used Base Measures include the following:

5455 [PA154.IG101.SP102.N103]

- 5456 • Estimates and actual measures of work product size (e.g., pages)
- 5457 • Estimates and actual measures of effort and cost (e.g., person
5458 hours)
- 5459 • Quality measures (e.g., number of defects, severity of defects)

5460
5461 Examples of commonly used derived measures include the following:

5462 [PA154.IG101.SP102.N104]

- 5463 • Earned Value (e.g. Actual Cost of Work Performed / Budgeted
5464 Cost of Work Performed)
- 5465 • Schedule Performance Index
- 5466 • Defect Density
- 5467 • Peer review coverage
- 5468 • Test or verification coverage
- 5469 • Reliability measures (e.g., mean time to failure)

5470
5471 Derived measures typically are expressed as ratios, composite indices,
5472 or other aggregate summary measures. They are often more
5473 quantitatively reliable and meaningfully interpretable than the base
5474 measures used to generate them. [PA154.IG101.SP102.N105]

5475 Typical Work Products

- 5476 1. Documented specifications of base and derived measures

5477 [PA154.IG101.SP102.W101]

5478

Subpractices

5479

1. Identify candidate measures based on documented measurement objectives. [PA154.IG101.SP102.SubP101]

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5481

The measurement objectives are refined into specific measures. The identified candidate measures are categorized and specified by name and unit of measure.

5482

5483

[PA154.IG101.SP102.SubP101.N101]

5484

2. Identify existing measures that already address the measurement objectives. [PA154.IG101.SP102.SubP102]

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Specifications for measures may already exist, perhaps established for other purposes earlier or elsewhere in the organization. [PA154.IG101.SP102.SubP102.N101]

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5488

3. Specify operational definitions for the measures. [PA154.IG101.SP102.SubP103]

5489

Operational definitions are stated in precise and unambiguous term. They address two important criteria as follows: [PA154.IG101.SP102.SubP103.N101]

5490

5491

- Communication: What has been measured, how was it measured, what are the units of measure, and what has been included or excluded?

5492

5493

- Repeatability: Can the measurement be repeated, given the same definition, to get the same results?

5494

5495

4. Prioritize, review, and revise measures. [PA154.IG101.SP102.SubP104]

5496

Proposed specifications of the measures are reviewed for their appropriateness with potential end users and other stakeholders. Priorities are set or changed, and specifications of the measures are revised as necessary.

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[PA154.IG101.SP102.SubP104.N101]

5500

SP 1.3 Specify Data Collection and Storage Procedures

5501

Specify how measurement data will be obtained and stored.

5502

[PA154.IG101.SP103]

5503

Explicit specification of collection methods helps ensure that the right data are collected properly. It may also aid in further clarifying information needs and measurement objectives. [PA154.IG101.SP103.N101]

5504

5505

5506

Proper attention to storage and retrieval procedures helps ensure that data are available and accessible for future use. [PA154.IG101.SP103.N102]

5507

5508

Typical Work Products

5509

1. Documented data collection and storage procedures

5510

[PA154.IG101.SP103.W101]

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2. Data collection tools [PA154.IG101.SP103.W102]

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Subpractices

1. Identify existing sources of data that are generated from current work products, processes, or transactions. [PA154.IG101.SP103.SubP101]

Existing sources of data may already have been identified when specifying the measures. Appropriate collection mechanisms may exist whether or not pertinent data have already been collected. [PA154.IG101.SP103.SubP101.N101]

2. Identify measures for which data are needed, but are not currently available. [PA154.IG101.SP103.SubP102]
3. Specify how to collect and store the data for each required measure. [PA154.IG101.SP103.SubP103]

Explicit specifications are made of how, where, and when the data will be collected. Procedures for collecting valid data are specified. The data are stored in an accessible manner for analysis, and it is determined whether they will be saved for possible reanalysis or documentation purposes. [PA154.IG101.SP103.SubP103.N101]

Questions to be considered typically include the following: [PA154.IG101.SP103.SubP103.N102]

- Have the frequency of collection and the points in the process where measurements will be made been determined?
- Has the time line that is required to move measurement results from the points of collection to repositories, other databases, or end users been established?
- Who is responsible for obtaining the data?
- 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]

5547

Examples of such automated support include: [PA154.IG101.SP103.SubP105.N102]

5548

- Time stamped activity logs
- Static or dynamic analyses of artifacts

5549

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5551

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]

5552

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6. Prioritize, review, and revise data collection and storage procedures. [PA154.IG101.SP103.SubP106]

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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]

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7. Revise measures and measurement objectives as necessary.

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[PA154.IG101.SP103.SubP107]

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Priorities may need to be reset based on the following: [PA154.IG101.SP103.SubP107.N101]

5563

- The importance of the measures
- The amount of effort required to obtain the data.

5564

5565

Considerations include whether new forms, tools, or training would be required to obtain the data. [PA154.IG101.SP103.SubP107.N102]

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5567

SP 1.4 Specify Analysis Procedures

5568

Specify how measurement data will be analyzed and reported.

5569

[PA154.IG101.SP104]

5570

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]

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Typical Work Products

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1. Documented analysis specification and procedures

5577

[PA154.IG101.SP104.W101]

5578

2. Data analysis tools [PA154.IG101.SP104.W102]

5579

Subpractices

5580

1. Specify and prioritize the analyses that will be conducted and the reports that will be prepared. [PA154.IG101.SP104.SubP101]

5581

5582 Early attention is paid to the analyses that will be conducted and to the manner in
5583 which the results will be reported as follows. [PA154.IG101.SP104.SubP101.N101]

- 5584
- The analyses explicitly address the documented measurement objectives.
 - Presentation of the results is clearly understandable by the audiences to whom the results are addressed.
- 5585
5586

5587 Priorities may have to be set within available resources. [PA154.IG101.SP104.SubP101.N102]

5588 **2. Select appropriate data analysis methods and tools.**

5589 [PA154.IG101.SP104.SubP102]

5590 *Refer to the Quantitative Project Management process area, Specific*
5591 *Practices 4 & 5 for more information about understanding variation and*
5592 *the appropriate use of statistical analysis techniques.*

5593 [PA154.IG101.SP104.SubP102.R101]

5594 Issues to be considered typically include the following: [PA154.IG101.SP104.SubP102.N101]

- 5595
- 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
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5602 Descriptive statistics should typically do the following: [PA154.IG101.SP104.SubP102.N102]

- 5603
- 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
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5608 **3. Specify administrative procedures for analyzing the data and**
5609 **communicating the results.** [PA154.IG101.SP104.SubP103]

5610 Issues to be considered typically include the following: [PA154.IG101.SP104.SubP103.N101]

- 5611
- Identifying the persons and groups responsible for analyzing the data and presenting the results
 - Determining the time line to analyze the data and present the results,
 - Determining the venues for communicating the results (e.g., progress reports, transmittal memos, written reports, or staff meetings)
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5616 **4. Review and revise the content and format of the proposed**
5617 **analyses and reports.** [PA154.IG101.SP104.SubP104]

5618 All of the proposed content and format are subject to review and revision,
5619 including analytic methods and tools, administrative procedures, and priorities.
5620 The stakeholders consulted should include intended end users, sponsors, data
5621 analyst, and data providers. [PA154.IG101.SP104.SubP104.N101]

5622 **5. Revise measures and measurement objectives as necessary.**

5623 [PA154.IG101.SP104.SubP105]

5624 Just as measurement needs drive data analysis, clarification of analysis criteria
5625 can affect measurement. Specifications for some measures may be refined
5626 further based on the specifications established for data analysis procedures.
5627 Other measures may prove to be unnecessary, or a need for additional measures
5628 may be recognized. [PA154.IG101.SP104.SubP105.N101]

5629 The exercise of specifying how measures will be analyzed and reported may also
5630 suggest the need for refining the measurement objectives themselves.

5631 [PA154.IG101.SP104.SubP105.N102]

5632 **6. Specify criteria for evaluating the utility of the analysis results, and**
5633 **of the conduct of the measurement and analysis activities.**

5634 [PA154.IG101.SP104.SubP106]

5635 Criteria for evaluating the utility of the analysis might include the extent to which
5636 the following apply: [PA154.IG101.SP104.SubP106.N101]

- 5637 • The results are (1) provided on a timely basis, (2) understandable, and (3) used
5638 for decision making.
- 5639 • The work does not cost more to perform than is justified by the benefits that it
5640 provides.

5641 Criteria for evaluating the conduct of the measurement and analysis might include
5642 the extent to which the following apply: [PA154.IG101.SP104.SubP106.N102]

- 5643 • The amount of missing data or the number of flagged inconsistencies are beyond
5644 specified thresholds.
- 5645 • There is selection bias in sampling (e.g., only satisfied end users are surveyed to
5646 evaluate end-user satisfaction, or only unsuccessful projects are evaluated to
5647 determine overall productivity).
- 5648 • The measurement data are repeatable (e.g., statistically reliable).
- 5649 • Statistical assumptions have been satisfied (e.g., about the distribution of data or
5650 about appropriate measurement scales).

5651 **SG 2 Provide Measurement Results** [PA154.IG102]

5652 ***Measurement results that address identified information needs and objectives***
5653 ***are provided.***

5654 The primary reason for doing measurement and analysis is to address
5655 identified information needs and objectives. Measurement results based
5656 on objective evidence can help to monitor performance, fulfill
5657 contractual obligations, make informed management and technical
5658 decisions, and enable corrective actions to be taken. [PA154.IG102.N101]

5659 SP 2.1 Collect Measurement Data

5660 **Obtain specified measurement data.** [PA154.IG102.SP101]

5661 The data necessary for analysis are obtained and checked for
5662 completeness and integrity. [PA154.IG102.SP101.N101]

5663 **Typical Work Products**

- 5664 1. Base and derived measurement data sets [PA154.IG102.SP101.W101]
- 5665 2. Results of data integrity tests [PA154.IG102.SP101.W102]

5666 **Subpractices**

- 5667 1. Obtain the data for base measures. [PA154.IG102.SP101.SubP101]

5668 Data are collected as necessary for previously used as well as for newly specified
5669 base measures. Existing data are gathered from project records or from
5670 elsewhere in the organization. [PA154.IG102.SP101.SubP101.N101]

5671 Note that data that were collected earlier may no longer be available for reuse in
5672 existing databases, paper records, or formal repositories. [PA154.IG102.SP101.SubP101.N102]

- 5673 2. Generate the data for derived measures. [PA154.IG102.SP101.SubP102]

5674 Values are newly calculated for all derived measures. [PA154.IG102.SP101.SubP102.N101]

- 5675 3. Perform data integrity checks as close to the source of the data as
5676 possible. [PA154.IG102.SP101.SubP103]

5677 All measurements are subject to error in specifying or recording data. It is always
5678 better to identify such errors and to identify sources of missing data early in the
5679 measurement and analysis cycle. [PA154.IG102.SP101.SubP103.N101]

5680 Checks can include scans for missing data, out-of-bounds data values, and
5681 unusual patterns and correlation across measures. [PA154.IG102.SP101.SubP103.N102]

5682 It is particularly important to do the following: [PA154.IG102.SP101.SubP103.N103]

- 5683 • Test and correct for inconsistency of classifications made by human judgement
5684 (i.e., to determine how frequently people make differing classification decisions
5685 based on the same information, otherwise known as "inter coder reliability").
- 5686 • Empirically examine the relationships among the measures that are used to
5687 calculate additional derived measures. Doing so can ensure that important

5688 distinctions are not overlooked and that the derived measures convey their
5689 intended meanings (otherwise known as "criterion validity").

5690 **SP 2.2 Analyze Measurement Data**

5691 **Analyze and interpret measurement data.** [PA154.IG102.SP102]

5692 The measurement data are analyzed as planned, additional analyses
5693 are conducted as necessary, results are reviewed with affected parties,
5694 and necessary revisions for future analyses are noted.

5695 [PA154.IG102.SP102.N101]

5696 **Typical Work Products**

5697 1. Analysis results and draft reports [PA154.IG102.SP102.W101]

5698 **Subpractices**

5699 1. Conduct initial analyses, interpret the results, and draw preliminary
5700 conclusions. [PA154.IG102.SP102.SubP101]

5701 The results of data analyses rarely "speak for themselves." Criteria for
5702 interpreting the results and drawing conclusions should be stated explicitly.

5703 [PA154.IG102.SP102.SubP101.N101]

5704 2. Conduct additional measurement and analysis as necessary, and
5705 prepare results for presentation. [PA154.IG102.SP102.SubP102]

5706 The results of planned analyses may suggest (or require) additional, unanticipated
5707 analyses. In addition, they may identify needs to refine existing measures, to
5708 calculate additional derived measures, or even to collect data for additional
5709 primitive measures to properly complete the planned analysis. Similarly, preparing
5710 the initial results for presentation may identify the need for additional,
5711 unanticipated analyses. [PA154.IG102.SP102.SubP102.N101]

5712 3. Review the initial results with affected stakeholders.

5713 [PA154.IG102.SP102.SubP103]

5714 It may be appropriate to review initial interpretations of the results and the way in
5715 which they are presented before disseminating and communicating them more
5716 widely. [PA154.IG102.SP102.SubP103.N101]

5717 Reviewing the initial results before their release may prevent needless
5718 misunderstandings, and lead to improvements in the data analysis and
5719 presentation. [PA154.IG102.SP102.SubP103.N102]

5720 Affected stakeholders with whom reviews may be conducted include intended end
5721 users and sponsors, as well as data analysts and data providers.

5722 [PA154.IG102.SP102.SubP103.N103]

5723 4. Refine criteria for future analyses. [PA154.IG102.SP102.SubP104]

5724 Valuable lessons that can improve future efforts are often learned from conducting
5725 data analyses and preparing results. Similarly, ways to improve measurement
5726 specifications and data collection procedures may become apparent, as may
5727 ideas for refining identified information needs and objectives.

5728 [PA154.IG102.SP102.SubP104.N101]

5729 SP 2.3 Store Data and Results

5730 ***Manage and store measurement data, measurement*** 5731 ***specifications, and analysis results.*** [PA154.IG102.SP103]

5732 Storing measurement-related information enables the timely and cost-
5733 effective future use of historical data and results. The information also is
5734 needed to provide sufficient context for interpretation of the data,
5735 measurement criteria, and analysis results. [PA154.IG102.SP103.N101]

5736 Information typically stored includes the following: [PA154.IG102.SP103.N102]

- 5737 • Measurement plans
- 5738 • Specifications of measures
- 5739 • Sets of data that have been collected
- 5740 • Analysis reports and presentations

5741 The stored information contains or references the information needed to
5742 understand and interpret the measures and assess them for
5743 reasonableness and applicability (e.g., measurement specifications
5744 used on different projects when comparing across projects).

5745 [PA154.IG102.SP103.N103]

5746 Data sets for derived measures typically can be recalculated and need
5747 not be stored. However, it may be appropriate to store summaries
5748 based on derived measures (e.g., charts, tables of results, or report
5749 prose). [PA154.IG102.SP103.N104]

5750 Interim analysis results need not be stored separately if they can be
5751 efficiently reconstructed. [PA154.IG102.SP103.N105]

5752 When data are shared more widely across projects, the data may reside
5753 in an organizational measurement repository. [PA154.IG102.SP103.N106]

5754 *Refer to the Organizational Process Definition process area, Specific*
5755 *Goal 2, Specific Practice 2 for more information about establishing an*
5756 *Organizational Measurement Repository.* [PA154.IG102.SP103.N106.R101]

5757 *Refer to the Configuration Management process area for information on*
5758 *managing measurement work products.* [PA154.IG102.SP103.N106.R102]

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Typical Work Products

1. Stored data inventory [PA154.IG102.SP103.W101]

Subpractices

1. Review the data to ensure their completeness, integrity, accuracy, and currency. [PA154.IG102.SP103.SubP101]
2. Make the stored contents available for use only by appropriate groups and personnel. [PA154.IG102.SP103.SubP102]
3. Prevent the stored information from being used inappropriately. [PA154.IG102.SP103.SubP103]

Examples of ways to prevent inappropriate use of the data and related information include controlling access to data, and educating people on the appropriate use of data. [PA154.IG102.SP103.SubP103.N101]

Examples of inappropriate use may include the following: [PA154.IG102.SP103.SubP103.N102]

- 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.

SP 2.4 Communicate Results

Report results of measurement and analysis activities to all affected stakeholders. [PA154.IG102.SP104]

The results of the measurement and analysis process are communicated to stakeholders in a timely and usable fashion to support decision making and assist in taking corrective action. [PA154.IG102.SP104.N101]

Affected stakeholders include intended users, sponsors, data analysts, and data providers. [PA154.IG102.SP104.N102]

Typical Work Products

1. Delivered reports and related analysis results [PA154.IG102.SP104.W101]
2. Transmittal and guidance documents [PA154.IG102.SP104.W102]

Subpractices

1. Keep stakeholders apprised of measurement results on a timely basis. [PA154.IG102.SP104.SubP101]

5793 Measurement results are communicated in time to be used for their intended
5794 purposes. Reports are unlikely to be used if they are distributed with little effort to
5795 follow up with those who need to know the results. [PA154.IG102.SP104.SubP101.N101]

5796 To the extent possible and as part of the normal way they do business, users of
5797 measurement results are kept personally involved in setting objectives and
5798 deciding on plans of action for measurement and analysis. The users are regularly
5799 kept apprised of progress and interim results. [PA154.IG102.SP104.SubP101.N102]

5800 2. Assist measurement stakeholders in understanding the results.
5801 [PA154.IG102.SP104.SubP102]

5802 Results are reported in a clear and concise manner appropriate to the
5803 methodological sophistication of the stakeholders. They are understandable,
5804 easily interpretable, and clearly tied to identified information needs and objectives.
5805 [PA154.IG102.SP104.SubP102.N101]

5806 The data often do not "speak for themselves" to practitioners who are not
5807 measurement experts. Measurement choices should be explicitly clear about the
5808 following: [PA154.IG102.SP104.SubP102.N102]

- 5809 • How and why the base and derived measures were specified
- 5810 • How the data were obtained
- 5811 • How to interpret the results based on the data analysis methods that were used
- 5812 • How the results address their information needs

5813 Examples of actions to assist in understanding of results include the following:
5814 [PA154.IG102.SP104.SubP102.N103]

- 5815 • Discussing the results with the stakeholders
- 5816 • Providing a transmittal memo that provides background and explanation
- 5817 • Briefing users on the results
- 5818 • Providing training on the appropriate use and understanding of measurement
5819 results.

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5821 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

5822 ***The process is institutionalized as a managed process.***

5823 Commitment to Perform

5824 **GP 2.1 (CO 1) Establish an Organizational Policy**

5825 ***Establish and maintain an organizational policy for planning and***
5826 ***performing the measurement and analysis process.*** [GP103]

5827 Elaboration:

5828 This policy establishes organizational expectations for aligning
5829 measurement objectives and practices with identified information needs
5830 and objectives and for providing measurement results. [PA154.EL101]

5831 Ability to Perform

5832 **GP 2.2 (AB 1) Plan the Process**

5833 *Establish and maintain the requirements and objectives, and plans*
5834 *for performing the measurement and analysis process.* [GP104]

5835 **GP 2.3 (AB 2) Provide Resources**

5836 *Provide adequate resources for performing the measurement and*
5837 *analysis process, developing the work products and providing the*
5838 *services of the process.* [GP105]

5839 Elaboration:

5840 Measurement personnel may be employed full-or part-time. A
5841 measurement group may or may not exist to support measurement
5842 activities across multiple projects. [PA154.EL104]

5843 Examples of tools used in performing the activities of the Measurement
5844 and Analysis process area include the following: [PA154.EL105]

- 5845 • Statistical packages
- 5846 • Packages that support data collection over networks

5847

5848 **GP 2.4 (AB 3) Assign Responsibility**

5849 *Assign responsibility and authority for performing the process,*
5850 *developing the work products, and providing the services of the*
5851 *measurement and analysis process.* [GP106]

5852 **GP 2.5 (AB 4) Train People**

5853 *Train the people performing or supporting the measurement and*
5854 *analysis process as needed.* [GP107]

5855 Elaboration:

5856 Examples of training topics include the following: [PA154.EL107]

- 5857
- Statistical techniques
 - Data collection, analysis, and reporting processes
 - Development of goal-related measurements (e.g., GQM)
- 5858
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5861 Directing Implementation

5862 **GP 2.6 (DI 1) Manage Configurations**

5863 *Place designated work products of the measurement and analysis*
5864 *process under appropriate levels of configuration management.*

5865 [GP109]

5866 Elaboration:

5867 Examples of work products placed under configuration management
5868 include the following: [PA154.EL108]

- 5869
- 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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5874 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

5875 *Identify and involve the relevant stakeholders of the measurement*
5876 *and analysis process as planned.* [GP124]

5877 Elaboration:

5878 Examples of activities for stakeholder involvement include: [PA154.EL114]

- 5879
- 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
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GP 2.8 (DI 3) Monitor and Control the Process

Monitor and control the measurement and analysis process against the plan and take appropriate corrective action. [GP110]

Elaboration:

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

Verifying Implementation

GP 2.9 (VE 1) Objectively Evaluate Adherence

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]

Elaboration:

Examples of activities reviewed include the following: [PA154.EL112]

- Aligning measurement and analysis activities
- Providing measurement results

Examples of work products reviewed include the following: [PA154.EL113]

- Specifications of base and derived measures
- Data collection and storage procedures
- Analysis results and draft reports

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

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

5914 PROCESS AND PRODUCT QUALITY ASSURANCE

5915 Maturity Level 2

5916 Purpose

5917 The purpose of Process and Product Quality Assurance is to provide
5918 staff and management with objective insight into the processes and
5919 associated work products. [PA145]

5920 Introductory Notes

5921 Process and Product Quality Assurance involves the following:

5922 [PA145.N101]

- 5923 • Objectively evaluating performed process, work products, and
5924 services against the applicable process descriptions, standards,
5925 and procedures
- 5926 • Identifying and documenting noncompliance issues
- 5927 • Providing feedback to project staff and managers on the results of
5928 the quality assurance activities
- 5929 • Ensuring that noncompliance issues are addressed

5930 Process and Product Quality Assurance supports the delivery of high-
5931 quality products and services by providing the project staff and all levels
5932 of managers with appropriate visibility into, and feedback on, the
5933 processes and associated work products throughout the life cycle.

5934 [PA145.N102]

5935 Process and Product Quality Assurance ensures planned processes
5936 are implemented while Verification ensures that the specified
5937 requirements are satisfied. Process and Product Quality Assurance and
5938 Verification may on occasion look at the same product but from different
5939 perspectives. Projects should take care to minimize duplication of effort.

5940 [PA145.N103]

5941 Objectivity in process and product quality assurance evaluations is
5942 critical to the success of the project. Traditionally, a quality assurance
5943 group that is independent of the project provides this objectivity. It may
5944 be appropriate in some organizations, however, to implement the
5945 process and product quality assurance role without that independence.
5946 For example, in an organization with an open, quality-oriented culture,
5947 the process and product quality assurance role may be performed,
5948 partially or completely, by peers, and the quality assurance function
5949 may be embedded in the process. [PA145.N104]

5950 If the Process and Product Quality Assurance function is embedded in
5951 the process, a number of issues need to be addressed to ensure
5952 objectivity. Everyone performing quality assurance activities should be
5953 trained in quality assurance. Those performing quality assurance
5954 activities for a work product should be separate from those directly
5955 involved in developing or maintaining the work products. An
5956 independent reporting channel to the appropriate level of organizational
5957 management allows noncompliance issues to be escalated as
5958 necessary. [PA145.N105]

5959 Process and Product Quality Assurance should begin in the early
5960 stages of a project to establish plans, processes, standards, and
5961 procedures that will add value to the project and satisfy the
5962 requirements of the project and the organizational policies. Those
5963 performing the quality assurance function participate in establishing the
5964 plans, processes, standards and procedures to ensure they fit the
5965 project's needs and that they will be useable for performing quality
5966 assurance evaluations. In addition, the specific processes and
5967 associated work products that will be evaluated during the life cycle are
5968 designated. This designation may be based on sampling or on objective
5969 criteria that are consistent with organizational policies and project
5970 requirements and needs. [PA145.N106]

5971 When noncompliance issues are identified, they are first addressed
5972 within the project and resolved there if possible. Any noncompliance
5973 issues that can not be resolved within the project are escalated to an
5974 appropriate level of management for resolution. [PA145.N107]

5975 This process area primarily applies to evaluations of projects and
5976 services, but it also applies to evaluations of non-project activities and
5977 work products such as training activities. For these activities and work
5978 products, the term "project" should be appropriately interpreted.
5979 [PA145.N108]

5980 Related Process Areas

5981 *Refer to the Project Planning process area for more information about*
5982 *identifying processes and associated work products that the quality*
5983 *assurance function will objectively evaluate. [PA145.R101]*

5984 *Refer to the Verification process area for more information about*
5985 *satisfying specified requirements. [PA145.R102]*

5986 Specific and Generic Goals

5987 **SG 1 Objectively Evaluate Processes and Work Products** [PA145.IG101]

5988 ***Adherence of the performed process and associated work products and***
 5989 ***services to applicable process descriptions, standards and procedures is***
 5990 ***objectively evaluated.***

5991 **SG 2 Provide Objective Insight** [PA145.IG102]

5992 ***Noncompliance issues are objectively tracked and communicated, and***
 5993 ***resolution is ensured.***

5994 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

5995 ***The process is institutionalized as a managed process.***

5996 Practice to Goal Relationship Table

5997 SG 1 Objectively Evaluate Processes and Work Products [PA145.IG101]

- 5998 SP 1.1 Objectively Evaluate Processes
- 5999 SP 1.2 Objectively Evaluate Work Products and Services

6000 SG 2 Provide Objective Insight [PA145.IG102]

- 6001 SP 2.1 Communicate and Ensure Resolution of Noncompliance Issues
- 6002 SP 2.2 Establish Records

6003 GG 2 Institutionalize a Managed Process

- 6004 GP 2.1 (CO 1) Establish an Organizational Policy
- 6005 GP 2.2 (AB 1) Plan the Process
- 6006 GP 2.3 (AB 2) Provide Resources
- 6007 GP 2.4 (AB 3) Assign Responsibility
- 6008 GP 2.5 (AB 4) Train People
- 6009 GP 2.6 (DI 1) Manage Configurations
- 6010 GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders
- 6011 GP 2.8 (DI 3) Monitor and Control the Process
- 6012 GP 2.9 (VE 1) Objectively Evaluate Adherence
- 6013 GP 2.10 (VE 2) Review Status with Higher-Level Management

6014 Specific Practices by Goal

6015 **SG 1 Objectively Evaluate Processes and Work Products** [PA145.IG101]

6016 ***Adherence of the performed process and associated work products and***
 6017 ***services to applicable process descriptions, standards and procedures is***
 6018 ***objectively evaluated.***

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SP 1.1 Objectively Evaluate Processes

Objectively evaluate the designated performed processes against the applicable process descriptions, standards and procedures.

[PA145.IG101.SP101]

Objectivity in Process and Product Quality Assurance evaluations is critical to the success of the project. A description of the quality assurance reporting chain and how it ensures objectivity of the process and product quality assurance function needs to be defined to ensure objectivity. [PA145.IG101.SP101.N101]

Typical Work Products

1. Audit reports [PA145.IG101.SP101.W101]
2. Noncompliance reports [PA145.IG101.SP101.W102]
3. Corrective actions [PA145.IG101.SP101.W103]

Subpractices

1. Advance use of an environment (created as part of project management) that encourages employee participation in identifying and reporting quality issues. [PA145.IG101.SP101.SubP101]
2. Establish and maintain clearly stated criteria for the evaluations. [PA145.IG101.SP101.SubP102]

The intent of this subpractice is to provide criteria, based on business needs, such as the following: [PA145.IG101.SP101.SubP102.N101]

- What will be evaluated during the evaluation process
- When or how often a process will be evaluated
- How the evaluation will be conducted
- Who must be involved in the evaluation

3. Use the stated criteria to evaluate performed processes for adherence to process descriptions, standards, and procedures. [PA145.IG101.SP101.SubP103]

[PA145.IG101.SP101.SubP103]

4. Identify each noncompliance found during the evaluation. [PA145.IG101.SP101.SubP104]

[PA145.IG101.SP101.SubP104]

SP 1.2 Objectively Evaluate Work Products and Services

Objectively evaluate the designated work products and services against the applicable process descriptions, standards, and procedures. [PA145.IG101.SP102]

Typical Work Products

1. Audit reports [PA145.IG101.SP102.W101]

- 6055 2. Noncompliance reports [PA145.IG101.SP102.W102]
- 6056 3. Corrective actions [PA145.IG101.SP102.W103]
- 6057 **Subpractices**
- 6058 1. Select work products to be evaluated, based on documented
- 6059 sampling criteria if sampling is used. [PA145.IG101.SP102.SubP101]
- 6060 2. Establish and maintain clearly stated criteria for the evaluation of
- 6061 work products. [PA145.IG101.SP102.SubP102]
- 6062 The intent of this subpractice is to provide criteria, based on business needs, such
- 6063 as the following: [PA145.IG101.SP102.SubP102.N101]
- 6064 • What will be evaluated during the evaluation of a work product
 - 6065 • When or how often a work product will be evaluated
 - 6066 • How the evaluation will be conducted
 - 6067 • Who must be involved in the evaluation
- 6068 3. Use the stated criteria during the evaluations of work products.
- 6069 [PA145.IG101.SP102.SubP103]
- 6070 4. Evaluate work products before delivery to the customer.
- 6071 [PA145.IG101.SP102.SubP104]
- 6072 5. Evaluate work products at selected milestones in their
- 6073 development. [PA145.IG101.SP102.SubP105]
- 6074 6. Perform in-progress or incremental evaluations of work products
- 6075 and services against process descriptions, standards, and
- 6076 procedures. [PA145.IG101.SP102.SubP106]
- 6077 7. Identify each noncompliance found during the evaluations.
- 6078 [PA145.IG101.SP102.SubP107]
- 6079 8. Identify lessons learned that improve processes for future products
- 6080 and services. [PA145.IG101.SP102.SubP108]

6081 **SG 2 Provide Objective Insight** [PA145.IG102]

6082 ***Noncompliance issues are objectively tracked and communicated, and***

6083 ***resolution is ensured.***

6084 **SP 2.1 Communicate and Ensure Resolution of Noncompliance Issues**

6085 ***Communicate quality issues and ensure resolution of***

6086 ***noncompliance issues with the staff and managers.*** [PA145.IG102.SP101]

6087 Noncompliance issues are problems identified in evaluations that reflect
6088 a lack of adherence to applicable standards, process descriptions, or
6089 procedures. The status of noncompliance issues provides an indication
6090 of quality trends. Quality issues include noncompliance issues and
6091 results of trend analysis. [PA145.IG102.SP101.N101]

6092 When local resolution of noncompliance issues cannot be obtained, use
6093 established escalation mechanisms to ensure that the appropriate level
6094 of management can resolve the issue. Track noncompliance issues to
6095 resolution. [PA145.IG102.SP101.N102]

6096 **Typical Work Products**

- 6097 1. Corrective action reports [PA145.IG102.SP101.W101]
- 6098 2. Audit reports [PA145.IG102.SP101.W102]
- 6099 3. Quality trends [PA145.IG102.SP101.W103]

6100 **Subpractices**

- 6101 1. Resolve each noncompliance with the appropriate members of the
6102 staff where possible. [PA145.IG102.SP101.SubP101]
- 6103 2. Document noncompliance issues when they cannot be resolved
6104 within the project. [PA145.IG102.SP101.SubP102]

6105 Examples of ways to resolve noncompliance within the project include the
6106 following: [PA145.IG102.SP101.SubP102.N101]

- 6107 • Fixing the noncompliance
- 6108 • Changing the process descriptions, standards, or procedures that were violated
- 6109 • Obtaining a waiver to cover the noncompliance issue

- 6110
- 6111 3. Escalate noncompliance issues that are not able to be resolved
6112 within the project to the appropriate level of management
6113 designated to receive and act on noncompliance issues.

6114 [PA145.IG102.SP101.SubP103]

- 6115 4. Analyze the noncompliance issues to see if there are any quality
6116 trends that can be identified and addressed. [PA145.IG102.SP101.SubP104]

- 6117 5. Ensure that relevant stakeholders are aware of the results of
6118 evaluations and the quality trends in a timely manner.

6119 [PA145.IG102.SP101.SubP105]

- 6120 6. Periodically review open noncompliance issues and trends with the
6121 manager designated to receive and act on noncompliance issues.

6122 [PA145.IG102.SP101.SubP106]

- 6123 7. Track noncompliance issues to resolution. [PA145.IG102.SP101.SubP107]

6124 **SP 2.2 Establish Records**

6125 ***Establish and maintain records of the quality assurance activities.***

6126 [PA145.IG102.SP102]

6127 **Typical Work Products**

- 6128 1. Audit logs [PA145.IG102.SP102.W101]
- 6129 2. Quality assurance reports [PA145.IG102.SP102.W102]
- 6130 3. Status of corrective actions [PA145.IG102.SP102.W103]
- 6131 4. Quality trends [PA145.IG102.SP102.W104]

6132 **Subpractices**

- 6133 1. Record process and product quality assurance activities in
- 6134 sufficient detail such that status and results are known.
- 6135 [PA145.IG102.SP102.SubP101]
- 6136 2. Revise the status and history of the quality assurance activities as
- 6137 necessary. [PA145.IG102.SP102.SubP102]

6138 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

6139 ***The process is institutionalized as a managed process.***

6140 Commitment to Perform

6141 **GP 2.1 (CO 1) Establish an Organizational Policy**

6142 ***Establish and maintain an organizational policy for planning and***

6143 ***performing the process and product quality assurance process.***

6144 [GP103]

6145 Elaboration:

6146 This policy establishes organizational expectations for objectively

6147 evaluating that processes and associated work products adhere to the

6148 applicable process descriptions, standards, and procedures, and

6149 ensuring that noncompliance are addressed. [PA145.EL101]

6150 This policy also establishes the expectation that the process and

6151 product quality assurance function is in place for all projects and

6152 possesses sufficient independence from project management to provide

6153 objectivity in identifying and reporting noncompliance issues. [PA145.EL102]

6154 Ability to Perform

6155 **GP 2.2 (AB 1) Plan the Process**

6156 *Establish and maintain the requirements and objectives, and plans*
6157 *for performing the process and product quality assurance*
6158 *process. [GP104]*

6159 **GP 2.3 (AB 2) Provide Resources**

6160 *Provide adequate resources for performing the process and*
6161 *product quality assurance process, developing the work products*
6162 *and providing the services of the process. [GP105]*

6163 Elaboration:

6164 Examples of tools used in performing the activities of the Process and
6165 Product Quality Assurance process area include the following:

[PA145.EL105]

- 6167 • Auditing tools

6169 **GP 2.4 (AB 3) Assign Responsibility**

6170 *Assign responsibility and authority for performing the process,*
6171 *developing the work products, and providing the services of the*
6172 *process and product quality assurance process. [GP106]*

6173 **GP 2.5 (AB 4) Train People**

6174 *Train the people performing or supporting the process and*
6175 *product quality assurance process as needed. [GP107]*

6176 Elaboration:

6177 Examples of training topics include the following: [PA145.EL106]

- 6178 • Application domain
- 6179 • Customer relations
- 6180 • Process descriptions, standards, procedures, and methods for the
6181 project
- 6182 • Quality assurance objectives, process descriptions, standards,
6183 procedures, methods, and tools

6184

6185 Directing Implementation

6186 **GP 2.6 (DI 1) Manage Configurations**

6187 *Place designated work products of the process and product*
6188 *quality assurance process under appropriate levels of*
6189 *configuration management.* [GP109]

6190 Elaboration:

6191 Examples of work products placed under configuration management
6192 include the following: [PA145.EL111]

- 6193 • Noncompliance reports
- 6194 • Audit logs and reports

6195

6196 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

6197 *Identify and involve the relevant stakeholders of the process and*
6198 *product quality assurance process as planned.* [GP124]

6199 Elaboration:

6200 Examples of activities for stakeholder involvement include: [PA145.EL113]

- 6201 • Establishing criteria for the objective evaluations of processes and
- 6202 work products
- 6203 • Evaluating processes and work products
- 6204 • Resolving issues on noncompliances
- 6205 • Tracking noncompliance issues to closure

6206

6207 **GP 2.8 (DI 3) Monitor and Control the Process**

6208 *Monitor and control the process and product quality assurance*
6209 *process against the plan and take appropriate corrective action.*
6210 [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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6218

Verifying Implementation

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GP 2.9 (VE 1) 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

6231

- Audit logs and reports

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

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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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6237 CONFIGURATION MANAGEMENT

6238 Maturity Level 2

6239 Purpose

6240 The purpose of Configuration Management is to establish and maintain
6241 the integrity of work products using configuration identification,
6242 configuration control, configuration status accounting, and configuration
6243 audits. [PA159]

6244 Introductory Notes

6245 Configuration Management involves the following: [PA159.N101]

- 6246 • Identifying the configuration of selected work products that
6247 compose the baselines at given points in time
- 6248 • Controlling changes to configuration items
- 6249 • Building or providing specifications to build work products from the
6250 configuration management system
- 6251 • Maintaining the integrity of baselines
- 6252 • Providing accurate status and current configuration data to
6253 developers, end users, and customers

6254 The work products placed under configuration management include the
6255 products that are delivered to the customer, designated internal work
6256 products, acquired products, tools, and other items that are used in
6257 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]

6296 Configuration Management includes control of content, versions,
6297 changes, and distribution of data. It is focused on the rigorous control
6298 of the managerial and technical aspects of the work products including
6299 the delivered system. [PA159.N107]

6300 This process area covers the practices for performing the configuration
6301 management function and is applicable to all work products that are
6302 placed under configuration management. [PA159.N108]

6303 Related Process Areas

6304 *Refer to the Project Planning process area for information on*
6305 *developing plans and work breakdown structures - a method of dividing*
6306 *project work that may be useful for determining configuration items.*
6307 [PA159.R101]

6308 *Refer to the Causal Analysis and Resolution process area for more*
6309 *information about both the method to use for analyzing the impact of*
6310 *change requests and the method to use when evaluating changes.*
6311 [PA159.R102]

6312 *Refer to the Project Monitoring and Control process area for more*
6313 *information about performance analyses and corrective actions.*
6314 [PA159.R103]

6315 Specific and Generic Goals

6316 **SG 1 Establish Baselines** [PA159.IG101]

6317 ***Baselines of identified work products are established and maintained.***

6318 **SG 2 Track and Control Changes** [PA159.IG102]

6319 ***Changes to the work products under configuration management are tracked***
6320 ***and controlled.***

6321 **SG 3 Establish Integrity** [PA159.IG103]

6322 ***Integrity of baselines is established and maintained.***

6323 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

6324 ***The process is institutionalized as a managed process.***

6325 Practice to Goal Relationship Table

6326	SG 1 Establish Baselines [PA159.IG101]		
6327	SP 1.1	Identify Configuration Items	
6328	SP 1.2	Establish a Configuration Management System	
6329	SP 1.3	Create or Release Baselines	
6330	SG 2 Track and Control Changes [PA159.IG102]		
6331	SP 2.1	Track Changes	
6332	SP 2.2	Control Changes	
6333	SG 3 Establish Integrity [PA159.IG103]		
6334	SP 3.1	Establish Configuration Management Records	
6335	SP 3.2	Perform Configuration Audits	
6336	GG 2 Institutionalize a Managed Process		
6337	GP 2.1	(CO 1)	Establish an Organizational Policy
6338	GP 2.2	(AB 1)	Plan the Process
6339	GP 2.3	(AB 2)	Provide Resources
6340	GP 2.4	(AB 3)	Assign Responsibility
6341	GP 2.5	(AB 4)	Train People
6342	GP 2.6	(DI 1)	Manage Configurations
6343	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
6344	GP 2.8	(DI 3)	Monitor and Control the Process
6345	GP 2.9	(VE 1)	Objectively Evaluate Adherence
6346	GP 2.10	(VE 2)	Review Status with Higher-Level Management

6347 Specific Practices by Goal

6348 **SG 1 Establish Baselines** [PA159.IG101]

6349 ***Baselines of identified work products are established and maintained.***

6350 **SP 1.1 Identify Configuration Items**

6351 ***Identify the configuration items, components, and related work***
 6352 ***products that will be placed under configuration management.***

6353 [PA159.IG101.SP101]

6354 Configuration identification is the selection, creation, and specification
 6355 of the products that are delivered to the customer, designated internal
 6356 work products, acquired products, tools, and other items that are used
 6357 in creating and describing these work products. Items under
 6358 configuration management will include specifications and interface
 6359 documents that define the requirements for the product. Other
 6360 documents, such as test results, may also be included depending on
 6361 their criticality to defining the product. [PA159.IG101.SP101.N101]

6362 A "configuration item" is an entity designated for configuration
6363 management, which may consist of multiple related work products that
6364 form a baseline. This logical grouping provides ease of identification
6365 and controlled access. The selection of work products for configuration
6366 management should be based on criteria established during planning.

6367 [PA159.IG101.SP101.N102]

6368 ***For Systems Engineering***

6369 *In a system that includes both hardware and software, where*
6370 *software represents a small part of the system, all of the*
6371 *software may be designated as a single configuration item. In*
6372 *other cases, the software may be decomposed into multiple*
6373 *configuration items.* [PA159.IG101.SP101.N102.AMP101]

6374 Configuration items can be decomposed into configuration components
6375 and configuration units. Only the term "configuration item" is used in
6376 this process area. In these practices, "configuration item" may be
6377 interpreted as "configuration component" or "configuration unit" as
6378 appropriate. For example, configuration items in the area of
6379 requirements management could vary from each individual requirement
6380 to a set of requirements. [PA159.IG101.SP101.N103]

6381 **Typical Work Products**

- 6382 1. Identified configuration items [PA159.IG101.SP101.W101]

6383 **Subpractices**

- 6384 1. Select the configuration items and work products that compose
6385 them based on documented criteria. [PA159.IG101.SP101.SubP101]

6386 Example criteria for selecting configuration items at the appropriate work product
6387 level include the following: [PA159.IG101.SP101.SubP101.N102]

- 6388
- 6389 • Work products that may be used by two or more groups
 - 6390 • Work products that are expected to change over time either because of errors or
change of requirements
 - 6391 • Work products that are dependent on each other and a change in one mandates a
6392 change in others
 - 6393 • Work products that are critical for the project
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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]

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]

SP 1.2 Establish a Configuration Management System

Establish and maintain a configuration management and change management system for controlling work products. [PA159.IG101.SP102]

A configuration management system includes the storage media, the procedures, and the tools for accessing the configuration system.

[PA159.IG101.SP102.N101]

A change management system includes the storage media, the procedures, and tools for recording and accessing change requests.

[PA159.IG101.SP102.N102]

Typical Work Products

1. Configuration management system with controlled work products

[PA159.IG101.SP102.W101]

2. Configuration management system access control procedures

[PA159.IG101.SP102.W102]

3. Change request database [PA159.IG101.SP102.W103]

Subpractices

1. Establish a mechanism to manage multiple control levels of configuration management. [PA159.IG101.SP102.SubP101]

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.

- 6468 2. Store and retrieve configuration items in the configuration
6469 management system. [PA159.IG101.SP102.SubP102]
- 6470 3. Share and transfer configuration items between control levels
6471 within the configuration management system. [PA159.IG101.SP102.SubP103]
- 6472 4. Store and recover archived versions of configuration items.
6473 [PA159.IG101.SP102.SubP104]
- 6474 5. Store, update, and retrieve configuration management records.
6475 [PA159.IG101.SP102.SubP105]
- 6476 6. Create configuration management reports from the configuration
6477 management system. [PA159.IG101.SP102.SubP106]
- 6478 7. Preserve the contents of the configuration management system.
6479 [PA159.IG101.SP102.SubP107]
- 6480 Examples of preservation functions of the configuration management system
6481 include the following: [PA159.IG101.SP102.SubP107.N101]
- 6482 • Backups and restoration of configuration management files
 - 6483 • Archiving of configuration management files
 - 6484 • Recovery from configuration management errors
- 6485
- 6486 8. Revise the configuration management structure as necessary.
6487 [PA159.IG101.SP102.SubP108]

6488 SP 1.3 Create or Release Baselines

6489 ***Create or release baselines for internal use and for delivery to the***
6490 ***customer.*** [PA159.IG101.SP103]

6491 A baseline is a set of specifications or work products that has been
6492 formally reviewed and agreed upon, that thereafter serves as the basis
6493 for further development, and that can be changed only through change
6494 control procedures. A baseline represents the assignment of an
6495 identifier to a configuration item and its associated entities.

6496 [PA159.IG101.SP103.N101]

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For Systems Engineering

Release of a baseline constitutes approval of a set of configuration data for the agreed upon set of configuration items from the configuration management system and releasing it for further development. Multiple baselines may be used to define an evolving product during its development cycle. One common set includes the system level requirements, system element level design requirements, and the product definition at the end of development/beginning of production. These are referred to as the functional, allocated, and product baselines. [PA159.IG101.SP103.N101.AMP101]

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For Software Engineering

A set of requirements, design, source code files and the associated executable code, build files, and user documentation (associated entities) that have been assigned a unique identifier can be considered to be a baseline. Release of a baseline constitutes retrieval of source code files (configuration items) from the configuration management system and generating the executable files. A baseline that is delivered to an external customer is typically called a "release" whereas a baseline for an internal use is typically called a "build." [PA159.IG101.SP103.N101.AMP102]

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Typical Work Products

1. Baselines [PA159.IG101.SP103.W101]
2. Description of baselines [PA159.IG101.SP103.W102]

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Subpractices

1. Obtain authorization from the configuration control board (CCB) before creating or releasing baselines of configuration items.
[PA159.IG101.SP103.SubP101]
2. Create or release baselines only from configuration items in the configuration management system. [PA159.IG101.SP103.SubP102]

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For Systems Engineering

Assure that the configuration items are built to the correct drawing. [PA159.IG101.SP103.SubP102.AMP101]

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3. Document the set of configuration items that are contained in a baseline. [PA159.IG101.SP103.SubP103]
4. Make the current set of baselines readily available.
[PA159.IG101.SP103.SubP104]

6535 **SG 2 Track and Control Changes** [PA159.IG102]

6536 ***Changes to the work products under configuration management are tracked***
6537 ***and controlled.***

6538 **SP 2.1 Track Changes**

6539 ***Track change requests for the configuration items.*** [PA159.IG102.SP101]

6540 Change requests address not only new or changed requirements, but
6541 also failures and defects in the work products. [PA159.IG102.SP101.N101]

6542 Changes are analyzed to determine the impact that the change will
6543 have on the work product, related work products, and schedule and
6544 COST. [PA159.IG102.SP101.N102]

6545 **Typical Work Products**

- 6546 1. Change requests [PA159.IG102.SP101.W101]

6547 **Subpractices**

- 6548 1. Initiate and record change requests in the change request system.
6549 [PA159.IG102.SP101.SubP101]

- 6550 2. Analyze the impact of proposed changes and fixes.
6551 [PA159.IG102.SP101.SubP102]

6552 Changes are evaluated through a process that ensures they are consistent with
6553 all the technical and project requirements. [PA159.IG102.SP101.SubP102.N101]

6554 Changes are evaluated for their impact beyond the immediate project or contract
6555 requirements. Changes to an item used in multiple products can resolve an
6556 immediate issue while causing a problem in other applications.
6557 [PA159.IG102.SP101.SubP102.N102]

- 6558 3. Review and get agreement with those affected by change requests
6559 that will be addressed in the next baseline. [PA159.IG102.SP101.SubP103]

6560 Schedule and conduct the change-request review by appropriate participants in
6561 the decision. Record the disposition and rationale, including success criteria, a
6562 brief action plan if appropriate, and needs met or unmet by the change. Perform
6563 the actions required in the disposition, and report the results to affected parties.
6564 [PA159.IG102.SP101.SubP103.N101]

- 6565 4. Track the status of change requests to closure. [PA159.IG102.SP101.SubP104]

6566 Changes brought into the system need to be handled in a proficient and timely
6567 manner. Once a change request has been processed, it is critical to close the
6568 request with the appropriate approved action as soon as it is practical. Actions left
6569 open result in larger than necessary status lists, which in turn result in added
6570 costs and confusion. [PA159.IG102.SP101.SubP104.N101]

SP 2.2 Control Changes

Control changes to the content of configuration items. [PA159.IG102.SP102]

Control is maintained over the configuration of the work product baseline. This control includes tracking the configuration of each of the configuration items, approving a new configuration if necessary, and updating the baseline. [PA159.IG102.SP102.N101]

Typical Work Products

1. Revision history of configuration items [PA159.IG102.SP102.W101]
2. Archives baseline [PA159.IG102.SP102.W102]

Subpractices

1. Control changes to configuration items throughout the life cycle.
[PA159.IG102.SP102.SubP101]
2. Obtain appropriate authorization before changed configuration items are entered into the configuration management system.
[PA159.IG102.SP102.SubP102]

For example, an authorization may come from CCB, project manager, or the customer. [PA159.IG102.SP102.SubP102.N101]

3. Check-in and check-out configuration items from the configuration management system for incorporation of changes in a manner that maintains the correctness and integrity of the configuration items.
[PA159.IG102.SP102.SubP103]

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]

6608 Configuration control mechanisms can be tailored to categories of changes. For
6609 example, the approval process could be shorter for component changes that do
6610 not affect other components. [PA159.IG102.SP102.SubP105.N102]

6611 Changed configuration items are released after review and approval of
6612 configuration changes. Changes are not official until they are released.

6613 [PA159.IG102.SP102.SubP105.N103]

6614 **SG 3 Establish Integrity** [PA159.IG103]

6615 ***Integrity of baselines is established and maintained.***

6616 **SP 3.1 Establish Configuration Management Records**

6617 ***Establish and maintain records describing configuration items.***

6618 [PA159.IG103.SP101]

6619 **Typical Work Products**

- 6620 1. Revision history of configuration items [PA159.IG103.SP101.W101]
- 6621 2. Change log [PA159.IG103.SP101.W102]
- 6622 3. Copy of the changes [PA159.IG103.SP101.W103]
- 6623 4. Status of configuration items [PA159.IG103.SP101.W104]
- 6624 5. Differences between baselines [PA159.IG103.SP101.W105]

6625 **Subpractices**

- 6626 1. Record configuration management actions in sufficient detail so the
6627 content and status of each configuration item is known and
6628 previous versions can be recovered. [PA159.IG103.SP101.SubP101]

- 6629 2. Ensure affected individuals and groups have access to and
6630 knowledge of the configuration status of the configuration items.

6631 [PA159.IG103.SP101.SubP102]

6632 Examples of activities for communicating configuration status include the
6633 following: [PA159.IG103.SP101.SubP102.N101]

- 6634 • Providing access permissions to authorized end users
- 6635 • Making baseline copies readily available to authorized end users

- 6636
- 6637 3. Specify the latest version of the baselines. [PA159.IG103.SP101.SubP103]

- 6638 4. Identify the version of configuration items that constitute a
6639 particular baseline. [PA159.IG103.SP101.SubP104]

- 6640 5. Describe the differences between successive baselines.
6641 [PA159.IG103.SP101.SubP105]
- 6642 6. Revise the status and history (i.e., changes and other actions) of
6643 each configuration item as necessary. [PA159.IG103.SP101.SubP106]

6644 **SP 3.2 Perform Configuration Audits**

6645 ***Perform configuration audits to maintain integrity of the***
6646 ***configuration baselines.*** [PA159.IG103.SP102]

6647 Audit configuration management activities and processes to confirm
6648 that the resulting baselines and documentation are accurate and record
6649 the audit results as appropriate. [PA159.IG103.SP102.N101]

6650 **Typical Work Products**

- 6651 1. Configuration audit results [PA159.IG103.SP102.W101]
6652 2. Action items [PA159.IG103.SP102.W102]

6653 **Subpractices**

- 6654 1. Assess the integrity of the baselines. [PA159.IG103.SP102.SubP101]
6655 2. Verify that the configuration records correctly identify the
6656 configuration of the configuration items. [PA159.IG103.SP102.SubP102]
- 6657 3. Review the structure and integrity of the items in the configuration
6658 management system. [PA159.IG103.SP102.SubP103]
- 6659 4. Verify the completeness and correctness of the items in the
6660 configuration management system. [PA159.IG103.SP102.SubP104]

6661 Completeness and correctness of the content is based on the requirements as
6662 stated in the plan and the disposition of approved change requests.

6663 [PA159.IG103.SP102.SubP104.N101]

- 6664 5. Verify compliance with applicable configuration management
6665 standards and procedures. [PA159.IG103.SP102.SubP105]
- 6666 6. Track action items from the audit to closure. [PA159.IG103.SP102.SubP106]

6667 **GG 2 Institutionalize a Managed Process** [CL103.GL101]

6668 ***The process is institutionalized as a managed process.***

6669 Commitment to Perform

6670 **GP 2.1 (CO 1) Establish an Organizational Policy**

6671 ***Establish and maintain an organizational policy for planning and***
6672 ***performing the configuration management process.*** [GP103]

6673 Elaboration:

6674 This policy establishes organizational expectations for establishing and
6675 maintaining baselines of identified work products, tracking and
6676 controlling changes to the work products (under configuration
6677 management), and establishing and maintaining integrity of the
6678 baselines. [PA159.EL101]

6679 Ability to Perform

6680 **GP 2.2 (AB 1) Plan the Process**

6681 ***Establish and maintain the requirements and objectives, and plans***
6682 ***for performing the configuration management process.*** [GP104]

6683 **GP 2.3 (AB 2) Provide Resources**

6684 ***Provide adequate resources for performing the configuration***
6685 ***management process, developing the work products and***
6686 ***providing the services of the process.*** [GP105]

6687 Elaboration:

6688 Examples of tools used in performing the activities of the Configuration
6689 Management process area include the following: [PA159.EL104]

- 6690 • Configuration management tools
- 6691 • Data management tools
- 6692 • Archiving and reproduction tools
- 6693 • Database programs

6694

6695 **GP 2.4 (AB 3) Assign Responsibility**

6696 *Assign responsibility and authority for performing the process,*
6697 *developing the work products, and providing the services of the*
6698 *configuration management process. [GP106]*

6699 **GP 2.5 (AB 4) Train People**

6700 *Train the people performing or supporting the configuration*
6701 *management process as needed. [GP107]*

6702 Elaboration:

6703 Examples of training topics include the following: [PA159.EL105]
6704 • Roles, responsibilities, and authority of the configuration
6705 management staff
6706 • Configuration management standards, procedures, and methods
6707 • Configuration library system
6708

6709 **Directing Implementation**

6710 **GP 2.6 (DI 1) Manage Configurations**

6711 *Place designated work products of the configuration management*
6712 *process under appropriate levels of configuration management.*
6713 *[GP109]*

6714 Elaboration:

6715 Examples of work products placed under configuration management
6716 include the following: [PA159.EL106]
6717 • Access lists
6718 • Change status reports
6719 • Change request database
6720 • Configuration Control Board meeting minutes
6721 • Archived baseline
6722

6723

GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders

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Identify and involve the relevant stakeholders of the configuration management process as planned. [GP124]

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Elaboration:

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Examples of activities for stakeholder involvement include: [PA159.EL111]

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- Establishing baselines
- Reviewing configuration management system reports and resolving issues
- Assessing the impact of changes for the configuration items
- Performing configuration audits
- Reviewing the results of configuration management audits

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GP 2.8 (DI 3) 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:

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[PA159.EL108]

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- Number of changes to configuration items
- Number of configuration audits conducted

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Verifying Implementation

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GP 2.9 (VE 1) 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:

Examples of activities reviewed include the following: [PA159.EL109]

- Establishing and maintaining baselines
- Tracking and controlling changes
- Establishing and maintaining integrity of baselines

Examples of work products reviewed include the following: [PA159.EL110]

- Archives baselines
- Change request database

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

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

6765 MATURITY LEVEL: 3 DEFINED

6766 The following section contains all of the process areas that belong to
6767 maturity level 3. The maturity level 3 process areas of CMMI are as
6768 follows: [FM110.T101]

- 6769 • Requirements Development
- 6770 • Technical Solution
- 6771 • Product Integration
- 6772 • Verification
- 6773 • Validation
- 6774 • Organizational Process Focus
- 6775 • Organizational Process Definition
- 6776 • Organizational Training
- 6777 • Integrated Project Management (IPPD)
- 6778 • Risk Management
- 6779 • Integrated Teaming
- 6780 • Decision Analysis and Resolution
- 6781 • Organizational Environment for Integration

6782 *Refer to the Model Components section of the Structure of the Model*
6783 *chapter of the Overview for more information about CMMI maturity*
6784 *levels.* [FM110.T101.R101]

6785 REQUIREMENTS DEVELOPMENT

6786 Maturity Level 3

6787 Purpose

6788 The purpose of Requirements Development is to produce and analyze
6789 customer, product, and product component requirements. [PA157]

6790 Introductory Notes

6791 The Requirements Development process area includes three principal
6792 groups of practices. The first includes those required to define a
6793 complete set of customer requirements to use in the development of
6794 product requirements. The second includes those required to define a
6795 complete set of product and product component requirements to use in
6796 the design of the products and product components. The third includes
6797 those for performing the necessary analysis to define, derive and
6798 understand the requirements. The three groups of practices may
6799 interact recursively with each other and the definition of alternative
6800 solutions and preferred product concepts developed in the Technical
6801 Solution process area. [PA157.N101]

6802 Requirements are developed that will be the basis for design. This
6803 includes the following: [PA157.N102]

- 6804
- 6805 • Collection and coordination of stakeholder needs
 - 6806 • Development of the life-cycle requirements of the product
 - 6807 • Establishment of the customer requirements
 - 6808 • Establishment of initial product and product component
6809 requirements consistent with customer requirements
 - 6810 • Elicitation, analysis, and communication of customer needs,
6811 expectations, and constraints to obtain customer requirements that
constitute an understanding of what will satisfy stakeholders

6812 This process area addresses all customer requirements rather than only
6813 product-level requirements because the customer may also provide
6814 specific design requirements. [PA157.N103]

6815 Customer requirements are further refined into product and product
6816 component requirements. In addition to customer requirements, product
6817 and product component requirements are derived from the selected
6818 solution. [PA157.N104]

6819 Requirements evolve throughout the product life cycle. Design
6820 decisions, subsequent corrective actions, and feedback from
6821 production, integration, verification, validation, product operations,
6822 support, and disposal are analyzed for impact on derived and allocated
6823 requirements. [PA157.N105]

6824 Analyses are used to understand, define, and select the requirements
6825 at all levels from competing alternatives. Analysis includes the
6826 following: [PA157.N106]

- 6827 • Analysis of needs and requirements
- 6828 • Development of an operational concept
- 6829 • Definition of the required functionality
- 6830 • Development of manufacturing and support concepts to address
6831 cost and affordability

6832 The definition of functionality, also referred to as functional analysis, is
6833 not the same as structured analysis in software development and does
6834 not presume a functionally oriented software design. In object oriented
6835 software design, it relates to defining the services. The definition of
6836 functions, their logical groupings, and association with requirements is
6837 referred to as a functional architecture. [PA157.N107]

6838 Analyses occur recursively at successively more detailed layers of a
6839 product's architecture, until sufficient detail is available to enable
6840 detailed design, acquisition, and testing of the product to proceed. As a
6841 result of the analysis of requirements and the operational concept
6842 (including functionality, support, maintenance, and disposal) and the
6843 manufacturing or production concept produces more derived
6844 requirements including consideration of the following the following:

6845 [PA157.N108]

- 6846 • Constraints of various types
- 6847 • Technological limitations
- 6848 • Cost and cost drivers
- 6849 • Time constraints and schedule drivers
- 6850 • Risks
- 6851 • Consideration of issues implied but not explicitly stated by the
6852 customer or end-user
- 6853 • Factors introduced by the developer's unique business
6854 considerations, regulations, and laws

6855 A hierarchy of logical entities (functions and subfunctions, object
6856 classes and subclasses) is established through iteration with the
6857 evolving operational concept. Requirements are refined, derived and
6858 allocated to these logical entities. Requirements and logical entities are
6859 allocated to products, product components, people, associated
6860 processes, or services. [PA157.N109]

6861 Involvement of all relevant stakeholders in both requirements
6862 development and analysis gives them visibility into the evolution of
6863 requirements. This activity continually assures them that the
6864 requirements are being properly defined. [PA157.N110]

6865 Related Process Areas

6866 *Refer to the Requirements Management process area for more*
6867 *information about managing customer and product requirements,*
6868 *obtaining agreement with the requirements provider, obtaining*
6869 *commitments with those implementing the requirements, and*
6870 *maintaining traceability.* [PA157.R101]

6871 *Refer to the Technical Solution process area for more information about*
6872 *how the outputs of the Requirements Development process area are*
6873 *used, and the development of alternative solutions and designs used in*
6874 *refining and deriving requirements.* [PA157.R102]

6875 *Refer to the Product Integration process area for more information*
6876 *about interface requirements and interface management.* [PA157.R103]

6877 *Refer to the Verification process area for more information about*
6878 *verifying that the resulting product meets the requirements.* [PA157.R104]

6879 *Refer to the Validation process area for more information about how the*
6880 *product built will be validated against the customer needs.* [PA157.R105]

6881 *Refer to the Risk Management process area for more information about*
6882 *identifying and managing risks that are related to requirements.* [PA157.R106]

6883 *Refer to the Configuration Management process area for information*
6884 *about ensuring that key work products are controlled and managed.*
6885 [PA157.R107]

6886 Specific and Generic Goals

6887 **SG 1 Develop Customer Requirements** [PA157.IG101]

6888 ***Stakeholder needs, expectations, constraints, and interfaces are collected and***
6889 ***translated into customer requirements.***

6890 **SG 2** **Develop Product Requirements** [PA157.IG103]

6891 *Customer requirements are refined and elaborated to develop product and*
6892 *product component requirements for the product life cycle.*

6893 **SG 3** **Analyze and Validate Requirements** [PA157.IG102]

6894 *The requirements are analyzed and validated, and a definition of required*
6895 *functionality is developed.*

6896 **GG 3** **Institutionalize a Defined Process** [CL104.GL101]

6897 *The process is institutionalized as a defined process.*

6898 Practice to Goal Relationship Table

6899	SG 1 Develop Customer Requirements [PA157.IG101]		
6900	SP 1.1	Elicit Needs	
6901	SP 1.2	Transform Stakeholder Needs, Expectations, Constraints, and Inter-	
6902		faces into Customer Requirements	
6903	SG 2 Develop Product Requirements [PA157.IG103]		
6904	SP 2.1	Establish Product and Product Component Requirements	
6905	SP 2.2	Allocate Product Component Requirements	
6906	SP 2.3	Identify Interface Requirements	
6907	SG 3 Analyze and Validate Requirements [PA157.IG102]		
6908	SP 3.1	Establish Operational Concepts and Scenarios	
6909	SP 3.2	Establish a Definition of Required Functionality	
6910	SP 3.3	Analyze Requirements	
6911	SP 3.4	Evaluate Product Cost, Schedule and Risk	
6912	SP 3.5	Validate Requirements with Comprehensive Methods	
6913	GG 3 Institutionalize a Defined Process		
6914	GP 2.1	(CO 1)	Establish an Organizational Policy
6915	GP 3.1	(AB 1)	Establish a Defined Process
6916	GP 2.2	(AB 2)	Plan the Process
6917	GP 2.3	(AB 3)	Provide Resources
6918	GP 2.4	(AB 4)	Assign Responsibility
6919	GP 2.5	(AB 5)	Train People
6920	GP 2.6	(DI 1)	Manage Configurations
6921	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
6922	GP 2.8	(DI 3)	Monitor and Control the Process
6923	GP 3.2	(DI 4)	Collect Improvement Information
6924	GP 2.9	(VE 1)	Objectively Evaluate Adherence
6925	GP 2.10	(VE 2)	Review Status with Higher-Level Management

6926 Specific Practices by Goal

6927 **SG 1 Develop Customer Requirements** [PA157.IG101]

6928 ***Stakeholder needs, expectations, constraints, and interfaces are collected and***
 6929 ***translated into customer requirements.***

6930 The needs of stakeholders (e.g., customers, end users, suppliers,
 6931 builders, and testers) are the basis for determining customer
 6932 requirements. The stakeholder needs, expectations, constraints,
 6933 interfaces, operational concepts, and product concepts are analyzed,
 6934 harmonized, refined, and elaborated for translation into a set of
 6935 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 Elicit Needs

Elicit stakeholder needs, expectations, constraints, and interfaces for all phases of the product's life cycle. [PA157.IG101.SP102]

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:

[PA157.IG101.SP102.N103]

- Technology demonstrations
- Interface control working groups
- Technical control working groups
- Interim project reviews
- Questionnaires, interviews, and operational scenarios obtained from end users
- Prototypes and models
- Brainstorming
- Quality function development
- Market surveys
- Beta testing
- Extraction from sources such as documents, standards, or specifications
- Observation of existing products, environments, and workflow patterns
- Use cases
- Business case analysis
- Reverse engineering (for legacy products)

Subpractices

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]
2. Remove conflicts in stakeholder needs, expectations, constraints, and interfaces and organize into related subjects based on analysis. [PA157.IG101.SP102.SubP102]

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The following specific practice appears in the continuous representation as SP 1.1-1, but is subsumed in the staged representation by SP 1.1 Elicit Needs. The specific practice is presented here only as informative material.

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SP 1.1-1 Collect Stakeholder Needs

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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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]

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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]

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SP 1.2 Transform Stakeholder Needs, Expectations, Constraints, and Interfaces into Customer Requirements

Transform stakeholder needs, expectations, constraints, and interfaces into customer requirements. [PA157.IG101.SP103]

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For Integrated Product and Process Development

Stakeholders representing all phases of the product's life cycle should include business as well as technical functions. In this way, concepts for all product-related life cycle processes are considered concurrently with the concepts for the products. Customers requirements result from informed decisions on the business as well as technical effects of their requirements.

[PA157.IG101.SP103.AMP101]

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The various inputs from the customer need to be consolidated, missing information obtained, conflicts resolved and documented as the recognized set of customer requirements. The customer requirements may include needs, expectations, and constraints with regard to verification and validation. [PA157.IG101.SP103.N101]

- 7019 **Typical Work Products**
- 7020 1. Customer requirements [PA157.IG101.SP103.W101]
- 7021 2. Requirements for verification process [PA157.IG101.SP103.W102]
- 7022 3. Requirements for validation process [PA157.IG101.SP103.W103]
- 7023 4. Test cases and expected results [PA157.IG101.SP103.W104]
- 7024 **Subpractices**
- 7025 1. Translate the stakeholder needs, expectations, constraints, and
- 7026 interfaces into documented customer requirements.
- 7027 [PA157.IG101.SP103.SubP101]
- 7028 2. Define methods, criteria, and constraints for the verification and
- 7029 validation processes. [PA157.IG101.SP103.SubP102]

7030 **SG 2 Develop Product Requirements** [PA157.IG103]

7031 ***Customer requirements are refined and elaborated to develop product and***

7032 ***product component requirements for the product life cycle.***

7033 Customer requirements are analyzed in conjunction with the

7034 development of the operational concept to derive a more detailed and

7035 precise sets of requirements called "product and product component

7036 requirements." Derived requirements arise from constraints,

7037 consideration of issues implied, but not explicitly stated in the customer

7038 requirements baseline, and factors introduced by the selected

7039 architecture, the design, and the developer's unique business

7040 considerations. The requirements are re-examined with each

7041 successive, lower-level set of requirements and functional architecture,

7042 and the preferred product concept is refined. [PA157.IG103.N101]

7043 The requirements are allocated to product functions and product

7044 components including objects, people, and processes. The traceability

7045 of requirements to functions, objects, tests, issues, or other entities is

7046 captured. The allocated requirements and functions are the basis for

7047 the synthesis of the technical solution. As internal components are

7048 developed, additional interfaces are defined and interface requirements

7049 established. [PA157.IG103.N102]

7050 **SP 2.1 Establish Product and Product Component Requirements**

7051 ***Establish and maintain, from the customer requirements, product***

7052 ***and product component requirements essential to product and***

7053 ***product component effectiveness and affordability.*** [PA157.IG103.SP101]

7054 The customer requirements may be expressed in the customer's terms
7055 and may be non-technical descriptions. The product requirements are
7056 the expression of these requirements in technical terms that can be
7057 used for design decisions. An example of this translation is found in the
7058 first House of Quality Functional Deployment, which maps customer
7059 desires into technical parameters. For instance, "solid sounding door"
7060 might be mapped to size, weight, fit, dampening, resonant frequencies,
7061 etc. [PA157.IG103.SP101.N101]

7062 Design constraints include specifications on product components that
7063 derive from design decisions, rather than higher level requirements.
7064 [PA157.IG103.SP101.N102]

For Software Engineering

For example, application components that must interface with an off-the-shelf database component must comply with interface requirements imposed by the selected database; such product component requirements are generally not traceable to higher level requirements. [PA157.IG103.SP101.N102.AMP101]

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7072 Derived requirements also address the cost and performance of other
7073 life-cycle phases (e.g., production, operations, and disposal), to the
7074 extent compatible with business objectives. [PA157.IG103.SP101.N103]

Typical Work Products

- 7075
7076 1. Derived requirements [PA157.IG103.SP101.W101]
7077 2. Product requirements [PA157.IG103.SP101.W102]
7078 3. Product component requirements [PA157.IG103.SP101.W103]
7079 4. House of quality [PA157.IG103.SP101.W104]

Subpractices

- 7080
7081 1. Develop requirements in technical terms necessary for product and
7082 product component design. [PA157.IG103.SP101.SubP101]
7083 2. Derive requirements that result from design decisions.
7084 [PA157.IG103.SP101.SubP102]

7085 *Refer to the Technical Solution process area for more information about*
7086 *developing the solutions that generate additional derived requirements.*
7087 [PA157.IG103.SP101.SubP102.R101]

7088 Selection of a technology brings additional requirements. For instance, use of
7089 electronics necessitates additional technology specific requirements such as
7090 electromagnetic interference limits. [PA157.IG103.SP101.SubP102.N101]

- 7091 3. Establish and maintain relationships between requirements for
7092 consideration during change management and requirements
7093 allocation. [PA157.IG103.SP101.SubP103]

7094 *Refer to the Requirements Management process area for more*
7095 *information about maintaining requirements traceability.*

7096 [PA157.IG103.SP101.SubP103.R101]

7097 Relationships between requirements can aid in evaluating the impact of changes.

7098 [PA157.IG103.SP101.SubP103.N101]

7099 **SP 2.2 Allocate Product Component Requirements**

7100 ***Allocate the requirements for each product component.***

7101 [PA157.IG103.SP102]

7102 *Refer to the Technical Solution process area for more information about*
7103 *allocation of requirements to products and product components. This*
7104 *practice provides information for defining the allocation of requirements*
7105 *but must interact with the practices in the Technical Solution process*
7106 *area to establish solutions to which the requirements are allocated.*

7107 [PA157.IG103.SP102.R101]

7108 The requirements for product components of the defined solution
7109 include allocation of product performance, design constraints, and fit,
7110 form, and function to meet requirements and facilitate production. In
7111 cases where a higher level requirement specifies performance that will
7112 be the responsibility of two or more product components, the
7113 performance must be partitioned for unique allocation to each product
7114 component as a derived requirement. [PA157.IG103.SP102.N101]

7115 **Typical Work Products**

- 7116 1. Requirement allocation sheets [PA157.IG103.SP102.W101]
7117 2. Provisional requirement allocations [PA157.IG103.SP102.W102]
7118 3. Design constraints [PA157.IG103.SP102.W103]
7119 4. Derived requirements [PA157.IG103.SP102.W104]
7120 5. Relationships between derived requirements [PA157.IG103.SP102.W105]
7121 6. Specifications [PA157.IG103.SP102.W106]

7122 **Subpractices**

- 7123 1. Allocate requirements to functions. [PA157.IG103.SP102.SubP101]
7124 2. Allocate requirements to product components. [PA157.IG103.SP102.SubP102]
7125 3. Allocate design constraints to product components.

7126 [PA157.IG103.SP102.SubP103]

- 7127 4. Document relationships between allocated requirements.
7128 [PA157.IG103.SP102.SubP104]

7129 Relationships include dependencies such that a change in one requirement may
7130 affect other requirements. [PA157.IG103.SP102.SubP104.N101]

7131 **SP 2.3 Identify Interface Requirements**

7132 ***Identify interface requirements.*** [PA157.IG103.SP103]

7133 Interfaces between functions (or between objects) are defined.
7134 Functional interfaces may drive the development of alternative solutions
7135 in the Technical Solution process area. [PA157.IG103.SP103.N101]

7136 *Refer to the Product Integration process area for more information*
7137 *about the management of interfaces and the integration of products and*
7138 *product components.* [PA157.IG103.SP103.N101.R101]

7139 Interface requirements between products or product components
7140 identified in the architecture and design are defined. They are
7141 controlled as part of product and product component integration.
7142 [PA157.IG103.SP103.N102]

7143 Life-cycle process interfaces must also be identified. [PA157.IG103.SP103.N103]

7144 Examples of these interfaces include interfaces with test equipment,
7145 transportation systems, support systems, and manufacturing facilities.
7146 [PA157.IG103.SP103.N104]

7147

7148 **Typical Work Products**

- 7149 1. Interface requirements [PA157.IG103.SP103.W101]

7150 **Subpractices**

- 7151 1. Identify interface requirements both external to the product and
7152 internal to the product (i.e., between functional partitions or
7153 objects). [PA157.IG103.SP103.SubP101]

- 7154 2. Fully define interfaces in terms of origination, destination, stimulus,
7155 and data characteristics for software, electrical, and mechanical
7156 characteristics for hardware. [PA157.IG103.SP103.SubP102]

7157 *Refer to the Technical Solution process area for information about*
7158 *generating interface requirements during the design process. As*
7159 *architectures are determined and interfaces are created, new interfaces*
7160 *are created. Also, as interface designs are defined, the design*
7161 *becomes a requirement for products and product components that are*
7162 *affected by the interface* [PA157.IG103.SP103.SubP102.R101]

7163 For internal interfaces, this information may be created as part of the design
7164 PROCESS. [PA157.IG103.SP103.SubP102.N101]

7165 **SG 3 Analyze and Validate Requirements** [PA157.IG102]

7166 ***The requirements are analyzed and validated, and a definition of required***
7167 ***functionality is developed.***

7168 Analyses are performed to determine what impact the intended
7169 operational environment will have on the ability to satisfy the
7170 stakeholders' needs, expectations, constraints, and interfaces.
7171 Considerations such as feasibility, mission needs, cost constraints,
7172 potential market size, and acquisition strategy must all be taken into
7173 account, depending on the product context. A definition of required
7174 functionality is also established. All specified usage modes for the
7175 product are considered, and a time line analysis is generated for time
7176 critical sequencing of functions. [PA157.IG102.N101]

7177 The objectives of the analyses are to determine candidate requirements
7178 for product concepts that will satisfy stakeholder needs, expectations,
7179 and constraints; and then translate these concepts into requirements. In
7180 parallel with this activity, the parameters that will be used to evaluate
7181 the effectiveness of the product are determined based on customer
7182 input and the preliminary product concept. [PA157.IG102.N102]

7183 Requirements are validated to increase probability that the resulting
7184 product will perform as intended in the use environment. [PA157.IG102.N103]

7185 **SP 3.1 Establish Operational Concepts and Scenarios**

7186 ***Establish and maintain operational concepts and scenarios.***
7187 [PA157.IG102.SP101]

7188 *Refer to the Technical Solution process area for detailed development*
7189 *of operations that are dependent on the selected designs.*
7190 [PA157.IG102.SP101.R101]

7191 A scenario is a sequence of events that might occur in the use of the
7192 product that is used to make explicit some of the needs of the
7193 stakeholders. In contrast, an operational concept for a product usually
7194 depends on both the design solution and the scenario. For example, the
7195 operational concept for a satellite-based communications product is
7196 quite different from one based on landlines. Since the alternative
7197 solutions have not usually been defined when preparing the initial
7198 operational concepts, conceptual solutions are developed for use when
7199 analyzing the requirements. The operational concepts are refined as
7200 solution decisions are made and lower-level detailed requirements are
7201 developed. [PA157.IG102.SP101.N101]

7202 Just as a design decision for a product may become a requirement for
7203 product components, the operational concept may become the
7204 scenarios (requirements) for product components. [PA157.IG102.SP101.N102]

7205 The scenarios may include operational sequences, provided those
7206 sequences are an expression of customer requirements rather than
7207 operational concepts. [PA157.IG102.SP101.N103]

7208 **Typical Work Products**

- 7209 1. Operational concept [PA157.IG102.SP101.W101]
- 7210 2. Product installation, operational, maintenance and support
7211 concepts [PA157.IG102.SP101.W102]
- 7212 3. Disposal concepts [PA157.IG102.SP101.W103]
- 7213 4. Use cases [PA157.IG102.SP101.W104]
- 7214 5. Timeline scenarios [PA157.IG102.SP101.W105]
- 7215 6. New requirements [PA157.IG102.SP101.W106]

7216 **Subpractices**

- 7217 1. Develop operational concepts and scenarios that include
7218 functionality, performance, maintenance, support, and disposal as
7219 appropriate. [PA157.IG102.SP101.SubP101]

7220 Identify and develop scenarios, consistent with the level of detail in the
7221 stakeholder needs, expectations and constraints, in which the proposed product is
7222 expected to operate. [PA157.IG102.SP101.SubP101.N101]

- 7223 2. Define the environment the product will operate in, including
7224 boundaries and constraints. [PA157.IG102.SP101.SubP102]
- 7225 3. Review operational concepts and scenarios to refine and discover
7226 requirements. [PA157.IG102.SP101.SubP103]

7227 Operational concept and scenario development is an iterative process. The
7228 reviews should be held periodically to ensure that they agree with the
7229 requirements. The review may be in the form of a walkthrough.

7230 [PA157.IG102.SP101.SubP103.N101]

- 7231 4. Develop a detailed operational concept as products and product
7232 components are selected that define the interaction of the product,
7233 the end-user, and the environment, that satisfies the operational,
7234 maintenance, support, and disposal needs. [PA157.IG102.SP101.SubP104]

7235 **SP 3.2 Establish a Definition of Required Functionality**

7236 ***Establish and maintain a definition of required functionality.***

7237 [PA157.IG102.SP102]

7238 The definition of functionality, also referred to as functional analysis, is
7239 the description of what the product is intended to do. The definition of
7240 functionality can include actions, sequence, inputs, outputs or other
7241 information that communicates the manner in which the product will be
7242 used. [PA157.IG102.SP102.N101]

7243 Functional analysis is not the same as structured analysis in software
7244 development and does not presume a functionally oriented software
7245 design. In object oriented software design, it relates to defining the
7246 services. The definition of functions, their logical groupings and
7247 association with requirements is referred to as a functional architecture.
7248 [PA157.IG102.SP102.N102]

7249 **Typical Work Products**

- 7250 1. Functional architecture [PA157.IG102.SP102.W101]
- 7251 2. Activity diagrams and use cases [PA157.IG102.SP102.W102]
- 7252 3. Object oriented analysis with services identified [PA157.IG102.SP102.W103]

7253 **Subpractices**

- 7254 1. Analyze and quantify functionality required by end users.
7255 [PA157.IG102.SP102.SubP101]
- 7256 2. Analyze requirements to identify logical or functional partitions
7257 (e.g., subfunctions). [PA157.IG102.SP102.SubP102]
- 7258 3. Partition requirements into groups, based on established criteria
7259 (e.g., similar functionality, performance, or coupling) to facilitate
7260 and focus the requirements analysis. [PA157.IG102.SP102.SubP103]
- 7261 4. Consider the sequencing of time-critical functions both initially and
7262 subsequently during product component development.
7263 [PA157.IG102.SP102.SubP104]
- 7264 5. Allocate customer requirements to functional partitions, objects,
7265 people, or support elements to support the synthesis of solutions.
7266 [PA157.IG102.SP102.SubP105]
- 7267 6. Allocate functional and performance requirements to functions and
7268 subfunctions. [PA157.IG102.SP102.SubP106]

7269 **SP 3.3 Analyze Requirements**

7270 **Analyze derived requirements to ensure that they are necessary**
7271 **and sufficient.** [PA157.IG102.SP103]

7272 The derived requirements are analyzed in light of the operational
7273 concept and scenarios to support the development of a more detailed
7274 and precise set of product or product component requirements. The
7275 analysis makes sure that the derived requirements are necessary and
7276 sufficient to meet the objectives of higher level requirements.

7277 [PA157.IG102.SP103.N102]

7278 As requirements are defined, their relationship to higher level
7279 requirements and the higher level defined functionality must be
7280 understood. One of the other key actions is the determination of which
7281 requirements will be identified to track technical progress against. For
7282 instance, the weight of a product or size of a software product may be
7283 monitored through development based on its risk. [PA157.IG102.SP103.N101]

7284 **Typical Work Products**

- 7285 1. Requirements defects reports [PA157.IG102.SP103.W101]
- 7286 2. Proposed requirements changes to resolve defects
7287 [PA157.IG102.SP103.W102]
- 7288 3. Key requirements [PA157.IG102.SP103.W103]
- 7289 4. Technical performance measures [PA157.IG102.SP103.W104]

7290 **Subpractices**

- 7291 1. Analyze stakeholder needs, expectations, constraints, and external
7292 interfaces to remove conflicts and to organize into related subjects.
7293 [PA157.IG102.SP103.SubP101]
- 7294 2. Analyze derived requirements to determine whether they satisfy
7295 the objectives of higher-level requirements. [PA157.IG102.SP103.SubP102]
- 7296 3. Analyze requirements to ensure that they are complete, feasible,
7297 realizable, and verifiable. [PA157.IG102.SP103.SubP103]

7298 While design determines the feasibility of a particular solution, this subpractice
7299 addresses the understanding of which requirements impact feasibility.

7300 [PA157.IG102.SP103.SubP103.N101]

- 7301 4. Identify key requirements that have a strong influence on cost,
7302 schedule, functionality, risk, or performance. [PA157.IG102.SP103.SubP104]
- 7303 5. Identify technical performance measures that will be tracked during
7304 the development effort. [PA157.IG102.SP103.SubP105]

7305 *Refer to the Measurement and Analysis process area for more*
7306 *information on the general use of measurements.* [PA157.IG102.SP103.SubP105.R101]

- 7307 6. Analyze operational concepts and scenarios to refine the customer
7308 needs, constraints and interfaces and discover new requirements.

7309 [PA157.IG102.SP103.SubP106]

7310 This analysis may result in more detailed operational concepts and scenarios as
7311 well as supporting the derivation of new requirements. [PA157.IG102.SP103.SubP106.N101]

7312 **SP 3.4 Evaluate Product Cost, Schedule and Risk**

7313 **Analyze requirements with the purpose of reducing the life-cycle**
7314 **cost, schedule and risk of product development.** [PA157.IG102.SP104]

7315 Use validated models, simulations, and prototyping to analyze the cost
7316 and risk associated with the customer requirements. Results of the
7317 analyses can be used to reduce the cost of the product and the risk in
7318 developing the product. [PA157.IG102.SP104.N101]

7319 **Typical Work Products**

- 7320 1. Assessment of risks related to requirements [PA157.IG102.SP104.W101]

7321 **Subpractices**

- 7322 1. Perform a risk assessment on the requirements and functional
7323 architecture. [PA157.IG102.SP104.SubP101]

7324 *Refer to the Risk Management process area for information about*
7325 *performing a risk assessment on customer and product requirements*
7326 *and the functional architecture.* [PA157.IG102.SP104.SubP101.R101]

- 7327 2. Examine life-cycle concepts for impacts of requirements on risks.
7328 [PA157.IG102.SP104.SubP102]

7329 **SP 3.5 Validate Requirements with Comprehensive Methods**

7330 **Validate requirements to ensure the resulting product will perform**
7331 **as intended in the user's environment using multiple techniques**
7332 **as appropriate.** [PA157.IG102.SP106]

7333 Requirements validation is performed early in the development effort to
7334 gain confidence that the requirements are capable of guiding a
7335 development that results in successful final validation. This activity
7336 should be integrated with the risk management activities. Mature
7337 organizations will typically perform requirements validation in a more
7338 sophisticated way and will broaden the basis of the validation to include
7339 other stakeholder needs and expectations. These organizations will
7340 typically perform analyses, simulations, or prototypes to ensure that
7341 requirements will satisfy stakeholder needs and expectations.

7342 [PA157.IG102.SP106.N102]

7343 **Typical Work Products**

- 7344 1. Record of analysis methods and results [PA157.IG102.SP106.W101]

7345

Subpractices

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1. Analyze the requirements to determine the risk that the resulting product will not perform appropriately in its intended use environment. [PA157.IG102.SP106.SubP101]

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2. Explore the adequacy and completeness of requirements by showing the customers and end users prototypes, simulations, analyses, scenarios, and storyboards. [PA157.IG102.SP106.SubP102]

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3. Assess the design as it matures in the context of the requirements validation environment to identify validation issues and expose unstated needs and customer requirements. [PA157.IG102.SP106.SubP103]

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The following specific practice appears in the continuous representation as SP 3.5-1, but is subsumed in the staged representation by SP 3.5 Validate Requirements with Comprehensive Methods. The specific practice is presented here only as informative material.

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SP 3.5-1 Validate Requirements

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Validate requirements to ensure the resulting product will perform appropriately in its intended use environment. [PA157.IG102.SP105]

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7362

Requirements validation is performed early in the development effort to gain confidence that the requirements are capable of guiding a development that results in successful final validation. This activity should be integrated with the risk management activities.

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[PA157.IG102.SP105.N101]

7367

Typical Work Products

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1. Results of requirements validation [PA157.IG102.SP105.W101]

7369

Subpractices

7370

1. Analyze the requirements to determine the risk that the resulting product will not perform appropriately in its intended use environment. [PA157.IG102.SP105.SubP101]

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GG 3 Institutionalize a Defined Process [CL104.GL101]

7374

The process is institutionalized as a defined process.

7375 Commitment to Perform

7376 **GP 2.1 (CO 1) Establish an Organizational Policy**

7377 ***Establish and maintain an organizational policy for planning and***
7378 ***performing the requirements development process.*** [GP103]

7379 Elaboration:

7380 This policy establishes organizational expectations for collecting
7381 stakeholder needs, formulating product and product component
7382 requirements, and analyzing and validating those requirements.

7383 [PA157.EL101]

7384 Ability to Perform

7385 **GP 3.1 (AB 1) Establish a Defined Process**

7386 ***Establish and maintain the description of a defined requirements***
7387 ***development process.*** [GP114]

7388 **GP 2.2 (AB 2) Plan the Process**

7389 ***Establish and maintain the requirements and objectives, and plans***
7390 ***for performing the requirements development process.*** [GP104]

7391 Elaboration:

7392 These requirements, objectives, and plans are typically described in the
7393 project plan as described in the Project Planning process area.

7394 [PA157.EL102]

7395 **GP 2.3 (AB 3) Provide Resources**

7396 ***Provide adequate resources for performing the requirements***
7397 ***development process, developing the work products and***
7398 ***providing the services of the process.*** [GP105]

7399 Elaboration:

7400 Special expertise in the application domain, methods for eliciting
7401 stakeholder needs, and methods and tools for specifying and analyzing
7402 customer, product and product component requirements may be
7403 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 (AB 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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GP 2.5 (AB 5) Train People

Train the people performing or supporting the requirements development process as needed. [GP107]

7419

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

7427

Directing Implementation

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GP 2.6 (DI 1) Manage Configurations

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

[GP109]

7432 Elaboration:

7433 Examples of work products placed under configuration management
7434 include the following: [PA157.EL106]

- 7435
- 7436 • Customer requirements
 - 7437 • Functional architecture
 - 7438 • Product and product component requirements
 - 7439 • Interface requirements

7440 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

7441 ***Identify and involve the relevant stakeholders of the requirements***
7442 ***development process as planned.*** [GP124]

7443 Elaboration:

7444 For engineering processes, consider stakeholders among customers,
7445 end users, developers, producers, testers, suppliers, marketers,
7446 maintainers, disposal personnel, and others who may be affected by, or
7447 may affect, the product as well as the process. [PA157.EL113]

7448 Examples of activities for stakeholder involvement include: [PA157.EL114]

- 7449
- 7450 • Reviewing adequacy of requirements to meet needs, expectations,
constraints, and interfaces.
 - 7451 • Establishing operational concepts and scenarios
 - 7452 • Assessing the adequacy of requirements
 - 7453 • Establishing product and product component requirements
 - 7454 • Assessing product cost, schedule, and risk

7455

7456 **GP 2.8 (DI 3) Monitor and Control the Process**

7457 ***Monitor and control the requirements development process***
7458 ***against the plan and take appropriate corrective action.*** [GP110]

7459 Elaboration:

7460 Examples of measures used in monitoring and controlling the activities
7461 of the Requirements Development process area include the following:

7462 [PA157.EL110]

- 7463 • Cost, schedule, and effort expended for rework
- 7464 • Defect density of requirements specifications

7465

7466 **GP 3.2 (DI 4) Collect Improvement Information**

7467 ***Collect work products, measures, measurement results, and***
7468 ***improvement information derived from planning and performing***
7469 ***the requirements development process to support the future use***
7470 ***and improvement of the organization's processes and process***
7471 ***assets.*** [GP117]

7472 Verifying Implementation

7473 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

7474 ***Objectively evaluate adherence of the requirements development***
7475 ***process and the work products and services of the process to the***
7476 ***applicable requirements, objectives, and standards, and address***
7477 ***noncompliance.*** [GP113]

7478 Elaboration:

7479 Examples of activities reviewed include the following: [PA157.EL111]

- 7480 • Collecting stakeholder needs
- 7481 • Formulating product and product component requirements
- 7482 • Analyzing and validating product and product component
- 7483 requirements

7484

7485 Examples of work products reviewed include the following: [PA157.EL112]

- 7486 • Product requirements
- 7487 • Product component requirements
- 7488 • Interface requirements
- 7489 • Functional architecture

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

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

7495 TECHNICAL SOLUTION

7496 Maturity Level 3

7497 Purpose

7498 The purpose of Technical Solution is to develop, design, and implement
7499 solutions to requirements. Solutions, designs and implementations
7500 encompass products, product components, and product related
7501 processes either singly or in combinations as appropriate. [PA160]

7502 Introductory Notes

7503 The Technical Solution process area is applicable at any level of the
7504 product architecture and to every product, product component, life cycle
7505 process, and service. The process area focuses on the following:

7506 [PA160.N101]

- 7507 • Evaluating and selecting solutions (sometimes referred to as
7508 design approaches, design concepts or preliminary designs) that
7509 potentially satisfy an appropriate set of allocated requirements
- 7510 • Developing detailed designs for the selected solutions (detailed in
7511 the context of containing all the information needed to
7512 manufacture, code, or otherwise implement the design as a
7513 product or product component)
- 7514 • Implementing the designs as a product or product component

7515 In practice, these activities interactively support with each other. Some
7516 level of design, at times fairly detailed, may be needed to select
7517 solutions. Product component prototypes may be used as a means of
7518 gaining sufficient knowledge to develop a complete technical data
7519 package or a complete set of requirements. [PA160.N102]

7520 Technical Solution practices apply not only to the product and product
7521 components but also to services and product-related processes. The
7522 product-related processes are developed in concert with product, or
7523 product component, development. Such development may include
7524 selecting and adapting existing processes (including standard
7525 processes) for use as well as developing new processes. [PA160.N103]

7526 Requirements for the product that originate in the Requirements
7527 Development process area or elsewhere are received from the
7528 Requirements Management process area after they have been placed
7529 under appropriate configuration management and after the traceability
7530 to previous requirements has been accomplished. [PA160.N104]

7531 For a sustainment organization, the requirements in need of
7532 maintenance actions or redesign may be driven by user needs or latent
7533 defects in the product components. New requirements may arise from
7534 changes in the life cycle utilization or other aspects of the operating
7535 environment for which modifications may be necessary (e.g., changes
7536 in stress spectrum resulting in unplanned for and accelerated
7537 mechanical aging or changes in the operating system software). Such
7538 occurrences are uncovered during continuous verification of the
7539 product(s) as used in their operating environment. These verifications
7540 expose actual performance delivered which can be compared against
7541 the performance specified and unacceptable degradation identified. The
7542 Technical Solution practices should be used to perform the sustainment
7543 design efforts. [PA160.N105]

7544 Related Process Areas

7545 *Refer to the Requirements Development process area for more*
7546 *information about requirements allocations, establishing operational*
7547 *concept, and interface requirements definition. Technical solutions are*
7548 *developed interactively with requirements definition and both evolve*
7549 *with requirements and stimulate requirements to be refined as the*
7550 *technical solution matures. [PA160.R101]*

7551 *Refer to the Verification process area for more information about*
7552 *conducting peer reviews, and verifying that the product and product*
7553 *components meet requirements. As verification issues are identified,*
7554 *the design may need to change. [PA160.R102]*

7555 *Refer to the Decision Analysis and Resolution process area for more*
7556 *information about structured decision making. Selecting the solution*
7557 *from a set of design alternatives is one place the structured Decision*
7558 *Analysis and Resolution process area should be used. [PA160.R103]*

7559 *Refer to the Requirements Management process area for more*
7560 *information about managing requirements. The practices in*
7561 *Requirements Management should be executed concurrently with*
7562 *Technical Solution. [PA160.R104]*

7563 *Refer to the Organizational Innovation and Deployment process area*
7564 *for more information about the organization's technology processes.*
7565 *[PA160.R105]*

7566 Specific and Generic Goals

7567 **SG 1** **Select Product Component Solutions** [PA160.IG101]

7568 *Product or product component solutions, including applicable product related*
7569 *processes, are selected from alternative solutions.*

7570 **SG 2** **Develop the Design** [PA160.IG102]

7571 *Product or product component designs are developed.*

7572 **SG 3** **Implement the Product Design** [PA160.IG103]

7573 *Product components, and associated support documentation, are*
7574 *implemented from their designs.*

7575 **GG 3** **Institutionalize a Defined Process** [CL104.GL101]

7576 *The process is institutionalized as a defined process.*

7577 Practice to Goal Relationship Table

7578	SG 1 Select Product Component Solutions [PA160.IG101]		
7579	SP 1.1	Develop Detailed Alternative Solutions and Selection Criteria	
7580	SP 1.2	Evolve Operational Concepts and Scenarios	
7581	SP 1.3	Select Product Component Solutions	
7582	SG 2 Develop the Design [PA160.IG102]		
7583	SP 2.1	Use Effective Design Methods	
7584	SP 2.2	Establish a Complete Technical Data Package	
7585	SP 2.3	Design Comprehensive Interface	
7586	SP 2.4	Perform Make, Buy, or Reuse Analyses	
7587	SG 3 Implement the Product Design [PA160.IG103]		
7588	SP 3.1	Implement the Design	
7589	SP 3.2	Establish Product Support Documentation	
7590	GG 3 Institutionalize a Defined Process		
7591	GP 2.1	(CO 1)	Establish an Organizational Policy
7592	GP 3.1	(AB 1)	Establish a Defined Process
7593	GP 2.2	(AB 2)	Plan the Process
7594	GP 2.3	(AB 3)	Provide Resources
7595	GP 2.4	(AB 4)	Assign Responsibility
7596	GP 2.5	(AB 5)	Train People
7597	GP 2.6	(DI 1)	Manage Configurations
7598	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
7599	GP 2.8	(DI 3)	Monitor and Control the Process
7600	GP 3.2	(DI 4)	Collect Improvement Information
7601	GP 2.9	(VE 1)	Objectively Evaluate Adherence
7602	GP 2.10	(VE 2)	Review Status with Higher-Level Management

7603 Specific Practices by Goal

7604 **SG 1 Select Product Component Solutions** [PA160.IG101]

7605	<i>Product or product component solutions, including applicable product related processes, are selected from alternative solutions.</i>
7606	

7607 Alternative solutions and their relative merits are considered in advance
7608 of selecting a solution. Key requirements, design issues and constraints
7609 are established for use in alternative solutions analysis. Architectural
7610 features that provide a foundation for product improvement and
7611 evolution are considered. Use of commercial-off-the-shelf (COTS)
7612 product components are considered relative to cost, schedule,
7613 performance, and risk. COTS alternatives may be used with or without
7614 modification. Sometimes such items may require modifications to
7615 aspects such as interfaces or a customization of some of the features
7616 to better achieve product requirements. [PA160.IG101.N101]

7617 One indicator of a good design process is that the design was chosen
7618 after comparing and evaluating it against alternative solutions.
7619 Decisions on architecture, custom development versus off-the-shelf,
7620 and component modularization are typical of the design choices that are
7621 addressed. [PA160.IG101.N102]

7622 Sometimes the search for solutions examines alternative instances of
7623 the same requirements with no allocations needed to lower-level
7624 components. Such is the case at the bottom of the product
7625 architecture. There are also cases where one or more of the solutions
7626 is fixed (e.g., a specific solution is directed or available products
7627 components, such as COTS, are investigated for use). [PA160.IG101.N103]

7628 In the general case, solutions are defined as a set. That is, when
7629 defining the next layer of product components, the solution for each of
7630 the product components in the set are established together. The
7631 alternative solutions are not only different ways of addressing the same
7632 requirements, but they also reflect a different allocation of requirements
7633 among the product components comprising the solution set. The
7634 objective is to optimize the set as a whole and not the individual pieces.
7635 There will be significant interaction with the Requirements Development
7636 process area to support the provisional allocations to product
7637 components until a solution set is selected and “final” allocations
7638 established. [PA160.IG101.N104]

7639 **SP 1.1 Develop Detailed Alternative Solutions and Selection Criteria**

7640 ***Develop detailed alternative solutions and selection criteria.***

7641 [PA160.IG101.SP102]

7642 *Refer to the Decision Analysis and Resolution process area for more*
7643 *information about establishing criteria used in making structured*
7644 *decisions.* [PA160.IG101.SP102.R101]

7645 ***For Integrated Product and Process Development***

7646 *The practice of selecting alternative solutions and issues to be*
7647 *subject to decision analyses and trade studies is*
7648 *accomplished by the involvement of relevant stakeholders,*
7649 *representing both business and technical functions and the*
7650 *concurrent development of the life cycle processes (e.g.,*
7651 *manufacturing, support, training, verification and disposal) with*
7652 *the product. In this way, important issues surface earlier in the*
7653 *product development than with traditional practices and can*
7654 *be addressed before they become costly mistakes.*

7655 [PA160.IG101.SP102.AMP101]

7656 Detailed alternative solutions are an essential concept of Technical
 7657 Solution. They provide more accurate and comprehensive information
 7658 about the solution than non-detailed alternatives. For example,
 7659 characterization of performance based on design content rather than on
 7660 simple estimating enables effective assessment and understanding of
 7661 environment and operating concept impacts. Alternative solutions need
 7662 to be identified and analyzed to enable the selection of a life cycle
 7663 balanced solution in terms of cost, schedule, and technical
 7664 performance. Alternative solutions span the acceptable range of cost,
 7665 schedule, and performance. The product component requirements are
 7666 received and used along with design issues, constraints, and criteria to
 7667 develop the alternative solutions. Selection criteria would typically
 7668 address costs (e.g., time, people, money), benefits (e.g., performance,
 7669 capability, effectiveness), and risks (e.g., executability, technical, cost,
 7670 schedule). Detailed alternative solutions and selection criteria include
 7671 the following: [PA160.IG101.SP102.N102]

- 7672 • Cost (development, procurement/reprocurement, support, life
- 7673 cycle)
- 7674 • Technical performance
- 7675 • Complexity of the product component and related life cycle
- 7676 processes
- 7677 • Robustness to product operating and use conditions, operating
- 7678 modes, environments, and variations in related life-cycle
- 7679 processes
- 7680 • Product expansion and growth
- 7681 • Technology limitations
- 7682 • Sensitivity to construction methods and materials
- 7683 • Risk
- 7684 • Evolution of requirements and technology
- 7685 • Disposal

7686 The considerations listed above are a basic set; organizations should
 7687 develop a list of screening criteria for alternatives that are consistent
 7688 with business objectives. Life-cycle cost, while being a desirable
 7689 parameter to minimize, may be outside the control of development
 7690 organizations. A customer may not be willing to pay for features that
 7691 cost more in the short term but ultimately decrease cost over the life of
 7692 the product. In such cases, customers should at least be advised of
 7693 any potential for reducing life-cycle costs. The criteria used in
 7694 selections should provide a balanced approach to costs, benefits, and
 7695 risks. [PA160.IG101.SP102.N103]

7696 **Typical Work Products**

- 7697 1. Alternative solutions [PA160.IG101.SP102.W101]

- 7698 2. Selection criteria [PA160.IG101.SP102.W102]
- 7699 3. Checklists for alternative solution screening criteria
7700 [PA160.IG101.SP102.W103]
- 7701 4. Evaluations of new technologies [PA160.IG101.SP102.W104]
- 7702 **Subpractices**
- 7703 1. Identify screening criteria to select a set of alternative solutions for
7704 consideration. [PA160.IG101.SP102.SubP101]
- 7705 2. Identify technologies currently in use and new product technologies
7706 for competitive advantage. [PA160.IG101.SP102.SubP102]
- 7707 *Refer to the Organizational Innovation and Deployment process area*
7708 *for more information about the organization's technology processes.*
7709 [PA160.IG101.SP102.SubP102.R101]
- 7710 The project should identify technologies applied to current products and
7711 processes and monitor the progress of currently used technologies through their
7712 life cycle. The project should identify, select, evaluate, and invest in new
7713 technologies to achieve competitive advantage. Alternative solutions could include
7714 newly developed technologies, but could also include applying mature
7715 technologies in different applications or to maintain current methods.
7716 [PA160.IG101.SP102.SubP102.N101]
- 7717 3. Generate alternative solutions. [PA160.IG101.SP102.SubP103]
- 7718 4. Obtain a complete requirements allocation for each alternative.
7719 [PA160.IG101.SP102.SubP104]
- 7720 5. Establish the criteria for selecting the best alternative solution.
7721 [PA160.IG101.SP102.SubP105]
- 7722 Criteria should be included addressing life cycle design issues such as provisions
7723 for more easily inserting new technologies or ability to better exploit commercial
7724 products. Examples would include criteria related to open design or open
7725 architecture concepts for the alternatives being evaluated. [PA160.IG101.SP102.SubP105.N101]
- 7726 6. Develop timeline scenarios for product operation and user
7727 interaction for each alternative solution. [PA160.IG101.SP102.SubP106]

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The following specific practice appears in the continuous representation as SP 1.1-1, but is subsumed in the staged representation by SP 1.1 Develop Detailed Alternative Solutions and Selection Criteria. The specific practice is presented here only as informative material.

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SP 1.1-1 Develop Alternative Solutions and Selection Criteria

Develop alternative solutions and establish selection criteria.

[PA160.IG101.SP101]

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Refer to the Allocate Product Component Requirements specific practice in the Requirements Development process area for more information about obtaining provisional allocations of requirements to solution alternatives for the product components. [PA160.IG101.SP101.R101]

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Refer to the Decision Analysis and Resolution process area for practices used to determine the need for establishing when alternatives may not be useful. [PA160.IG101.SP101.R102]

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Refer to the Requirements Management process area for more information about managing the provisional and established allocated requirements. [PA160.IG101.SP101.R103]

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Alternatives frequently span a design space that explores the feasible solutions available. As selections are made, the design space may be constricted and other alternatives examined until the most promising (i.e., optimal) solutions that meet requirements and established criteria are identified. The selection criteria identify the key factors that provide a basis for the selection of the solution. These criteria should provide meaningful discrimination and an indication of success or goodness in arriving at a life cycle balanced solution. They typically include measures of cost, schedule, performance, and risk. The alternative solutions evaluated frequently encompass alternative requirement allocations to different product components. These alternatives may also be structured to evaluate the use of COTS solutions in the product architecture. Practices such as those in the Requirements Development process area would then be employed to provide a more complete and robust provisional allocation of requirements to the alternative solutions. Selection of the “best” solution establishes the requirements provisionally allocated to that solution as the set of allocated requirements. The circumstances in which it would be “not useful” to examine alternative solutions are infrequent in new developments. However, developments of precedented product components are candidates for not examining, or only minimally examining, alternative solutions. [PA160.IG101.SP101.N101]

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Typical Work Products

1. Alternative solutions [PA160.IG101.SP101.W101]

7769 2. Selection criteria [PA160.IG101.SP101.W102]

7770 **Subpractices**

7771 1. Establish and maintain a process or processes for identifying
7772 solution alternatives, selection criteria, and design issues.

7773 [PA160.IG101.SP101.SubP101]

7774 Selection criteria are influenced by a wide variety of factors driven by the
7775 requirements imposed on the develop program as well as the life cycle of the
7776 product. For example, criteria related to mitigating cost and schedule risks may
7777 influence a greater preference for COTS solutions provided such selections do not
7778 result in unacceptable risks in the remaining product components to be
7779 developed. When using existing items, such as COTS, either with or without
7780 modification, criteria dealing with diminishing sources of supply or technological
7781 obsolescence should be examined as well as criteria capturing the benefits of
7782 standardization, maintaining relationships with suppliers and so forth. The criteria
7783 used in selections should provide a balanced approach to costs, benefits, and
7784 risks. [PA160.IG101.SP101.SubP101.N101]

7785 2. Identify alternative groupings of requirements that characterize sets
7786 of solution alternatives that span the feasible design space.

7787 [PA160.IG101.SP101.SubP102]

7788 Effective employment of COTS alternatives can provide special challenges.
7789 Knowledgeable designers familiar with candidate COTS alternatives may explore
7790 architectural opportunities to exploit potential COTS payoff.

7791 [PA160.IG101.SP101.SubP102.N101]

7792 3. Identify design issues for each solution alternative in each set of
7793 alternatives. [PA160.IG101.SP101.SubP103]

7794 4. Characterize design issues and take appropriate action.

7795 [PA160.IG101.SP101.SubP104]

7796 Appropriate actions could range from characterizing the issues as a risk for risk
7797 management, adjusting the solution alternative to preclude the issue, rejecting the
7798 solution alternative and replacing it with a different alternative.

7799 [PA160.IG101.SP101.SubP104.N101]

7800 5. Obtain a complete requirements allocation for each alternative.

7801 [PA160.IG101.SP101.SubP105]

7802 6. Establish the rationale for each alternative set of solutions.

7803 [PA160.IG101.SP101.SubP106]

7804 **SP 1.2 Evolve Operational Concepts and Scenarios**

7805 ***Evolve the operational concept, scenarios, and environments to***
7806 ***describe the conditions, operating modes, and operating states***
7807 ***specific to each product component.*** [PA160.IG101.SP103]

7808 *Refer to the Establish Operational Concepts and Scenarios specific*
7809 *practice of the Requirements Development process area for information*
7810 *on product-level influences and implications of product component*
7811 *operations.* [PA160.IG101.SP103.R101]

7812 ***For Systems Engineering***

7813 *Integrate the operational concepts and scenarios produced by*
7814 *various individuals or groups for each level of physical product*
7815 *decomposition.* [PA160.IG101.SP103.AMP101]

7816 Operational concepts and scenarios document the stimulus-response
7817 time sequenced behavior of the interaction of the product components
7818 with the environment, users, and other components. They should be
7819 documented for operations, product deployment/delivery, support
7820 (including maintenance and sustainment), training, and disposal and for
7821 all modes and states. The environments (operating, support, training,
7822 etc.) also need to be evolved. The environment experienced by any
7823 given product component will be influenced by other product
7824 components as well as the external environment. The environments
7825 may include thermal, stress, and electromagnetic and other elements
7826 that need to be documented. [PA160.IG101.SP103.N101]

7827 **Typical Work Products**

- 7828 1. Product component operational concepts, scenarios, and
7829 environments for all pertinent life-cycle processes (operations,
7830 support, training, manufacturing, verification,
7831 deployment/fielding/delivery/disposal) [PA160.IG101.SP103.W101]
- 7832 2. Timeline analyses of product component interactions
7833 [PA160.IG101.SP103.W102]
- 7834 3. Event trace diagrams [PA160.IG101.SP103.W103]
- 7835 4. Use cases [PA160.IG101.SP103.W104]

7836 **SP 1.3 Select Product Component Solutions**

7837 ***Select the product component solutions that best satisfy the***
7838 ***criteria established.*** [PA160.IG101.SP104]

7839 *Refer to the Allocate Product Component Requirements and Identify*
7840 *Interface Requirements specific practices of the Requirements*
7841 *Development process area for information on establishing the allocated*
7842 *requirements for product components and interface requirements*
7843 *between product components.* [PA160.IG101.SP104.R101]

7844 *Refer to the Decision Analysis and Resolution process area for more*
7845 *information about structured decision making.* [PA160.IG101.SP104.R102]

7846 Selection of the product components that best satisfies the criteria
7847 establishes the requirement allocations to product components. The
7848 selected alternative is either evolved as lower-level requirements or
7849 used to develop the technical data package. The product component to
7850 product component interface requirements will be described
7851 predominately functionally. Physical interface descriptions will be
7852 included in the technical data package when the interface is to
7853 items/activities external to the product. [PA160.IG101.SP104.N101]

7854 The description of the solutions and the rationale for selection are
7855 documented in an initial technical data package. The technical data
7856 package evolves throughout development as solutions and detailed
7857 designs are developed and those designs implemented. Maintaining a
7858 record of rationale is critical to downstream decision making. Such
7859 records keep downstream stakeholders from redoing work and provide
7860 insights to apply technology, as it becomes available in applicable
7861 circumstances. [PA160.IG101.SP104.N102]

7862 **Typical Work Products**

- 7863 1. Product component selection decisions and rationale
7864 [PA160.IG101.SP104.W101]
- 7865 2. Documented relationships between requirements and product
7866 components [PA160.IG101.SP104.W102]
- 7867 3. Initial product component technical data package. [PA160.IG101.SP104.W103]

7868 **Subpractices**

- 7869 1. Evaluate each alternative solution/set of solutions against the
7870 selection criteria established in the context of the operating
7871 concepts, operating modes, and operating states.
7872 [PA160.IG101.SP104.SubP101]
- 7873 2. Based on the evaluation of alternatives, assess the adequacy of
7874 the selection criteria and update these criteria as necessary.
7875 [PA160.IG101.SP104.SubP102]
- 7876 3. Identify and resolve issues with the alternative solutions and
7877 requirements. [PA160.IG101.SP104.SubP103]
- 7878 4. Select the “best” set of alternative solutions that satisfy the
7879 established selection criteria. [PA160.IG101.SP104.SubP104]
- 7880 5. Establish the requirements associated with the selected set of
7881 alternatives to be the set of allocated requirements to those
7882 product components. [PA160.IG101.SP104.SubP105]
- 7883 6. Establish and maintain the documentation of the solutions,
7884 evaluations, and rationale. [PA160.IG101.SP104.SubP106]

7885 **SG 2** **Develop the Design** [PA160.IG102]

7886 ***Product or product component designs are developed.***

7887 Product or product component designs must provide the appropriate
 7888 life-cycle content not just for implementation, but also for modification,
 7889 reprourement, maintenance, sustainment, and installation. The design
 7890 documentation provides a reference to support mutual understanding of
 7891 the design by relevant stakeholders and supports future changes to the
 7892 design both during development and downstream in the product life
 7893 cycle. A complete design description is documented in a technical data
 7894 package that includes a full range of features and parameters including
 7895 form, fit, function, interface, manufacturing process characteristics, and
 7896 other parameters. Established organizational or project design
 7897 standards (e.g., checklists, templates) form the basis for achieving a
 7898 high degree of definition and completeness in design documentation.

7899 [PA160.IG102.N101]

7900 ***For Integrated Product and Process Development***

7901 *The integrated teams develop the designs of the appropriate*
 7902 *life cycle processes, e.g., the manufacturing process and the*
 7903 *support process, concurrently with the design of the product*
 7904 *unless these processes are selected and not modified from*
 7905 *the organization's set of standard processes.* [PA160.IG102.AMP101]

7906

7907 **SP 2.1** **Use Effective Design Methods**

7908 ***Establish and use effective design methods.*** [PA160.IG102.SP101]

7909 ***For Software Engineering***

7910
 7911 *Use effective methods to design software. Examples of*
 7912 *techniques and methods that facilitate effective software*
 7913 *design include the following:* [PA160.IG102.SP101.AMP101]

- 7914 • *Prototypes*
- 7915 • *Structural models*
- 7916 • *Object-oriented design*
- 7917 • *Essential systems analysis*
- 7918 • *Entity relationship models*
- 7919 • *Design reuse*
- 7920 • *Design patterns*

7921

7922 Effective design methods can embody a wide range of activities, tools,
7923 and descriptive techniques. Whether a given method is effective or not
7924 depends on the situation. For example, software design tools are not
7925 particularly effective methods to use when designing hydraulic pumps.
7926 Two companies may have very effective design methods for products
7927 they specialize in but these methods may not be effective in cooperative
7928 ventures. Highly sophisticated methods are not necessarily effective in
7929 the hands of designers that have not been trained in the used of the
7930 methods. [PA160.IG102.SP101.N101]

7931 Whether or not a method is effective also depends on how much
7932 assistance it provides the designer, and the cost effectiveness of that
7933 assistance. For example, a multi-year prototyping effort may not be
7934 appropriate for a pump or a software module but might be the right thing
7935 to do for an unprecedented, expensive, and complex product
7936 development. Rapid prototyping techniques (for example, stereo
7937 lithography for the pump), however, may be highly effective for product
7938 components of that product. Methods that use tools to ensure that a
7939 design will encompass all the necessary attributes needed to implement
7940 the product component design can be very effective. For example, a
7941 design tool that “knows” the capabilities of the manufacturing processes
7942 can allow the variability of the manufacturing process to be accounted
7943 for in the design tolerances. [PA160.IG102.SP101.N102]

7944 **Typical Work Products**

- 7945 1. Criteria for design methods [PA160.IG102.SP101.W101]
- 7946 2. Design methods [PA160.IG102.SP101.W102]
- 7947 3. Criteria for selection of the design method [PA160.IG102.SP101.W103]
- 7948 4. Design tools [PA160.IG102.SP101.W104]
- 7949 5. Design processes/activities [PA160.IG102.SP101.W105]

7950 **Subpractices**

- 7951 1. Establish and maintain criteria against which the effectiveness of
7952 design methods can be determined. [PA160.IG102.SP101.SubP101]
- 7953 2. Identify, develop, or acquire the design methods that satisfy the
7954 criteria. [PA160.IG102.SP101.SubP102]
- 7955 3. Ensure that the design methods adhere to applicable design
7956 standards and criteria. [PA160.IG102.SP101.SubP103]

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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]

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]

5. Use the design method(s) that have been established as effective for the applicable portions of the design. [PA160.IG102.SP101.SubP105]

SP 2.2 Establish a Complete Technical Data Package

Establish and maintain a complete technical data package.
[PA160.IG102.SP103]

7992 A complete technical data package provides the developer with a
7993 comprehensive description of the product or product component as it
7994 develops. Such a package also provides procurement flexibility in a
7995 variety of circumstances such as performance-based contracting or
7996 build-to-print. [PA160.IG102.SP103.N102]

7997 A complete technical data package would provide the following if such
7998 information is appropriate to the type of product and product component
7999 (for example, material or manufacturing requirements may not be useful
8000 for software only, service, or process product components):

8001 [PA160.IG102.SP103.N103]

- 8002 • product component descriptions in terms of required life-cycle
- 8003 functionality and performance
- 8004 • product-related process descriptions if not described as separate
- 8005 product components
- 8006 • key product characteristics
- 8007 • required physical characteristics and constraints
- 8008 • interface requirements
- 8009 • materials requirements (bills or material and material
- 8010 characteristics)
- 8011 • fabrication/manufacturing requirements (for both the original
- 8012 equipment manufacturer and field support)
- 8013 • the verification criteria used to ensure requirements have been
- 8014 achieved
- 8015 • conditions of use (environments) and operating/usage scenarios,
- 8016 modes and states for operations, support, training, manufacturing,
- 8017 disposal, and verifications throughout the life cycle
- 8018 • rationale for decisions and characteristics (requirements,
- 8019 requirement allocations; design choices)

8020 Because design descriptions can involve a very large amount of data
8021 and be crucial to successful product component development, it is
8022 advisable to establish criteria for organizing the data and for selecting
8023 the data content. A particularly useful approach is to choose a
8024 taxonomy in which the top level consists of design views such as the
8025 following: [PA160.IG102.SP103.N104]

- 8026 • customers
- 8027 • the environment
- 8028 • functionality
- 8029 • data
- 8030 • states/modes
- 8031 • construction

- 8032
- management

8033 These views are captured in the complete technical data package.

8034 [PA160.IG102.SP103.N105]

8035 **Typical Work Products**

- 8036 1. Complete technical data package [PA160.IG102.SP103.W101]

8037 **Subpractices**

- 8038 1. Determine the number of levels of design and the appropriate level
8039 of documentation for each design level. [PA160.IG102.SP103.SubP101]

8040 Determining the number of levels of product components (e.g., subsystem,
8041 hardware configuration item, circuit board, computer software configuration item
8042 (CSCI), computer software component, computer software unit) that require
8043 documentation and requirements traceability is important to manage
8044 documentation costs and to support integration and verification plans.

8045 [PA160.IG102.SP103.SubP101.N101]

- 8046 2. Base detailed designs on the allocated product component
8047 requirements, architecture, and higher level designs.

8048 [PA160.IG102.SP103.SubP102]

- 8049 3. Document the design in the technical data package.

8050 [PA160.IG102.SP103.SubP103]

- 8051 4. Capture the rationale for key (i.e., significant effect on cost,
8052 schedule or technical performance) decisions made or defined.

8053 [PA160.IG102.SP103.SubP104]

- 8054 5. Revise the design as necessary. [PA160.IG102.SP103.SubP105]

8055 The following specific practice appears in the continuous representation as
8056 SP 2.2-1, but is subsumed in the staged representation by SP 2.2 Establish a Complete
8057 Technical Data Package . The specific practice is presented here only as in-
8058 formative material.

8059 **SP 2.2-1 Develop a Technical Data Package**

8060 *Develop a product or product component technical data package.*

8061 [PA160.IG102.SP102]

8062 The technical data package provides the description of a product or
 8063 product component (including product-related processes if not handled
 8064 as separate product components) that supports an acquisition strategy,
 8065 or the implementation, production, engineering, and logistics support
 8066 portions of the product life cycle. The description includes the definition
 8067 of the required design configuration and procedures to ensure
 8068 adequacy of product or product component performance. It includes all
 8069 applicable technical data such as drawings, associated lists,
 8070 specifications, standards, performance requirements, quality assurance
 8071 provisions, and packaging details. The technical data package includes
 8072 a description of the selected alternative solution that was chosen for
 8073 implementation. [PA160.IG102.SP102.N101]

8074 **Typical Work Products**

- 8075 1. Technical data package [PA160.IG102.SP102.W101]

8076 **SP 2.3 Design Comprehensive Interface**

8077 ***Design product component interfaces in terms of established and***
 8078 ***maintained criteria.*** [PA160.IG102.SP105]

8079 Interface designs include the following: [PA160.IG102.SP105.N101]

- 8080 • Origination
- 8081 • Destination
- 8082 • Stimulus and data characteristics for software
- 8083 • Electrical, mechanical, and functional characteristics for hardware.

8084 The criteria for interfaces frequently reflect a comprehensive list of
 8085 critical parameters that must be defined, or at least investigated, to
 8086 ascertain their applicability. These parameters are often peculiar to a
 8087 given type of product (e.g., software, mechanical, electrical) and are
 8088 often associated with safety, security, durability, and mission critical
 8089 characteristics. [PA160.IG102.SP105.N102]

8090 **Typical Work Products**

- 8091 1. Interface specifications [PA160.IG102.SP105.W101]
- 8092 2. Interface control documents [PA160.IG102.SP105.W102]
- 8093 3. Interface specification criteria and templates [PA160.IG102.SP105.W103]
- 8094 4. Updates to interface specification templates [PA160.IG102.SP105.W104]

8095 The following specific practice appears in the continuous representation as
 8096 SP 2.3-1, but is subsumed in the staged representation by SP 2.3 Design Compre-

8097 hensive Interface . The specific practice is presented here only as informative mate-
8098 rial.

8099 SP 2.3-1 Establish Interface Descriptions

8100 ***Establish and maintain the solution for product component***
8101 ***interfaces.*** [PA160.IG102.SP104]

8102 The product component interface description documents:

8103 [PA160.IG102.SP104.N101]

- 8104 • product component-to-product component
- 8105 • lower-level component-to-higher level component
- 8106 • product component-to-product related process
8107 (infrastructure/existing, reused, or developed)
- 8108 • product component-to-external item interfaces

8109 Typical Work Products

- 8110 1. Interface design [PA160.IG102.SP104.W101]
- 8111 2. Interface design documents [PA160.IG102.SP104.W102]

8112 SP 2.4 Perform Make, Buy, or Reuse Analyses

8113 ***Evaluate whether the product components should be developed,***
8114 ***purchased, or reused based on established criteria.*** [PA160.IG102.SP106]

8115 *Refer to the Decision Analysis and Resolution process area for more*
8116 *information about defining criteria, alternatives and performing*
8117 *structured decision making. Make, buy, and reuse decisions*
8118 *significantly impact both project and organization success.*

8119 [PA160.IG102.SP106.R101]

8120 *Refer to the Supplier Agreement Management process area for more*
8121 *information about how to address the acquisition of the product*
8122 *components that will be purchased.* [PA160.IG102.SP106.R102]

8123 As technology evolves, so does the rationale for choosing to develop or
8124 purchase a product component. While complex development efforts
8125 may favor purchasing an off-the-shelf component, advances in
8126 productivity and tools may provide an opposing rationale. Off-the-shelf
8127 products may have incomplete or inaccurate documentation and may or
8128 may not be supported in the future. [PA160.IG102.SP106.N101]

8129 Once the decision is made to purchase an off-the-shelf product
 8130 component, the requirements are used to establish a supplier
 8131 agreement. There are times when "off-the-shelf" refers to an existing
 8132 item that may not be readily available in the marketplace. For example,
 8133 some types of aircraft, engines, etc, are not truly "on-the-shelf" but can
 8134 be readily procured. In some cases the use of such non-developed
 8135 items is in situations where the specifics of the performance and other
 8136 product characteristics expected need to be within the limits specified.
 8137 In these cases, inclusion of the requirements, and acceptance criteria,
 8138 may need to be in the supplier agreement and managed. In other
 8139 cases, the off-the-shelf product is literally off-the-shelf (word processing
 8140 software for example) and there is no agreement with the supplier that
 8141 needs to be managed. [PA160.IG102.SP106.N102]

8142 **Typical Work Products**

- 8143 1. Criteria for design and component reuse [PA160.IG102.SP106.W101]
- 8144 2. Make or buy analyses [PA160.IG102.SP106.W102]
- 8145 3. Guidelines for choosing COTS components [PA160.IG102.SP106.W103]

8146 **Subpractices**

- 8147 1. When purchased or non-developmental (COTS, government off-
 8148 the-shelf, and reuse) items are selected, plan for their
 8149 maintenance. [PA160.IG102.SP106.SubP101]

8150 *For Software Engineering*
 8151 *Consider how the compatibility of future releases of an*
 8152 *operating system and a database manager will be handled.*
 8153 [PA160.IG102.SP106.SubP101.AMP101]

8154 **SG 3 Implement the Product Design** [PA160.IG103]

8155 ***Product components, and associated support documentation, are***
 8156 ***implemented from their designs.***

8157 Product components are implemented from the designs established by
 8158 the practices in Goal 2. The implementation usually includes unit testing
 8159 of the product components before sending them to Product Integration
 8160 and development of end-user documentation. [PA160.IG103.N101]

8161 **SP 3.1 Implement the Design**

8162 ***Implement the designs of the product components.*** [PA160.IG103.SP101]

8163 *For Software Engineering*
 8164 *Software code is a typical software product component.*
 8165 [PA160.IG103.SP101.AMP101]

8166 Once the design has been completed, it is implemented as a product
8167 component. The characteristics of that implementation depend on the
8168 type of product component. [PA160.IG103.SP101.N101]

8169 Examples characteristics of this implementation are: [PA160.IG103.SP101.N102]

- 8170 • Software is coded.
- 8171 • Data is documented.
- 8172 • Services are documented.
- 8173 • Electrical and mechanical parts are fabricated.
- 8174 • Product unique manufacturing processes are put into operation.
- 8175 • Processes are documented (hardware and software and their
8176 integrated product components that are part of the process are
8177 built, coded, and integrated as appropriate).
- 8178 • Facilities are constructed.
- 8179 • Materials are produced (e.g., a product-unique material could be: a
8180 petroleum, oil, or lubricant; or a new alloy).

8181

8182 **Typical Work Products**

- 8183 1. Implemented design [PA160.IG103.SP101.W101]

8184 **Subpractices**

- 8185 1. Use effective methods to implement the product components.
8186 [PA160.IG103.SP101.SubP101]

8187

For Software Engineering

8188 *Examples of software coding methods include the following:*
8189 [PA160.IG103.SP101.SubP101.AMP101]

- 8190 • *Structured programming*
- 8191 • *Object-oriented programming*
- 8192 • *Automatic code generation*
- 8193 • *Software code reuse*
- 8194 • *Use of applicable design patterns*

8195

8196

For Systems Engineering

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Examples of appropriate fabrication methods the following:

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[PA160.IG103.SP101.SubP101.AMP102]

8199

• *Casting*

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• *Molding*

8201

• *Forming*

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• *Joining*

8203

• *Machining*

8204

• *Tooling*

8205

• *Welding*

8206

• *Extruding*

8207

8208

Methods to implement the product components are documented, either directly or by reference, in the project's defined process. *[PA160.IG103.SP101.SubP101.N101]*

8209

8210

2. Adhere to applicable standards and criteria. *[PA160.IG103.SP101.SubP102]*

8211

For Software Engineering

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Examples of software coding standards include the following:

8213

[PA160.IG103.SP101.SubP102.AMP101]

8214

• *Languages standards*

8215

• *Naming conventions for variables*

8216

• *Acceptable language structures*

8217

• *Structure and hierarchy of software components*

8218

• *Format of code and comments*

8219

8220

For Software Engineering

8221

Examples of software coding criteria include the following:

8222

[PA160.IG103.SP101.SubP102.AMP102]

8223

• *Modularity*

8224

• *Clarity*

8225

• *Simplicity*

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• *Structured (e.g., no GOTOs, one entrance, and one exit)*

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• *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 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]

8263 2. User's manual [PA160.IG103.SP102.W102]

8264 3. Operator's manual [PA160.IG103.SP102.W103]

8265 4. Maintenance manual [PA160.IG103.SP102.W104]

8266 5. On-line help [PA160.IG103.SP102.W105]

8267 **Subpractices**

8268 1. Review the requirements, the design, the product, and the test
8269 results to ensure that issues affecting the installation, operation,
8270 and maintenance documentation are identified and resolved.

8271 [PA160.IG103.SP102.SubP101]

8272 2. Use effective methods to develop the installation, operation, and
8273 maintenance documentation. [PA160.IG103.SP102.SubP102]

8274 Documentation methods are documented, either directly or by reference, in the
8275 project's defined process. [PA160.IG103.SP102.SubP102.N101]

8276 3. Adhere to the applicable documentation standards.

8277 [PA160.IG103.SP102.SubP103]

8278 Examples of documentation standards include the following:

8279 [PA160.IG103.SP102.SubP103.N101]

- 8280 • Compatibility with designated word processors
- 8281 • Acceptable fonts
- 8282 • Numbering of pages, sections, and paragraphs
- 8283 • Consistency with designated style manual
- 8284 • Use of abbreviations
- 8285 • Security classification markings
- 8286 • Internationalization requirements

8287

8288 4. Develop preliminary versions of the installation, operation, and
8289 maintenance documentation early in the life cycle for review by the
8290 relevant stakeholders. [PA160.IG103.SP102.SubP104]

8291 5. Conduct peer reviews of the installation, operation, and
8292 maintenance documentation. [PA160.IG103.SP102.SubP105]

8293 *Refer to the Verification process area for more information about*
8294 *conducting peer reviews.* [PA160.IG103.SP102.SubP105.R101]

8295 6. Revise the installation, operation, and maintenance documentation
8296 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

8305 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

8306 ***The process is institutionalized as a defined process.***

8307 Commitment to Perform

8308 **GP 2.1 (CO 1) Establish an Organizational Policy**

8309 ***Establish and maintain an organizational policy for planning and***
8310 ***performing the technical solution process.*** [GP103]

8311 Elaboration:

8312 This policy establishes organizational expectations for addressing the
8313 iterative cycle in which product component solutions are selected,
8314 product and product component designs are developed, and the
8315 product component designs are implemented. [PA160.EL101]

8316 Ability to Perform

8317 **GP 3.1 (AB 1) Establish a Defined Process**

8318 ***Establish and maintain the description of a defined technical***
8319 ***solution process.*** [GP114]

8320 **GP 2.2 (AB 2) Plan the Process**

8321 ***Establish and maintain the requirements and objectives, and plans***
8322 ***for performing the technical solution process.*** [GP104]

8323 Elaboration:

8324 These requirements, objectives, and plans are typically described in the
8325 project plan as described in the Project Planning process area.

8326 [PA160.EL102]

8327 **GP 2.3 (AB 3) Provide Resources**

8328 ***Provide adequate resources for performing the technical solution***
8329 ***process, developing the work products and providing the services***
8330 ***of the process.*** [GP105]

8331 Elaboration:

8332 Special facilities may be required for developing, designing, and
8333 implementing solutions to requirements. When necessary, the facilities
8334 required for the activities in the Technical Solution process area are
8335 developed or purchased. [PA160.EL111]

8336 Examples of tools used to perform the activities of the Technical
8337 Solution process area include the following: [PA160.EL104]

- 8338 • Design specification tools
- 8339 • Simulators and modeling tools
- 8340 • Prototyping tools
- 8341 • Scenario definition and management tools
- 8342 • Requirements tracking tools
- 8343 • Interactive documentation tools

8344

8345 **GP 2.4 (AB 4) Assign Responsibility**

8346 ***Assign responsibility and authority for performing the process,***
8347 ***developing the work products, and providing the services of the***
8348 ***technical solution process.*** [GP106]

8349 **GP 2.5 (AB 5) Train People**

8350 ***Train the people performing or supporting the technical solution***
8351 ***process as needed.*** [GP107]

8352 Elaboration:

- 8353 Examples of training topics include the following: [PA160.EL105]
- 8354 • Application domain of the product and product components
 - 8355 • Design methods
 - 8356 • Interface design
 - 8357 • Unit testing techniques
 - 8358 • Standards (e.g., product, safety, human factors, environmental)
 - 8359

8360 Directing Implementation

8361 **GP 2.6 (DI 1) Manage Configurations**

8362 *Place designated work products of the technical solution process*
8363 *under appropriate levels of configuration management.* [GP109]

8364 Elaboration:

- 8365 Examples of work products placed under configuration management
8366 include the following: [PA160.EL106]
- 8367 • Product, product component, process, service and interface
8368 designs
 - 8369 • Complete technical data package
 - 8370 • Interface design documents
 - 8371 • Criteria for design and component reuse
 - 8372 • Implemented design (e.g., software code, fabricated product
8373 components)
 - 8374 • User, installation, operation, and maintenance documentation
 - 8375

8376 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

8377 *Identify and involve the relevant stakeholders of the technical*
8378 *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]

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- 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

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GP 2.8 (DI 3) 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]

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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

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GP 3.2 (DI 4) 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.

[GP117]

8413 Verifying Implementation

8414 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

8415 ***Objectively evaluate adherence of the technical solution process***
8416 ***and the work products and services of the process to the***
8417 ***applicable requirements, objectives, and standards, and address***
8418 ***noncompliance.*** [GP113]

8419 Elaboration:

8420 Examples of activities reviewed include the following: [PA160.EL110]

- 8421 • Selecting product component solutions
- 8422 • Developing product and product component designs
- 8423 • Implementing product component designs

8424

8425 Examples of work products reviewed include the following: [PA160.EL112]

- 8426 • Technical data packages
- 8427 • Product, product component, and interface designs
- 8428 • Implemented design (e.g., software code, fabricated product
- 8429 components)
- 8430 • User, installation, operation, and maintenance documentation

8431

8432 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

8433 ***Review the activities, status, and results of the technical solution***
8434 ***process with higher-level management and resolve issues.*** [GP112]

8435 PRODUCT INTEGRATION

8436 Maturity Level 3

8437 Purpose

8438 The purpose of Product Integration is to assemble the product from the
8439 product components, ensure that the product, as integrated, functions
8440 properly, and deliver the product. [PA147]

8441 Introductory Notes

8442 This process area addresses the integration of product components into
8443 more complex product components or into complete products. The
8444 term "integration" is used in this sense throughout this process area and
8445 is not to be confused with integration of people or activities that may be
8446 described elsewhere in the model. [PA147.N101]

8447 The scope of this process area is to achieve complete product
8448 integration through progressive assembly of product components, in one
8449 stage or in incremental stages, according to a defined integration
8450 strategy. [PA147.N102]

8451 A critical aspect of product integration is the management of internal
8452 and external interfaces of the products and product components to
8453 ensure compatibility among the interfaces. Attention should be paid to
8454 interface management throughout the project. [PA147.N103]

8455 Product integration is more than just a one-time assembly of the
8456 product components at the conclusion of design and fabrication.
8457 Product integration can be conducted incrementally, using an iterative
8458 process of assembling product components, evaluating them, and then
8459 assembling more product components. This process may begin with
8460 analysis and simulations (e.g., threads, rapid prototypes, virtual
8461 prototypes, and physical prototypes) and steadily progress through
8462 increasingly more realistic incremental functionality until the final
8463 product is achieved. In each successive "build," prototypes (virtual,
8464 rapid, or physical) are constructed, evaluated, improved, and
8465 reconstructed based upon knowledge gained in the evaluation process.
8466 The degree of virtual vs. physical prototyping required depends on the
8467 functionality of the design tools, the complexity of the product, and its
8468 associated risk. There is a high probability that the product, integrated
8469 in this manner, will pass product verification and validation. For some
8470 products, the last integration phase will occur when the product is
8471 deployed at its intended operational site. [PA147.N104]

8472 Related Process Areas

- 8473 *Refer to the Requirements Development process area for more*
8474 *information about identifying interface requirements. [PA147.R101]*
- 8475 *Refer to the Technical Solution process area for more information about*
8476 *defining the interfaces and the integration environment (when the*
8477 *integration environment needs to be developed). [PA147.R102]*
- 8478 *Refer to the Verification process area for more information about*
8479 *verifying the interfaces, the integration environment, and the*
8480 *progressively assembled product components. [PA147.R103]*
- 8481 *Refer to the Validation process area for more information about*
8482 *performing validation of the product components and the integrated*
8483 *product. [PA147.R104]*
- 8484 *Refer to the Risk Management process area for more information about*
8485 *identifying risks and the use of prototypes in risk mitigation for both*
8486 *interface compatibility and product component integration. [PA147.R105]*
- 8487 *Refer to the Decision Analysis and Resolution process area for more*
8488 *information about using a structured approach for selecting the*
8489 *appropriate integration strategy and for deciding whether the integration*
8490 *environment should be acquired or developed. [PA147.R106]*
- 8491 *Refer to the Configuration Management process area for more*
8492 *information about managing changes to interface definitions and on the*
8493 *distribution of information. [PA147.R107]*
- 8494 *Refer to the Supplier Agreement Management process area for more*
8495 *information about acquiring product components or parts of the*
8496 *integration environment. [PA147.R108]*

8497 Specific and Generic Goals

8498 **SG 1 Prepare for Product Integration** [PA147.IG101]

8499 ***The strategy for conducting product integration is established and***
8500 ***maintained.***

8501 **SG 2 Ensure Interface Compatibility** [PA147.IG102]

8502 ***The product component interfaces, both internal and external, are compatible.***

8503 **SG 3 Assemble Product Components and Deliver the Product** [PA147.IG103]

8504 *Verified product components are assembled and the integrated, verified, and*
8505 *validated product is delivered.*

8506 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

8507 *The process is institutionalized as a defined process.*

8508 Practice to Goal Relationship Table

8509 SG 1 Prepare for Product Integration [PA147.IG101]

- 8510 SP 1.1 Establish a Product Integration Strategy
- 8511 SP 1.2 Establish the Product Integration Environment
- 8512 SP 1.3 Define Detailed Product Integration Procedures

8513 SG 2 Ensure Interface Compatibility [PA147.IG102]

- 8514 SP 2.1 Review Interface Descriptions for Completeness
- 8515 SP 2.2 Manage Interfaces

8516 SG 3 Assemble Product Components and Deliver the Product [PA147.IG103]

- 8517 SP 3.1 Confirm Readiness of Product Components for Integration
- 8518 SP 3.2 Assemble Product Components
- 8519 SP 3.3 Checkout Assembled Product Components
- 8520 SP 3.4 Package and Deliver the Product or Product Component

8521 GG 3 Institutionalize a Defined Process

- 8522 GP 2.1 (CO 1) Establish an Organizational Policy
- 8523 GP 3.1 (AB 1) Establish a Defined Process
- 8524 GP 2.2 (AB 2) Plan the Process
- 8525 GP 2.3 (AB 3) Provide Resources
- 8526 GP 2.4 (AB 4) Assign Responsibility
- 8527 GP 2.5 (AB 5) Train People
- 8528 GP 2.6 (DI 1) Manage Configurations
- 8529 GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders
- 8530 GP 2.8 (DI 3) Monitor and Control the Process
- 8531 GP 3.2 (DI 4) Collect Improvement Information
- 8532 GP 2.9 (VE 1) Objectively Evaluate Adherence
- 8533 GP 2.10 (VE 2) Review Status with Higher-Level Management

8534 Specific Practices by Goal

8535 **SG 1 Prepare for Product Integration** [PA147.IG101]

8536 *The strategy for conducting product integration is established and*
8537 *maintained.*

8538 Preparing for integration of product components involves establishing
8539 and maintaining an integration strategy. An integration strategy is
8540 developed early in the project concurrently with the practices in the
8541 Technical Solution process area. The integration strategy and
8542 supporting documentation identify a sequence for receipt, assembly,
8543 and evaluation of the various product components that make up the
8544 product. [PA147.IG101.N101]

8545 SP 1.1 Establish a Product Integration Strategy

8546 ***Establish and maintain a strategy for integration of the product***
8547 ***components.*** [PA147.IG101.SP101]

8548 *Refer to the Define Interfaces specific practice in the Technical Solution*
8549 *process area for more information about defining interfaces for products*
8550 *and product components.* [PA147.IG101.SP101.R101]

8551 ***For Integrated Product and Process Development***

8552 *The integration strategy should be developed concurrently and*
8553 *iteratively with the product and product component designs.*

8554 [PA147.IG101.SP101.AMP101]

8555 The basis for effective product integration is an integration strategy. A
8556 successful integration strategy should use a combination of techniques,
8557 depending on the complexity of both the product components to be
8558 assembled and the complexity of interim and final assembled products.
8559 [PA147.IG101.SP101.N101]

8560 To develop an integration strategy, one must analyze alternative
8561 assembly sequences; select the best solution, and identify the
8562 environment and a minimum set of procedures for integration of the
8563 product components. Availability of the product components, test
8564 equipment, procedures, integration environment, and personnel skills
8565 are factors in developing the integration strategy. [PA147.IG101.SP101.N102]

8566 Integration strategies can provide for incremental assembly and
8567 evaluation of product components that provide a problem-free
8568 foundation for incorporation of other product components as they
8569 become available, or for prototypes of high-risk product components.
8570 For complex products, the integration strategy should be incremental
8571 and address the iterative process of build-evaluate-build.
8572 [PA147.IG101.SP101.N103]

8573 The integration strategy should be harmonized with the selection of
8574 solutions and the design of product and product components in the
8575 Technical Solution process area. [PA147.IG101.SP101.N104]

8576 *Refer to the Decision Analysis and Resolution process area for more*
8577 *information about using a structured approach to selecting the*
8578 *appropriate product integration strategy. [PA147.IG101.SP101.N104.R101]*

8579 *Refer to the Configuration Management process area for more*
8580 *information about protecting and distributing changes to the product*
8581 *integration strategy so that everyone can know the current state of the*
8582 *interfaces. [PA147.IG101.SP101.N104.R102]*

8583 *Refer to the Risk Management process area for more information about*
8584 *identifying and handling risks in the product integration strategy.*
8585 *[PA147.IG101.SP101.N104.R103]*

8586 **Typical Work Products**

- 8587 1. Product integration sequence and the rationale for selecting it
8588 [PA147.IG101.SP101.W101]
- 8589 2. Rationale for rejecting other assembly scenarios [PA147.IG101.SP101.W102]
- 8590 3. Product Integration environment definition [PA147.IG101.SP101.W103] Error -
8591 No case for: Comment
- 8592 4. Product integration procedures and criteria [PA147.IG101.SP101.W104]
- 8593 5. Evaluation strategy for assemblies of product components
8594 [PA147.IG101.SP101.W105]
- 8595 6. Product integration strategy documentation [PA147.IG101.SP101.W106]

8596 **Subpractices**

- 8597 1. Identify the product components to be assembled.
8598 [PA147.IG101.SP101.SubP101]
- 8599 2. Identify the product integration verifications to be performed using
8600 the definition of the interfaces between the product components.
8601 [PA147.IG101.SP101.SubP102]
- 8602 3. Identify the product integration environment required for integrating
8603 the product components. [PA147.IG101.SP101.SubP103]

8604 This can include defining the specific tools and test equipment to establish the
8605 product integration environment. [PA147.IG101.SP101.SubP103.N101]
- 8606 4. Identify the logical sequences for integrating the product
8607 components. [PA147.IG101.SP101.SubP104]
- 8608 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 Establish the Product Integration Environment

Establish and maintain the environment needed to support the integration of the product components. [PA147.IG101.SP102]

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]

8637 The product integration strategy may identify needs for an environment
8638 that must be acquired or developed. This may yield requirements for the
8639 purchase or development of equipment, software, or other resources.
8640 These requirements are provided to the Requirements Development
8641 process area for development. The product integration environment
8642 may include the reuse of existing organizational resources. In this case,
8643 the strategy should outline the use of these resources and
8644 arrangements for their use must be made. The decision to acquire or
8645 develop the product integration environment is conducted in the
8646 Technical Solution process area. If the decision is to develop the
8647 product integration environment, the other practices in Technical
8648 Solution and all other process areas involved in conducting a
8649 development project are used. [PA147.IG101.SP102.N101]

8650 The environment required at each step of the product integration
8651 process may include test equipment, simulators (taking the place of
8652 non-available product components), pieces of real equipment, and
8653 recording devices. [PA147.IG101.SP102.N102]

8654 **Typical Work Products**

- 8655 1. Verified environment for product integration [PA147.IG101.SP102.W101]
- 8656 2. Support documentation for the product integration environment
8657 [PA147.IG101.SP102.W102]

8658 **Subpractices**

- 8659 1. Identify the requirements for the product integration environment.
8660 [PA147.IG101.SP102.SubP101]
- 8661 2. Identify verification criteria and procedures for the product
8662 integration environment. [PA147.IG101.SP102.SubP102]
- 8663 3. Decide whether to make or buy the needed product integration
8664 environment. [PA147.IG101.SP102.SubP103]
- 8665 4. Initiate a project to develop the integration environment if it cannot
8666 be acquired. [PA147.IG101.SP102.SubP104]

8667 For unprecedented, complex projects, the product integration environment can be
8668 a major development. As such, it would involve project planning, requirements
8669 development, technical solutions, verification, validation, and risk management.
8670 [PA147.IG101.SP102.SubP104.N101]

- 8671 5. Maintain the product integration environment throughout the
8672 project. [PA147.IG101.SP102.SubP105]
- 8673 6. Dispose of those portions of the environment that are no longer
8674 useful. [PA147.IG101.SP102.SubP106]

8675 **SP 1.3 Define Detailed Product Integration Procedures**

8676 ***Define detailed procedures and criteria for integration of the***
8677 ***product components.*** [PA147.IG101.SP103]

8678 As the product integration strategy matures, detailed procedures,
8679 inputs, outputs, expected results, and progress criteria are needed.

8680 [PA147.IG101.SP103.N101]

8681 Detailed procedures for the integration of the product components can
8682 include such things as the number of incremental iterations to be
8683 performed and details of the expected tests and other evaluations to be
8684 carried out at each stage. [PA147.IG101.SP103.N102]

8685 Detailed criteria can include criteria indicating the readiness of a
8686 product component for integration or its acceptability. [PA147.IG101.SP103.N103]

8687 For example, the probability of proper functioning, the delivery rate and
8688 its variation, the lead time from order to delivery, personnel availability,
8689 availability of the integration facility/line/environment. [PA147.IG101.SP103.N105]

8690
8691 Detailed criteria can be defined for how the product components are to
8692 be verified and the functions it is expected to have. Details can be
8693 defined for how the assembled product components and final integrated
8694 product are to be validated and delivered. [PA147.IG101.SP103.N106]

8695 Detailed criteria may also include the degree of simulation permitted for
8696 a product component to pass a test or the detailed criteria for the
8697 environment for the integration test. [PA147.IG101.SP103.N104]

8698 **Typical Work Products**

8699 1. Detailed product integration procedures [PA147.IG101.SP103.W101]

8700 2. Detailed product integration criteria [PA147.IG101.SP103.W102]

8701 **Subpractices**

8702 1. Establish and maintain detailed product integration procedures for
8703 the product components. [PA147.IG101.SP103.SubP101]

8704 2. Establish and maintain the detailed criteria for product component
8705 integration and evaluation. [PA147.IG101.SP103.SubP102]

8706 3. Establish and maintain the detailed criteria for validation and
8707 delivery of the integrated product. [PA147.IG101.SP103.SubP103]

8708 **SG 2 Ensure Interface Compatibility** [PA147.IG102]

8709 ***The product component interfaces, both internal and external, are compatible.***

8710 Many product integration problems arise from unknown or uncontrolled
8711 aspects of both internal and external interfaces. Effective management
8712 of product component interface requirements, specifications, and
8713 designs helps ensure that implemented interfaces will be complete and
8714 compatible. [PA147.IG102.N101]

8715 SP 2.1 Review Interface Descriptions for Completeness

8716 ***Review interface descriptions for coverage and completeness.***

8717 [PA147.IG102.SP101]

8718 The interfaces should include, in addition to product component
8719 interfaces, all the interfaces with the product integration environment.

8720 [PA147.IG102.SP101.N101]

8721 Typical Work Products

- 8722 1. Categories of interfaces [PA147.IG102.SP101.W101]
- 8723 2. List of interfaces per category [PA147.IG102.SP101.W102]
- 8724 3. Mapping of the interfaces to the product components and product
8725 integration environment [PA147.IG102.SP101.W103]

8726 Subpractices

- 8727 1. Review interface data for completeness and ensure complete
8728 coverage of all interfaces. [PA147.IG102.SP101.SubP101]

8729 *For Software Engineering*

8730 *In the message category for software, interfaces would include*
8731 *the following:* [PA147.IG102.SP101.SubP101.AMP101]

- 8732 • *Origination*
- 8733 • *Destination*
- 8734 • *Stimulus*
- 8735 • *Protocols and data characteristics*

8736 *For Systems Engineering*

8737 *For mechanical and electronic components, the interface data*
8738 *should include the following:* [PA147.IG102.SP101.SubP101.AMP102]

- 8739 • *Mechanical interfaces (e.g., weight and size, center of*
8740 *gravity, clearance of parts in operation, space required*
8741 *for maintenance, fixed links, mobile links, shocks and*
8742 *vibrations received from the bearing structure)*
- 8743 • *Noise interfaces (e.g., noise transmitted by the structure,*
8744 *noise transmitted in the air, acoustics)*

- 8745 • Climatic interfaces (e.g., temperature, humidity, pressure,
8746 salinity)
- 8747 • Thermal interfaces (e.g., heat dissipation, transmission of
8748 heat to the bearing structure, air conditioning
8749 characteristics)
- 8750 • Fluid interfaces (e.g., fresh water inlet/outlet, seawater
8751 inlet/outlet for a naval/coastal product, air conditioning,
8752 compressed air, nitrogen, fuel, lubricating oil, exhaust gas
8753 outlet)
- 8754 • Electrical interfaces (e.g., power supply consumption by
8755 network with transients and peak values; non-sensitive
8756 control signal for power supply, communications, etc.;
8757 sensitive signal [analog links]; disturbing signal
8758 [microwave, etc.]; grounding signal to comply with the
8759 TEMPEST standard)
- 8760 • Electromagnetic interfaces (e.g., magnetic field, radio and
8761 radar links, optical band link wave guides, coaxial and
8762 optical fibers)
- 8763 • Man-machine interface (e.g., audio or voice synthesis, audio
8764 or voice recognition, display [analog dial, TV screen, or
8765 liquid crystal display, indicators' light emitting diodes],
8766 manual controls [pedal, joystick, ball, keys, push buttons,
8767 touch screen])

8768 Consider all the product components and prepare a relationship table mapping.
8769 Interfaces are usually classified in three main classes: environmental, physical,
8770 and functional. Typical categories for these classes include the following:
8771 mechanical, fluid, sound, electrical, climatic, electromagnetic, thermal, message,
8772 and the man-machine or human interface. [PA147.IG102.SP101.SubP101.N101]

8773 2. Ensure that product components and interfaces are marked to
8774 ensure easy and correct connection to the joining product
8775 component. [PA147.IG102.SP101.SubP102]

8776 3. Periodically review the adequacy of interface descriptions.
8777 [PA147.IG102.SP101.SubP103]

8778 Once established, the interface descriptions must be periodically reviewed to
8779 ensure there is no deviation between the existing descriptions and the products
8780 being developed, processed, produced, or bought. [PA147.IG102.SP101.SubP103.N101]

8781 SP 2.2 Manage Interfaces

8782 **Manage internal and external interface definitions, designs, and**
8783 **changes for products and product components.** [PA147.IG102.SP102]

8784 Refer to the Requirements Development process area for more
8785 information about requirements for interfaces. [PA147.IG102.SP102.R101]

8786 *Refer to the Technical Solution process area for more information about*
8787 *design of interfaces between product components.* [PA147.IG102.SP102.R102]

8788 *Refer to the Requirements Management process area for more*
8789 *information about managing the changes to the interface requirements.*
8790 [PA147.IG102.SP102.R103]

8791 *Refer to the Configuration Management process area for more*
8792 *information about distributing changes to the interface descriptions*
8793 *(specifications), so that everyone can know the current state of the*
8794 *interfaces.* [PA147.IG102.SP102.R104]

8795 Management of the interfaces includes the maintenance of the
8796 consistency of the interfaces throughout the development cycle and
8797 resolution of conflict, noncompliance, and change issues.
8798 [PA147.IG102.SP102.N101]

8799 The interfaces should include, in addition to product component
8800 interfaces, all the interfaces with the environment as well as other
8801 environments for verification, validation, operations and support.
8802 [PA147.IG102.SP102.N102]

8803 The interface changes are captured, maintained, and readily
8804 accessible. [PA147.IG102.SP102.N103]

8805 **Typical Work Products**

- 8806 1. Table of relationships between the product components and the
8807 external environment (e.g., main power supply, fastening product,
8808 computer bus system, etc.) [PA147.IG102.SP102.W101]
- 8809 2. Table of relationships between the different product components
8810 [PA147.IG102.SP102.W102]
- 8811 3. List of agreed-to interfaces defined for each pair of product
8812 components, when applicable [PA147.IG102.SP102.W103]
- 8813 4. Reports from the interface control working group meetings
8814 [PA147.IG102.SP102.W104]
- 8815 5. Action items for interface updating [PA147.IG102.SP102.W105]
- 8816 6. Application Program Interface [PA147.IG102.SP102.W106]
- 8817 7. Updated interface description or agreement [PA147.IG102.SP102.W107]

8818 **Subpractices**

- 8819 1. Ensure the compatibility of the interfaces throughout the
8820 development cycle. [PA147.IG102.SP102.SubP101]
- 8821 2. Resolve conflict, noncompliance, and change issues.
8822 [PA147.IG102.SP102.SubP102]

- 8823 3. Maintain a repository for interface data accessible to project
8824 participants. [PA147.IG102.SP102.SubP103]
- 8825 A common accessible repository for interface data provides a mechanism to
8826 ensure that everyone knows where the current interface data resides and can
8827 access it for use. [PA147.IG102.SP102.SubP103.N101]

8828 **SG 3 Assemble Product Components and Deliver the Product** [PA147.IG103]

8829 ***Verified product components are assembled and the integrated, verified, and***
8830 ***validated product is delivered.***

8831 Integration of product components proceeds according to the product
8832 integration strategy. Before integration, each product component should
8833 be confirmed to be compliant with its interface requirements. Product
8834 components are assembled into larger, more complex product
8835 components. These assembled product components are checked for
8836 correct inter-operation. This process continues until product integration
8837 is complete. If, during this process, problems are identified, the problem
8838 should be documented and a corrective action process initiated.

8839 [PA147.IG103.N101]

8840 Ensure that the assembly of the product components into larger and
8841 more complex product components is conducted according to the
8842 product integration strategy. The timely receipt of needed product
8843 components and the involvement of the right people contribute to the
8844 successful integration of the product components that comprise the
8845 product. [PA147.IG103.N102]

8846 **SP 3.1 Confirm Readiness of Product Components for Integration**

8847 ***Confirm, prior to assembly, that each product component required***
8848 ***to assemble the product has been properly identified, functions***
8849 ***according to its description, and that the product component***
8850 ***interfaces comply with the interface descriptions.*** [PA147.IG103.SP101]

8851 *Refer to the Verification process area for more information about*
8852 *verifying product components.* [PA147.IG103.SP101.R101]

8853 *Refer to the Technical Solution process area for more information about*
8854 *unit test of product components.* [PA147.IG103.SP101.R102]

8855 The purpose of this practice is to ensure that the properly identified
8856 product component that meets its description can actually be
8857 assembled according to the product integration strategy. The product
8858 components are checked for quantity, obvious damage, and
8859 consistency between the product component and interface descriptions.

8860 [PA147.IG103.SP101.N101]

8861 Although unit tests are conducted in Technical Solution, verifications
8862 are conducted in Verification, and other assurances are conducted in
8863 Process and Product Quality Assurance, the ultimate responsibility for
8864 checking to make sure everything is proper with the product
8865 components before assembly is the responsibility of Product
8866 Integration. [PA147.IG103.SP101.N102]

8867 **Typical Work Products**

- 8868 1. Acceptance documents for the received product components
8869 [PA147.IG103.SP101.W101]
- 8870 2. Delivery receipts [PA147.IG103.SP101.W102]
- 8871 3. Checked packing lists [PA147.IG103.SP101.W103]
- 8872 4. Exception reports [PA147.IG103.SP101.W104]
- 8873 5. Waivers [PA147.IG103.SP101.W105]

8874 **Subpractices**

- 8875 1. Track the status of all product components as soon as they
8876 become available for integration. [PA147.IG103.SP101.SubP101]
- 8877 2. Ensure that product components are delivered to the product
8878 integration environment in accordance with the product integration
8879 strategy. [PA147.IG103.SP101.SubP102]
- 8880 3. Confirm the receipt of each properly identified product component.
8881 [PA147.IG103.SP101.SubP103]
- 8882 4. Ensure that each received product component meets its
8883 description. [PA147.IG103.SP101.SubP104]
- 8884 5. Check the configuration status against the expected configuration.
8885 [PA147.IG103.SP101.SubP105]
- 8886 6. Perform pre-check (for example by a visual inspection and using
8887 basic metrics) of all the physical interfaces before connecting
8888 product components together. [PA147.IG103.SP101.SubP106]

8889 **SP 3.2 Assemble Product Components**

8890 ***Assemble product components according to the product***
8891 ***integration strategy.*** [PA147.IG103.SP102]

8892 *Refer to the Verification process area for more information about*
8893 *verifying assembled product components.* [PA147.IG103.SP102.R101]

8894 *Refer to the Validation process area for more information about*
8895 *validating assembled product components.* [PA147.IG103.SP102.R102]

8896 The assembly and checkout activities of the next practice are
8897 conducted iteratively, from the initial product components, through the
8898 interim assemblies of product components, to the product as a whole.
8899 [PA147.IG103.SP102.N101]

8900 **Typical Work Products**

8901 1. Assembled product or product components. [PA147.IG103.SP102.W101]

8902 **Subpractices**

8903 1. Ensure the readiness of the product integration environment.

8904 [PA147.IG103.SP102.SubP101]

8905 2. Ensure that the assembly sequence is properly performed.

8906 [PA147.IG103.SP102.SubP102]

8907 Record all appropriate information (e.g., configuration status, serial numbers of
8908 the product components, types, and calibration date of the meters).

8909 [PA147.IG103.SP102.SubP102.N101]

8910 3. Record all appropriate information (e.g., configuration status, serial
8911 numbers of the elements, types and calibration date of the meters).

8912 [PA147.IG103.SP102.SubP103]

8913 4. Revise the product integration strategy as appropriate.

8914 [PA147.IG103.SP102.SubP104]

8915 **SP 3.3 Checkout Assembled Product Components**

8916 ***Checkout an assembly of product components.*** [PA147.IG103.SP103]

8917 The activity of checkout is used here as the action of examining and
8918 evaluating something for performance, suitability, or readiness and is
8919 not to be confused with the activity used in configuration management
8920 processes. The checkout activity is performed as appropriate for the
8921 stages of assembly of product components as identified in the product
8922 integration strategy. The product integration strategy may define a
8923 more refined integration sequence than might be envisioned just by
8924 examining the product architecture. For example, if an assembly of
8925 product components were composed of four less complex product
8926 components, the integration sequence will not necessarily call for the
8927 simultaneous integration and checkout of the four units as one. Rather,
8928 the four less complex units may be integrated progressively, one at a
8929 time, with a checkout after each assembly operation prior to realizing
8930 the more complex product component that matched the specification in
8931 the product architecture. Alternately, the strategy could have
8932 determined that only a final check was the best one to perform.

8933 [PA147.IG103.SP103.N101]

8934 The adjustment required to fit components together in the factory could
8935 be different from the one required to fit components when installed on
8936 the operational site. In that case, the product's logbook for the customer
8937 should be used to record such specific parameters. [PA147.IG103.SP103.N102]

8938 **Typical Work Products**

- 8939 1. Checked out assembled product or product components
8940 [PA147.IG103.SP103.W101]
- 8941 2. Exception reports [PA147.IG103.SP103.W102]
- 8942 3. Interface checkout reports [PA147.IG103.SP103.W103]
- 8943 4. Product integration summary reports [PA147.IG103.SP103.W104]

8944 **Subpractices**

- 8945 1. Conduct the checkout of assembled product components following
8946 the product integration strategy. [PA147.IG103.SP103.SubP101]
- 8947 2. Record the checkout results. [PA147.IG103.SP103.SubP102]

8948 Example results include the following: [PA147.IG103.SP103.SubP102.N101]

- 8949 • Any adaptation required to the integration procedure
- 8950 • Any change to the product configuration (spare parts, new release)
- 8951 • Checkout procedure deviations

8952

8953 **SP 3.4 Package and Deliver the Product or Product Component**

8954 ***Package the assembled product or product component and deliver***
8955 ***it to the appropriate customer.*** [PA147.IG103.SP104]

8956 *Refer to the Verification process area for more information about*
8957 *verifying the product or an assembly of product components before*
8958 *packaging.* [PA147.IG103.SP104.R101]

8959 *Refer to the Validation process area for more information about*
8960 *validating the product or an assembly of product components before*
8961 *packaging.* [PA147.IG103.SP104.R102]

8962 The packaging requirements for some products may be addressed in
8963 their specifications and verification criteria. This is especially important
8964 when items are stored and transported by the customer. In such cases,
8965 there may be a spectrum of environmental and stress conditions
8966 specified for the package. In other circumstances, factors such as the
8967 following may become important: [PA147.IG103.SP104.N101]

- 8968 • Economy and ease of transportation (e.g., containerization)

- 8969 • Accountability (e.g., shrinkwrapping)
- 8970 • Ease and safety of unpacking (e.g., sharp edges, strength of
- 8971 binding methods, childproofing, environmental friendliness of
- 8972 packing material, weight)

8973 The adjustment required to fit product components together in the
8974 factory could be different from the one required to fit product
8975 components when installed on the operational site. In that case, the
8976 product's logbook for the customer should be used to record such
8977 specific parameters. [PA147.IG103.SP104.N102]

8978 **Typical Work Products**

- 8979 1. Packaged product or product components [PA147.IG103.SP104.W101]
- 8980 2. Delivery documentation [PA147.IG103.SP104.W102]

8981 **Subpractices**

- 8982 1. Review the requirements, design, product, verification results, and
8983 documentation to ensure that issues affecting the packaging and
8984 delivery of the product are identified and resolved.
8985 [PA147.IG103.SP104.SubP101]
- 8986 2. Use effective methods to package and deliver the assembled
8987 product. [PA147.IG103.SP104.SubP102]

8988 *For Software Engineering*

8989 *Examples of software packaging and delivery methods include*
8990 *the following:*

8991 *(Packaging and delivery methods are documented, either*
8992 *directly or by reference, in the project's defined process.)*

8993 [PA147.IG103.SP104.SubP102.AMP101]

- 8994 • *Magnetic tape*
- 8995 • *Diskettes*
- 8996 • *Hardcopy documents*
- 8997 • *Compact disks*
- 8998 • *Other electronic distribution such as the Internet*

- 8999
- 9000 3. Satisfy the applicable requirements and standards for packaging
9001 and delivering the product. [PA147.IG103.SP104.SubP103]

9002

For Software Engineering

9003

Examples of requirements and standards for packaging and delivering the software include the following:

9004

[PA147.IG103.SP104.SubP103.AMP101]

9005

9006

• *Type of storage and delivery media*

9007

• *Custodians of the master and backup copies of the software*

9008

• *Required documentation*

9009

• *Copyrights*

9010

• *License provisions*

9011

• *Security of the software*

9012

9013

For Systems Engineering

9014

Examples of requirements and standards include those for safety, the environment, security, and transportability.

9015

[PA147.IG103.SP104.SubP103.AMP102]

9016

9017

9018

4. Prepare the operational site for installation of the product.

9019

[PA147.IG103.SP104.SubP104]

9020

Preparing the operational site may be the responsibility of the customer or end-

9021

USERS. *[PA147.IG103.SP104.SubP104.N101]*

9022

5. Deliver the product and related documentation and confirm receipt.

9023

[PA147.IG103.SP104.SubP105]

9024

6. Install the product at the operational site and confirm correct operation.

9025

[PA147.IG103.SP104.SubP106]

9026

Installing the product may be the responsibility of the customer or end-users. In

9027

some circumstances, very little may need to be done to confirm correct operation

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(more like a checkout procedure). In other circumstances, final verification of the

9029

integrated product occurs at the operational site. *[PA147.IG103.SP104.SubP106.N101]*

9030

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

9031

The process is institutionalized as a defined process.

9032 Commitment to Perform

9033 **GP 2.1 (CO 1) Establish an Organizational Policy**

9034 ***Establish and maintain an organizational policy for planning and***
9035 ***performing the product integration process.*** [GP103]

9036 Elaboration:

9037 This policy establishes organizational expectations for developing a
9038 product integration strategy and environment, ensuring interface
9039 compatibility among product components, assembling the product
9040 components, and delivering the product and product components.

9041 [PA147.EL101]

9042 Ability to Perform

9043 **GP 3.1 (AB 1) Establish a Defined Process**

9044 ***Establish and maintain the description of a defined product***
9045 ***integration process.*** [GP114]

9046 **GP 2.2 (AB 2) Plan the Process**

9047 ***Establish and maintain the requirements and objectives, and plans***
9048 ***for performing the product integration process.*** [GP104]

9049 Elaboration:

9050 These requirements, objectives, and plans are described in the plan for
9051 product integration. This plan for product integration differs from the
9052 product integration strategy described in the specific practices in this
9053 process area. The product integration strategy addresses individual
9054 product integration requirements (e.g., sequencing, environment,
9055 interfaces, procedures.), whereas the plan for product integration
9056 ensures that the planning needed to define those requirements occurs,
9057 as well as the planning for interface management, assembly, and the
9058 other activities of this process area [PA147.EL102]

9059 **GP 2.3 (AB 3) Provide Resources**

9060 ***Provide adequate resources for performing the product integration***
9061 ***process, developing the work products and providing the services***
9062 ***of the process.*** [GP105]

9063

Elaboration:

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9067

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]

9068

9069

9070

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]

9071

9072

Examples of tools used to perform the activities of the Product Integration process area include the following: [PA147.EL117]

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9079

- Prototyping tools
- Analysis tools
- Simulation tools
- Interface management tools
- Assembly tools (e.g., compilers, make files, joining tools, jigs and fixtures)

9080

GP 2.4 (AB 4) Assign Responsibility

9081

9082

9083

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

9084

GP 2.5 (AB 5) Train People

9085

9086

Train the people performing or supporting the product integration process as needed. [GP107]

9087

Elaboration:

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Examples of training topics include the following: [PA147.EL105]

- Application domain
- Product integration procedures and methods
- Organization's facilities for integration and assembly
- Assembly methods
- Packaging standards

9095 Directing Implementation

9096 **GP 2.6 (DI 1) Manage Configurations**

9097 ***Place designated work products of the product integration***
9098 ***process under appropriate levels of configuration management.***

9099 [GP109]

9100 Elaboration:

9101 Examples of work products placed under configuration management
9102 include the following: [PA147.EL106]

- 9103 • Acceptance documents for the received product components
- 9104 • Checked out assembled product and product components
- 9105 • Product integration strategy
- 9106 • Updated interface description or agreement

9107

9108 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

9109 ***Identify and involve the relevant stakeholders of the product***
9110 ***integration process as planned.*** [GP124]

9111 Elaboration:

9112 For engineering-related processes, consider stakeholders among
9113 customers, end users, developers, producers, testers, suppliers,
9114 marketers, maintainers, disposal personnel, and others who may be
9115 affected by, or may affect, the product as well as the process. [PA147.EL120]

9116 Examples of activities for stakeholder involvement include: [PA147.EL121]

- 9117 • Reviewing interface descriptions for completeness
- 9118 • Establishing the product integration strategy
- 9119 • Assembling and delivering the product and product components
- 9120 • Communicating the results after checkout
- 9121 • Communicating new, effective product integration practices to give
- 9122 affected people the opportunity to improve their performance.

9123

9124 **GP 2.8 (DI 3) Monitor and Control the Process**

9125 ***Monitor and control the product integration process against the***
9126 ***plan and take appropriate corrective action.*** [GP110]

9127 Elaboration:

9128 Examples of measures used in monitoring and controlling the activities
9129 of the Product Integration process area include the following: [PA147.EL112]

- 9130 • Product component integration profile (e.g., product component
9131 assemblies planned, performed, and number of exceptions found)
- 9132 • Integration checkout problem report trends (e.g., number written
9133 and number closed)
- 9134 • Integration checkout problem report aging (i.e., how long each
9135 problem report has been open)
- 9136

9137 **GP 3.2 (DI 4) Collect Improvement Information**

9138 ***Collect work products, measures, measurement results, and***
9139 ***improvement information derived from planning and performing***
9140 ***the product integration process to support the future use and***
9141 ***improvement of the organization's processes and process assets.***

9142 [GP117]

9143 Verifying Implementation

9144 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

9145 ***Objectively evaluate adherence of the product integration process***
9146 ***and the work products and services of the process to the***
9147 ***applicable requirements, objectives, and standards, and address***
9148 ***noncompliance.*** [GP113]

9149 Elaboration:

9150 Examples of activities reviewed include the following: [PA147.EL114]

- 9151 • Establishing and maintaining a product integration strategy
- 9152 • Ensuring interface compatibility
- 9153 • Assembling product components and delivering the product.
- 9154

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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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9161
9162

GP 2.10 (VE 2) 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]

9163 VERIFICATION

9164 Maturity Level 3

9165 Purpose

9166 The purpose of Verification is to assure that selected work products
9167 meet their specified requirements. [PA150]

9168 Introductory Notes

9169 Verification encompasses verification preparation, verification
9170 performance, and identification of corrective action. [PA150.N101]

9171 Verification includes verification of the product and intermediate work
9172 products against all selected requirements, including customer, product,
9173 and product component requirements. [PA150.N102]

9174 Verification is inherently an incremental process since it occurs
9175 throughout the development of the product and work products,
9176 beginning with verification of the requirements, progressing through the
9177 verification of the evolving work products, and culminating in the
9178 verification of the completed product. [PA150.N103]

9179 Verification of work products at each level of the product substantially
9180 increases the likelihood that the product will meet the customer,
9181 product, and product component requirements. [PA150.N104]

9182 The Verification and Validation process areas are similar, but they
9183 address different issues. Validation demonstrates that the product, as
9184 provided (or as it will be provided), will fulfill its intended use, whereas
9185 Verification addresses whether the work product properly reflects the
9186 specified requirements. In other words, verification assures "you built it
9187 right;" whereas, validation assures "you built the right thing." [PA150.N105]

9188 Peer reviews are an important part of verification and are a proven
9189 mechanism for effective defect removal. An important corollary is to
9190 develop a better understanding of the work products and the processes
9191 that produced them so defects can be prevented and process
9192 improvement opportunities can be identified. [PA150.N106]

9193 Peer reviews involve a methodical examination of work products by the
9194 producers' peers to identify defects and other changes that are needed.
9195 [PA150.N107]

9196

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

9197

- Inspections

9198

- Structured walkthroughs

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9200

9201

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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]

9204 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]

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

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

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

9216 Specific and Generic Goals

9217 **SG 1 Prepare for Verification** [PA150.IG101]

9218 ***Preparation for verification is conducted.***

9219 **SG 2 Perform Peer Reviews** [PA150.IG102]

9220 ***Peer reviews are performed on selected work products.***

9221 **SG 3 Verify Selected Work Products** [PA150.IG103]

9222 ***Selected work products are verified against their specified requirements.***

9223 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

9224 ***The process is institutionalized as a defined process.***

9225 Practice to Goal Relationship Table

9226 SG 1 Prepare for Verification [PA150.IG101]

- 9227 SP 1.1 Establish a Verification Strategy
- 9228 SP 1.2 Establish the Verification Environment
- 9229 SP 1.3 Establish Detailed Verification Plans

9230 SG 2 Perform Peer Reviews [PA150.IG102]

- 9231 SP 2.1 Prepare for Peer Reviews
- 9232 SP 2.2 Conduct Peer Reviews
- 9233 SP 2.3 Analyze Peer Review Data

9234 SG 3 Verify Selected Work Products [PA150.IG103]

- 9235 SP 3.1 Perform Verification
- 9236 SP 3.2 Analyze Verification Results and Identify Corrective Action
- 9237 SP 3.3 Perform Re-Verification

9238 GG 3 Institutionalize a Defined Process

- 9239 GP 2.1 (CO 1) Establish an Organizational Policy
- 9240 GP 3.1 (AB 1) Establish a Defined Process
- 9241 GP 2.2 (AB 2) Plan the Process
- 9242 GP 2.3 (AB 3) Provide Resources
- 9243 GP 2.4 (AB 4) Assign Responsibility
- 9244 GP 2.5 (AB 5) Train People
- 9245 GP 2.6 (DI 1) Manage Configurations
- 9246 GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders
- 9247 GP 2.8 (DI 3) Monitor and Control the Process
- 9248 GP 3.2 (DI 4) Collect Improvement Information
- 9249 GP 2.9 (VE 1) Objectively Evaluate Adherence
- 9250 GP 2.10 (VE 2) Review Status with Higher-Level Management

9251 Specific Practices by Goal

9252 SG 1 Prepare for Verification [PA150.IG101]

9253 ***Preparation for verification is conducted.***

9254 For comprehensive verification, preparation is required to assure that all
 9255 levels of verification are conducted. Verification includes inspection,
 9256 testing, analyses, and demonstration. This up-front preparation is also
 9257 necessary to ensure that verification provisions are embedded in
 9258 product and product component requirements, designs, and
 9259 developmental plans and schedules. [PA150.IG101.N101]

9260 Methods of verification include, but are not limited to, inspections, peer
 9261 reviews, audits, walkthroughs, analyses, simulations, testing, and
 9262 demonstrations. [PA150.IG101.N102]

9263 Preparation also entails the definition of support tools, test equipment
 9264 and software, simulations, prototypes, and facilities. [PA150.IG101.N103]

9265 **SP 1.1 Establish a Verification Strategy**

9266 ***Establish and maintain a verification strategy for selected work***
9267 ***products.*** [PA150.IG101.SP101]

9268 *Refer to the Integrated Project Management (IPPD) process area for*
9269 *more information about identifying work products for peer review.*

9270 [PA150.IG101.SP101.R101]

9271 ***For Software Engineering***

9272 *Examples of verification methods include the following:*

9273 [PA150.IG101.SP101.AMP101]

- 9274 • *Path coverage testing*
- 9275 • *Load, stress, and performance testing*
- 9276 • *Decision table based testing*
- 9277 • *Functional decomposition based testing*
- 9278 • *Test case reuse*
- 9279 • *Alpha and Beta test*
- 9280 • *Operational scenario testing*
- 9281 • *Acceptance tests*

9282 ***For Integrated Product and Process Development***

9283 *The verification strategy should be developed concurrently*
9284 *and iteratively with the product and product component*
9285 *designs.* [PA150.IG101.SP101.AMP102]

9287 The verification strategy is created to derive the specific activities
9288 related to verifying work products. These result in detailed strategies
9289 and procedures for the verification of the work products.

9290 [PA150.IG101.SP101.N101]

9291 The requirements and strategies for verification are typically
9292 documented in a verification strategy. The verification strategy
9293 addresses the specific actions, resources, and environments required
9294 for work product verification. This differs from the verification plans
9295 addressed by the Plan the Process generic practice. The generic
9296 practice addresses the process tasks, who is responsible for them, and
9297 resources generally needed. The verification strategy defines the
9298 technical approach to work product verification and the specific
9299 approaches that will be used to verify specific work products.

9300 [PA150.IG101.SP101.N102]

9301 The verification strategy typically begins with involvement in the
 9302 definition of product and product component requirements to ensure
 9303 that these requirements are verifiable. This strategy includes ensuring
 9304 that an appropriate method of verification is assigned to each
 9305 requirement when necessary, and verification criteria are developed. At
 9306 a minimum, a method of verification is assigned to each selected work
 9307 product. [PA150.IG101.SP101.N103]

9308 The verification strategy may address peer reviews. The specific work
 9309 products that will undergo a peer review are typically identified in the
 9310 project plan. [PA150.IG101.SP101.N104]

9311 **Typical Work Products**

- 9312 1. Verification strategy [PA150.IG101.SP101.W101]
- 9313 2. Commercial off-the-shelf (COTS) verification strategy
 9314 [PA150.IG101.SP101.W102]
- 9315 3. Verification procedures [PA150.IG101.SP101.W103]
- 9316 4. Verification criteria [PA150.IG101.SP101.W104]

9317 **Subpractices**

- 9318 1. Define the requirements for a realistic verification environment.
 9319 [PA150.IG101.SP101.SubP102]
- 9320 2. Identify the verification methods and processes that are available
 9321 for use. [PA150.IG101.SP101.SubP103]

9322 **SP 1.2 Establish the Verification Environment**

9323 ***Establish and maintain the environment needed to support***
 9324 ***verification.*** [PA150.IG101.SP102]

9325 An environment needs to be established to enable verification to take
 9326 place. The verification environment may be acquired, developed,
 9327 reused, modified, or a combination of these depending on the needs of
 9328 the project. [PA150.IG101.SP102.N101]

9329 The type of environment required will depend on the verification criteria
 9330 and the verification method used. A peer review may require little more
 9331 than a package of materials, reviewers, and a room. A product test
 9332 may require simulators, emulators, scenario generators, data reduction
 9333 tools, environmental controls, and interfaces with other systems.
 9334 [PA150.IG101.SP102.N102]

9335 **Typical Work Products**

- 9336 1. Verification support equipment [PA150.IG101.SP102.W101]
- 9337 2. Verification environment [PA150.IG101.SP102.W102]

- 9338 **Subpractices**
- 9339 1. Identify verification environment requirements. [PA150.IG101.SP102.SubP101]
- 9340 2. Identify verification resources that are available for reuse and
- 9341 modification. [PA150.IG101.SP102.SubP102]
- 9342 3. Identify verification equipment and tools. [PA150.IG101.SP102.SubP103]
- 9343 4. Acquire verification support equipment and an environment, such
- 9344 as test equipment and software. [PA150.IG101.SP102.SubP104]

9345 **SP 1.3 Establish Detailed Verification Plans**

9346 ***Establish and maintain detailed verification plans for selected***

9347 ***work products.*** [PA150.IG101.SP103]

9348 **Subpractices**

- 9349 1. Plan the set of comprehensive, integrated verification activities for
- 9350 work products and any COTS products, as necessary.
- 9351 [PA150.IG101.SP103.SubP101]
- 9352 2. Develop and refine the verification criteria when necessary.
- 9353 [PA150.IG101.SP103.SubP102]
- 9354 3. For verification of each work product, define which method and
- 9355 process will be used (globally or for each of their requirements).
- 9356 [PA150.IG101.SP103.SubP103]
- 9357 4. Identify the expected results and any tolerances allowed in the
- 9358 observation and other criteria for satisfying the requirements.
- 9359 [PA150.IG101.SP103.SubP104]
- 9360 5. Identify any equipment and environmental components needed to
- 9361 support verification. [PA150.IG101.SP103.SubP105]

9362 **SG 2 Perform Peer Reviews** [PA150.IG102]

9363 ***Peer reviews are performed on selected work products.***

9364 Peer reviews involve a methodical examination of work products by the

9365 producers' peers to identify defects for removal and to recommend

9366 other changes that are needed. [PA150.IG102.N101]

9367 The peer review is an important and effective engineering method

9368 implemented via inspections, structured walkthroughs, or a number of

9369 other collegial review methods. [PA150.IG102.N102]

9370 Peer reviews are primarily applied to work products developed by the
9371 projects, but they can also be applied to other work products such as
9372 documentation and training work products that are typically developed
9373 by support groups. [PA150.IG102.N103]

9374 **SP 2.1 Prepare for Peer Reviews**

9375 ***Prepare for peer reviews of selected work products.*** [PA150.IG102.SP101]

9376 Preparation activities for peer reviews typically include identifying the
9377 staff who will be invited to participate in the peer review of each work
9378 product, identifying the key reviewers who must participate in the peer
9379 review, preparing and updating any materials that will be used during
9380 the peer reviews such as checklists and review criteria, and scheduling
9381 peer reviews. [PA150.IG102.SP101.N101]

9382 **Typical Work Products**

- 9383 1. Peer review schedule [PA150.IG102.SP101.W101]
- 9384 2. Peer review checklist [PA150.IG102.SP101.W102]
- 9385 3. Entry and exit criteria for work products [PA150.IG102.SP101.W103]
- 9386 4. Re-review criteria [PA150.IG102.SP101.W104]
- 9387 5. Peer review training material [PA150.IG102.SP101.W105]
- 9388 6. Selected work products to be reviewed [PA150.IG102.SP101.W106]

9389 **Subpractices**

- 9390 1. Determine what type of peer review will be conducted.
9391 [PA150.IG102.SP101.SubP101]

9392 Examples of types of peer reviews include the following: [PA150.IG102.SP101.SubP101.N101]

- 9393 • Inspections
- 9394 • Structured walkthroughs
- 9395 • Active reviews

- 9396
- 9397 2. Define requirements for collecting data during the peer review.
9398 [PA150.IG102.SP101.SubP102]

9399 *Refer to the Measurement and Analysis process area for practices on*
9400 *identifying and collecting data.* [PA150.IG102.SP101.SubP102.R101]

- 9401 3. Establish and maintain entry and exit criteria for the peer review.
9402 [PA150.IG102.SP101.SubP103]

9403 4. Establish and maintain criteria for requiring a re-review of the work
9404 product. [PA150.IG102.SP101.SubP104]

9405 5. Establish and maintain checklists to ensure that the work products
9406 are reviewed consistently. [PA150.IG102.SP101.SubP105]

9407 Examples of items addressed by the checklists include the following:

9408 [PA150.IG102.SP101.SubP105.N102]

- 9409
- 9410 • Rules of construction
 - 9411 • Design guidelines
 - 9412 • Completeness
 - 9413 • Correctness
 - 9414 • Maintainability
 - 9415 • Common defect types

9416 The checklists are modified as necessary to address the specific type of work
9417 product and peer review. The peers of the checklist developers and potential
9418 users review the checklists. [PA150.IG102.SP101.SubP105.N101]

9419 6. Develop a detailed peer review schedule including the dates for
9420 peer review training and when materials for peer reviews will be
9421 available. [PA150.IG102.SP101.SubP106]

9422 7. Ensure that the work product satisfies the peer review entry criteria
9423 prior to distribution. [PA150.IG102.SP101.SubP107]

9424 8. Distribute the work product to be reviewed and its related
9425 information to the participants early enough to enable participants
9426 to adequately prepare for the peer review. [PA150.IG102.SP101.SubP108]

9427 Examples of related information include the following: [PA150.IG102.SP101.SubP108.N101]

- 9428
- 9429 • The plan for the peer review
 - 9430 • Objectives of the work product
 - 9431 • Applicable standards
 - 9432 • Relevant inputs to the work product (e.g., the relevant requirements for a design)
 - 9433 • Checklists

9434 9. Assign roles for the peer review as appropriate. [PA150.IG102.SP101.SubP109]

9435

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

9436

- Leader

9437

- Reader

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- Recorder

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- Author

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9441

10. Prepare for the peer review by reviewing the work product prior to

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conducting the peer review. [PA150.IG102.SP101.SubP110]

9443

SP 2.2 Conduct Peer Reviews

9444

Conduct peer reviews on selected work products and identify

9445

issues resulting from the peer review. [PA150.IG102.SP102]

9446

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.

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[PA150.IG102.SP102.N101]

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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]

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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]

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9457

When issues arise during the peer review, they are communicated to the primary developer of the work product for correction.

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[PA150.IG102.SP102.N104]

9460

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

9461

9462

[PA150.IG102.SP102.N104.R101]

9463

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

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[PA150.IG102.SP102.N105]

9468

Typical Work Products

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1. Peer review results [PA150.IG102.SP102.W101]

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2. Peer review issues [PA150.IG102.SP102.W102]

- 9471 3. Peer review data [PA150.IG102.SP102.W103]
- 9472 **Subpractices**
- 9473 1. Perform the assigned roles in the peer review. [PA150.IG102.SP102.SubP101]
- 9474 2. Identify and document defects and other issues in the work
- 9475 product. [PA150.IG102.SP102.SubP102]
- 9476 3. Capture the results of the peer review and document the action
- 9477 items. [PA150.IG102.SP102.SubP103]
- 9478 4. Collect peer review data. [PA150.IG102.SP102.SubP104]
- 9479 *Refer to the Measurement and Analysis process area for data collection*
- 9480 *practices.* [PA150.IG102.SP102.SubP104.R101]
- 9481 5. Identify action items and communicate the issues to stakeholders.
- 9482 [PA150.IG102.SP102.SubP105]
- 9483 *Refer to the Requirements Development process area where*
- 9484 *appropriate to address the action items identified in the peer reviews.*
- 9485 [PA150.IG102.SP102.SubP105.R101]
- 9486 *Refer to the Technical Solution process area where appropriate to*
- 9487 *address the action items identified in the peer reviews.*
- 9488 [PA150.IG102.SP102.SubP105.R102]
- 9489 *Refer to the Product Integration process area where appropriate to*
- 9490 *address the action items identified in the peer reviews.*
- 9491 [PA150.IG102.SP102.SubP105.R103]
- 9492 6. Plan a re-review of the work product if the re-review criteria are
- 9493 satisfied. [PA150.IG102.SP102.SubP106]
- 9494 7. Ensure that the exit criteria for the peer review are satisfied.
- 9495 [PA150.IG102.SP102.SubP107]

9496 **SP 2.3 Analyze Peer Review Data**

9497 **Analyze data about preparation, conduct, and results of the peer**

9498 **reviews.** [PA150.IG102.SP103]

9499 *Refer to the Measurement and Analysis process area for information*

9500 *about analyzing peer review data.* [PA150.IG102.SP103.R101]

9501 **Typical Work Products**

- 9502 1. Peer review data [PA150.IG102.SP103.W101]
- 9503 2. Peer review action items [PA150.IG102.SP103.W102]

9504

Subpractices

9505

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

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9507

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

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2. Store the data for future reference and analysis. [PA150.IG102.SP103.SubP102]

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3. Protect the data to ensure that peer review data are not used inappropriately. [PA150.IG102.SP103.SubP103]

9515

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

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

9520

SG 3 Verify Selected Work Products [PA150.IG103]

9521

Selected work products are verified against their specified requirements.

9522

SP 3.1 Perform Verification

9523

Perform verification according to the verification strategy.

9524

[PA150.IG103.SP101]

9525

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

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Typical Work Products

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1. Verification results [PA150.IG103.SP101.W101]

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2. Verification reports [PA150.IG103.SP101.W102]

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3. Demonstrations [PA150.IG103.SP101.W103]

9533

4. "As Verified" procedures log [PA150.IG103.SP101.W104]

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Subpractices

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1. Verify COTS and reused components to verify that they meet the requirements. [PA150.IG103.SP101.SubP101]

9536

- 9537 2. Perform product verification against the requirements according to
9538 the verification strategy and procedures. [PA150.IG103.SP101.SubP102]
- 9539 3. Capture the results of verification activities. [PA150.IG103.SP101.SubP103]
- 9540 4. Identify action items resulting from verification of work products.
9541 [PA150.IG103.SP101.SubP104]
- 9542 5. Document the "as-run" verification method and the deviations from
9543 the strategies and procedures made during its performance.
9544 [PA150.IG103.SP101.SubP105]

SP 3.2 Analyze Verification Results and Identify Corrective Action

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

9548 Actual results must be compared to established verification criteria to
9549 determine acceptability. [PA150.IG103.SP102.N101]

9550 The results of the analysis are recorded as evidence that verification
9551 was conducted. [PA150.IG103.SP102.N102]

9552 Analysis reports or "as-run" method documentation may also indicate
9553 that bad verification results are due to method problems, criteria
9554 problems, or an infrastructure problem. [PA150.IG103.SP102.N103]

9555 *Refer to the corrective action practices of Project Monitoring and*
9556 *Control process area for implementing corrective action.*
9557 [PA150.IG103.SP102.N103.R101]

Typical Work Products

- 9558 1. Analysis report (such as statistics on performances, causal
9559 analysis of non-conformances, comparison of the behavior
9560 between the real product and models, trends, etc.)
9561 [PA150.IG103.SP102.W101]
- 9562 2. Trouble reports [PA150.IG103.SP102.W102]
- 9563 3. Method, criteria, and infrastructure change requests
9564 [PA150.IG103.SP102.W103]
- 9565 4. Corrective actions to verification methods, criteria, and/or
9566 infrastructure [PA150.IG103.SP102.W104]
- 9567

Subpractices

- 9568 1. Compare actual results to expected results. [PA150.IG103.SP102.SubP101]
- 9569 2. Based on the established verification criteria, identify products that
9570 have not met their requirements or identify problems with the
9571 methods, criteria, and/or infrastructure. [PA150.IG103.SP102.SubP102]
- 9572

- 9573 3. Analyze the verification data on defects. [PA150.IG103.SP102.SubP103]
- 9574 4. Capture all results of the analysis into a report. [PA150.IG103.SP102.SubP104]
- 9575 5. Use verification results to compare actual measurements and
9576 performance to technical performance parameters.
9577 [PA150.IG103.SP102.SubP105]
- 9578 6. Provide information on how defects may be resolved (including
9579 verification methods, criteria, and/or infrastructure) and formalize it
9580 in a plan. [PA150.IG103.SP102.SubP106]

9581 **SP 3.3 Perform Re-Verification**

9582 ***Perform re-verification of corrected work products and ensure that***
9583 ***work products have not been negatively impacted.*** [PA150.IG103.SP103]

9584 Re-verification is done to ensure that the defect has been corrected,
9585 and to ensure that the work product has not been corrupted as a result
9586 of defect-correction actions. [PA150.IG103.SP103.N101]

9587 Re-verification will typically focus in detail on the part of the work
9588 product where the defect was detected. However, the work product that
9589 was being verified when the defect was detected will need to be re-
9590 verified to the extent needed to ensure that no new defects have been
9591 introduced. [PA150.IG103.SP103.N103]

9592 Re-verification is also necessary when there are changes in the
9593 requirements and/or the designs. [PA150.IG103.SP103.N104]

9594 Re-verification may be necessary when problems have been detected
9595 on the verification method. (See the "Perform Verification" specific
9596 practice.) [PA150.IG103.SP103.N105]

9597 **Typical Work Products**

- 9598 1. Re-verification results [PA150.IG103.SP103.W101]
- 9599 2. Subsystem and component verification results [PA150.IG103.SP103.W102]
- 9600 3. System verification results [PA150.IG103.SP103.W103]

9601 **Subpractices**

- 9602 1. Identify where re-verification is necessary. [PA150.IG103.SP103.SubP101]
- 9603 2. Perform re-verification. [PA150.IG103.SP103.SubP102]
- 9604 3. Perform re-test, as appropriate, including regression testing.
9605 [PA150.IG103.SP103.SubP103]

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For Software Engineering

Perform regression testing, as appropriate, whenever the software that is being tested changes or the software environment changes. [PA150.IG103.SP103.SubP103.AMP101]

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4. Supplement or correct the documentation describing the verification activities. [PA150.IG103.SP103.SubP104]

9612 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

9613 ***The process is institutionalized as a defined process.***

9614 Commitment to Perform

9615 **GP 2.1 (CO 1) Establish an Organizational Policy**

9616 ***Establish and maintain an organizational policy for planning and***
9617 ***performing the verification process. [GP103]***

9618 Elaboration:

9619 This policy establishes organizational expectations for establishing and
9620 maintaining a verification strategy and environment, and performing
9621 peer reviews and verifying selected work products. [PA150.EL101]

9622 Ability to Perform

9623 **GP 3.1 (AB 1) Establish a Defined Process**

9624 ***Establish and maintain the description of a defined verification***
9625 ***process. [GP114]***

9626 **GP 2.2 (AB 2) Plan the Process**

9627 ***Establish and maintain the requirements and objectives, and plans***
9628 ***for performing the verification process. [GP104]***

9629

Elaboration:

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These requirements, objectives, and plans are described in the plan for verification. This plan for verification differs from the verification strategy described in the specific practices in this process area. The verification strategy addresses specific actions, resources, and environments required for work product verification, whereas the plan for verification addresses high-level planning for all the verification. [PA150.EL102]

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GP 2.3 (AB 3) Provide Resources

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Provide adequate resources for performing the verification 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 to perform the activities of the Verification process area include the following: [PA150.EL103]

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

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

[PA150.EL104]

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9655

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

9656

GP 2.4 (AB 4) Assign Responsibility

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9659

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

9660

GP 2.5 (AB 5) Train People

9661

9662

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

9663 Elaboration:

- 9664 Examples of training topics include the following: [PA150.EL105]
- 9665 • Application domain
 - 9666 • Verification principles, standards, and methods (e.g., analysis,
9667 demonstration, inspection, test)
 - 9668 • Verification tools and facilities
 - 9669 • Peer review preparation and procedures
 - 9670 • Meeting facilitation
- 9671

9672 Directing Implementation

9673 **GP 2.6 (DI 1) Manage Configurations**

9674 *Place designated work products of the verification process under*
9675 *appropriate levels of configuration management.* [GP109]

9676 Elaboration:

- 9677 Examples of work products placed under configuration management
9678 include the following: [PA150.EL106]
- 9679 • Verification strategy
 - 9680 • Peer review training material
 - 9681 • Peer review data
 - 9682 • Verification reports
- 9683

9684 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

9685 *Identify and involve the relevant stakeholders of the verification*
9686 *process as planned.* [GP124]

9687 Elaboration:

9688 For engineering processes, consider stakeholders among customers,
9689 end users, developers, producers, testers, suppliers, marketers,
9690 maintainers, disposal personnel, and others who may be affected by, or
9691 may affect, the product as well as the process. [PA150.EL113]

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

- Establishing a verification strategy
- Conducting peer reviews
- Assessing verification results and identify corrective action

9697

GP 2.8 (DI 3) Monitor and Control the Process

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9699

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

9700

Elaboration:

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9702

Examples of measures used in monitoring and controlling the activities of the Verification process area include the following: [PA150.EL107]

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

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GP 3.2 (DI 4) Collect Improvement Information

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

[GP117]

9718

Verifying Implementation

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GP 2.9 (VE 1) Objectively Evaluate Adherence

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

9724

Elaboration:

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

9726

- Establishing and maintaining a verification strategy

9727

- Performing peer reviews

9728

- Verifying selected work products

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

9731

- Verification strategy

9732

- Peer review checklists

9733

- Verification reports

9734

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

9736

Review the activities, status, and results of the verification

9737

process with higher-level management and resolve issues. [GP112]

9738 VALIDATION

9739 Maturity Level 3

9740 Purpose

9741 The purpose of Validation is to demonstrate that a product or product
9742 component fulfills its intended use when placed in its intended
9743 environment. [PA149]

9744 Introductory Notes

9745 Validation demonstrates that the as-built product actually performs its
9746 intended function(s) in its intended environment. [PA149.N101]

9747 Validation activities use approaches similar to verification (e.g., test,
9748 analysis, simulation, etc.). Both validation and verification activities
9749 often run concurrently and may use portions of the same environment.
9750 The difference is that verification demonstrates compliance with
9751 requirements, while validation demonstrates satisfactory suitability for
9752 use in the intended operating environment. In other words, verification
9753 assures "you built it right;" whereas validation assures "you built the
9754 right thing." [PA149.N102]

9755 *Refer to the Verification process area for more information about*
9756 *verification activities.* [PA149.N102.R101]

9757 Product validation should be accomplished using the actual product
9758 operating in its intended environment where possible. The entire
9759 environment may be used or only part of it. Validation issues can be
9760 discovered early in the development life cycle through the use of early
9761 validation activities (such as validation of customer requirements
9762 against the operational needs of the customers and end-users).

9763 [PA149.N103]

9764 *Refer to the Requirements Development process area for more*
9765 *information about requirements validation. Requirements validation*
9766 *practices are included in Requirements Development to ensure early*
9767 *requirements validation activities are performed.* [PA149.N103.R101]

9768 Validation issues may include the identification of unsatisfactory product
9769 requirements or unanticipated or unintended functions or behavior.
9770 When issues are identified, they are referred to the Requirements
9771 Development, Technical Solution, or Project Monitoring and Control
9772 process area's practices for resolution. [PA149.N104]

9773 Related Process Areas

9774 *Refer to the Requirements Development process area for more*
 9775 *information about requirements generation based on the customer*
 9776 *needs and for corrective action when validation issues are identified*
 9777 *that affect the product or product component requirements.* [PA149.R101]

9778 *Refer to the Technical Solution process area for more information about*
 9779 *transforming requirements into product specifications and for corrective*
 9780 *action when validation issues are identified that affect the product or*
 9781 *product component design.* [PA149.R102]

9782 *Refer to the Verification process area for more information about*
 9783 *verifying that the product and product components meet their*
 9784 *requirements.* [PA149.R103]

9785 *Refer to the Decision Analysis and Resolution process area for more*
 9786 *information about structured decision making related to deciding on the*
 9787 *optimum validation strategy.* [PA149.R104]

9788 Specific and Generic Goals

9789 **SG 1 Prepare for Validation** [PA149.IG101]

9790 ***Preparation for validation is conducted.***

9791 **SG 2 Validate Product or Product Components** [PA149.IG102]

9792 ***The product or product components are validated to ensure that they are***
 9793 ***suitable for use in their intended operating environment.***

9794 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

9795 ***The process is institutionalized as a defined process.***

9796 Practice to Goal Relationship Table

9797	SG 1 Prepare for Validation [PA149.IG101]		
9798	SP 1.1		Establish a Validation Strategy
9799	SP 1.2		Establish the Validation Environment
9800	SP 1.3		Define Detailed Validation Procedures
9801	SG 2 Validate Product or Product Components [PA149.IG102]		
9802	SP 2.1		Perform Validation
9803	SP 2.2		Capture and Analyze Validation Results
9804	GG 3 Institutionalize a Defined Process		
9805	GP 2.1	(CO 1)	Establish an Organizational Policy
9806	GP 3.1	(AB 1)	Establish a Defined Process
9807	GP 2.2	(AB 2)	Plan the Process
9808	GP 2.3	(AB 3)	Provide Resources
9809	GP 2.4	(AB 4)	Assign Responsibility
9810	GP 2.5	(AB 5)	Train People
9811	GP 2.6	(DI 1)	Manage Configurations
9812	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
9813	GP 2.8	(DI 3)	Monitor and Control the Process
9814	GP 3.2	(DI 4)	Collect Improvement Information
9815	GP 2.9	(VE 1)	Objectively Evaluate Adherence
9816	GP 2.10	(VE 2)	Review Status with Higher-Level Management

9817 Specific Practices by Goal

9818 **SG 1 Prepare for Validation** [PA149.IG101]

9819 ***Preparation for validation is conducted.***

9820 Preparation activities for validation allow for flexibility to the technical
 9821 approach in the product development effort. Preparation activities
 9822 include establishing and maintaining a validation strategy, environment,
 9823 and detailed procedures. The validation strategy may include the
 9824 validation of only the end product or it may include appropriate levels of
 9825 the product components that are used to build the product. Any product
 9826 may be subject to validation including replacement, maintenance, and
 9827 training products to name just a few. [PA149.IG101.N101]

9828 The environment required to validate the product or product
 9829 components is prepared according to the strategy. The environment
 9830 may be purchased or specified, designed, and built. Reuse of all or part
 9831 of the environment is also described in the validation strategy. The
 9832 environments used for product integration and verification should be
 9833 considered in a collaborative effort in the validation strategy to reduce
 9834 cost and improve efficiency or productivity. [PA149.IG101.N102]

9835 **SP 1.1 Establish a Validation Strategy**

9836 ***Establish and maintain a validation strategy.*** [PA149.IG101.SP101]

9837 *For Integrated Product and Process Development*

9838 *The validation strategy should be developed concurrently and*
9839 *iteratively with the product and product component designs.*

9840 [PA149.IG101.SP101.AMP101]

9841 The requirements and strategies for validation are documented in a
9842 validation strategy. The validation strategy addresses the specific
9843 actions, resources, and environments required for product validation.
9844 When planning the validation process (see Project Planning and the
9845 Planning generic practice), specific tasks should be included to address
9846 the detailed validation strategies and activities needed. The validation
9847 strategy not only defines the technical approach to product validation,
9848 but also detailed activities and resources. These activities and
9849 resources may include facilities, validation equipment, environments,
9850 time phasing, resource sharing among validation activities within the
9851 project and by other projects within the same organization, etc. This
9852 may result in the generation of lower-level product component
9853 requirements that are handled by the Requirements Development
9854 process area. Derived requirements, such as interface requirements to
9855 test sets and test equipment, may be generated. These requirements
9856 are also passed to the Requirements Development processes to ensure
9857 that the product or product components can be validated in the
9858 environment defined by the strategy. [PA149.IG101.SP101.N101]

9859 A validation strategy should be available early in the development
9860 process so that the validation mechanisms are clearly understood and
9861 agreed to by the relevant stakeholders. [PA149.IG101.SP101.N102]

9862 The validation strategy and procedures address the development,
9863 maintenance, support, and training for the product and product
9864 components as appropriate. [PA149.IG101.SP101.N103]

9865 **Typical Work Products**

- 9866 1. Validation strategy [PA149.IG101.SP101.W101]

9867 **Subpractices**

- 9868 1. Identify the key principles, features, and phases for product or
9869 product component validation throughout the development life
9870 cycle. [PA149.IG101.SP101.SubP101]

- 9871 2. Define requirements for a realistic validation environment that
9872 covers operation, maintenance, training, and support.

9873 [PA149.IG101.SP101.SubP102]

9874 The product must be maintainable and supportable in its intended operational
 9875 environment. This practice addresses the actual maintenance, training, and
 9876 support services that may be delivered along with the product. In some cases, this
 9877 practice may be performed by organizations other than the development
 9878 organization. [PA149.IG101.SP101.SubP102.N101]

9879 An example of evaluation of maintenance concepts in the operational environment
 9880 is a demonstration that maintenance tools are operating in the actual product.

9881 [PA149.IG101.SP101.SubP102.N102]

- 9882
- 9883 3. Define the evaluation criteria for validation. [PA149.IG101.SP101.SubP103]
- 9884 4. Review the validation strategy with relevant stakeholders.
 9885 [PA149.IG101.SP101.SubP104]

9886 **SP 1.2 Establish the Validation Environment**

9887 ***Establish and maintain the environment needed to support***
 9888 ***validation.*** [PA149.IG101.SP102]

9889 The validation strategy may identify needs for an environment that must
 9890 be acquired or developed. This may yield requirements for the purchase
 9891 or development of equipment, software, or other resources. These
 9892 requirements are provided to the Requirements Development process
 9893 areas for development. The validation environment may include the
 9894 reuse of existing resources. In this case, the strategy should outline the
 9895 use of these resources and arrangements for their use must be made.
 9896 Examples of the type of elements in a validation environment include
 9897 the following: [PA149.IG101.SP102.N101]

- 9898 • Test tools interfaced with the product being validated (e.g., scope,
 9899 electronic devices, probes)
- 9900 • Temporary embedded test software
- 9901 • Recording tools for dump or further analysis and replay
- 9902 • Simulated subsystems or components (by software or by
 9903 electronics or by mechanics)
- 9904 • Simulated interfaced systems (e.g., a dummy warship for testing a
 9905 naval radar)
- 9906 • Real interfaced systems (e.g., aircraft for testing a radar with
 9907 trajectory tracking facilities)
- 9908 • Facilities and Customer-Supplied Products
- 9909 • The skilled people to operate or use all the above elements
- 9910 • Dedicated computing or network test environment (e.g., pseudo
 9911 operational telecommunications network test bed or facility with

9912 actual trunks, switches and systems established for realistic
9913 integration and validation trials)

9914 Early development of the validation strategy is needed to ensure that
9915 the validation environment will be available when necessary.

9916 [PA149.IG101.SP102.N102]

9917 The validation environment should be carefully controlled to provide for
9918 replication, analysis of results, and re-validation of problem areas.

9919 [PA149.IG101.SP102.N103]

9920 **Typical Work Products**

9921 1. Validation environment [PA149.IG101.SP102.W101]

9922 **Subpractices**

9923 1. Identify validation environment requirements. [PA149.IG101.SP102.SubP101]

9924 2. Identify customer-supplied products. [PA149.IG101.SP102.SubP102]

9925 3. Identify reuse items. [PA149.IG101.SP102.SubP103]

9926 4. Identify test equipment and tools. [PA149.IG101.SP102.SubP104]

9927 5. Identify validation resources that are available for re-use and
9928 modification. [PA149.IG101.SP102.SubP105]

9929 6. Plan the availability of resources in detail. [PA149.IG101.SP102.SubP106]

9930 **SP 1.3 Define Detailed Validation Procedures**

9931 ***Define detailed procedures and criteria for validation.*** [PA149.IG101.SP103]

9932 Validation procedures are defined to ensure that the product or product
9933 component will fulfill its intended use when placed in its intended
9934 environment. Acceptance test cases and procedures may meet the
9935 need for validation procedures. [PA149.IG101.SP103.N101]

9936 The detailed validation procedures include test and evaluation of
9937 maintenance, training and support services. [PA149.IG101.SP103.N102]

9938 **Typical Work Products**

9939 1. Validation procedures [PA149.IG101.SP103.W101]

9940 2. Validation criteria [PA149.IG101.SP103.W102]

9941 3. Test and evaluation procedures for maintenance, training, and
9942 support [PA149.IG101.SP103.W103]

- 9943 **Subpractices**
- 9944 1. Review the product requirements to ensure that issues affecting
- 9945 validation of the product are identified and resolved.
- 9946 [PA149.IG101.SP103.SubP101]
- 9947 2. Document the environment, operational scenario, procedures,
- 9948 inputs, outputs, and expected results for the validation strategy.
- 9949 [PA149.IG101.SP103.SubP102]
- 9950 3. Assess the design as it matures in the context of the validation
- 9951 environment to identify validation issues. [PA149.IG101.SP103.SubP103]

9952 **SG 2 Validate Product or Product Components** [PA149.IG102]

9953 ***The product or product components are validated to ensure that they are***

9954 ***suitable for use in their intended operating environment.***

9955 Validation activities should start early in the project and are performed

9956 according to the validation strategy. [PA149.IG102.N101]

9957 The validation strategy and procedures are used to validate the product

9958 and or product components and any associated maintenance, training

9959 and support services using the appropriate validation environment. In

9960 some cases, this practice may be performed by organizations other

9961 than the development organization. [PA149.IG102.N102]

9962 **SP 2.1 Perform Validation**

9963 ***Perform validation according to the validation strategy.***

9964 [PA149.IG102.SP101]

9965 To be acceptable to users, the product and product components must

9966 perform as expected in their intended operational environment.

9967 [PA149.IG102.SP101.N101]

9968 Validation activities are performed and the resulting data is collected

9969 according to established plans and procedures. [PA149.IG102.SP101.N102]

9970 The as-run validation procedures should be documented and the

9971 deviations occurring during the execution should be noted, as

9972 appropriate. [PA149.IG102.SP101.N103]

9973 **Typical Work Products**

- 9974 1. Validation reports [PA149.IG102.SP101.W101]
- 9975 2. Validation results [PA149.IG102.SP101.W102]
- 9976 3. Validation cross-reference matrix [PA149.IG102.SP101.W103]
- 9977 4. As-run procedures log [PA149.IG102.SP101.W104]

9978 5. Operational demonstrations [PA149.IG102.SP101.W105]

9979 **SP 2.2 Capture and Analyze Validation Results**

9980 ***Capture and analyze the results of the validation activities and***
 9981 ***identify issues.*** [PA149.IG102.SP102]

9982 The data resulting from validation tests, inspections, demonstrations, or
 9983 evaluations are analyzed against the defined validation criteria. Analysis
 9984 reports indicate whether or not the needs were met; and in the case of
 9985 deficiencies, these reports document the degree of success or failure
 9986 and categorize probable cause of failure. The collected test, inspection,
 9987 or review results are compared with established evaluation criteria to
 9988 determine whether to proceed or to address requirements or design
 9989 issues in the Requirements Development or Technical Solution process
 9990 areas. [PA149.IG102.SP102.N101]

9991 Analysis reports or as-run validation documentation may also indicate
 9992 that bad test results are due to a validation procedure problem or a
 9993 validation environment problem. [PA149.IG102.SP102.N102]

9994 **Typical Work Products**

- 9995 1. Validation deficiency reports [PA149.IG102.SP102.W101]
- 9996 2. Validation issues [PA149.IG102.SP102.W102]
- 9997 3. Procedure change request [PA149.IG102.SP102.W103]

9998 **Subpractices**

- 9999 1. Compare actual results to expected results. [PA149.IG102.SP102.SubP101]
- 10000 2. Based on the established validation criteria, identify products or
 10001 product components that do not perform suitably in their intended
 10002 operating environments or identify problems with the methods,
 10003 criteria, and/or environment. [PA149.IG102.SP102.SubP102]
- 10004 3. Analyze the validation data for defects. [PA149.IG102.SP102.SubP103]
- 10005 4. Capture the results of the analysis and identify issues.
 10006 [PA149.IG102.SP102.SubP104]
- 10007 5. Use validation results to compare actual measurements and
 10008 performance to intended use or operational need.
 10009 [PA149.IG102.SP102.SubP105]

10010 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

10011 ***The process is institutionalized as a defined process.***

10012 Commitment to Perform

10013 **GP 2.1 (CO 1) Establish an Organizational Policy**

10014 ***Establish and maintain an organizational policy for planning and***
10015 ***performing the validation process.*** [GP103]

10016 Elaboration:

10017 This policy establishes organizational expectations for establishing and
10018 maintaining a validation strategy and environment, and for ensuring that
10019 the product and product components are suitable for use in their
10020 intended operating environment. [PA149.EL101]

10021 Ability to Perform

10022 **GP 3.1 (AB 1) Establish a Defined Process**

10023 ***Establish and maintain the description of a defined validation***
10024 ***process.*** [GP114]

10025 **GP 2.2 (AB 2) Plan the Process**

10026 ***Establish and maintain the requirements and objectives, and plans***
10027 ***for performing the validation process.*** [GP104]

10028 Elaboration:

10029 These requirements, objectives, and plans are described in the plan for
10030 validation. This plan for validation differs from the validation strategy
10031 described in the specific practices in this process area. The validation
10032 strategy addresses the specific actions, resources, and environments
10033 required for validation, whereas the plan for validation addresses high
10034 level planning for all the validation activities. [PA149.EL102]

10035 **GP 2.3 (AB 3) Provide Resources**

10036 ***Provide adequate resources for performing the validation process,***
10037 ***developing the work products and providing the services of the***
10038 ***process.*** [GP105]

10039 Elaboration:

10040 Special facilities may be required for validating the product and product
10041 components. When necessary, the facilities required for the activities in
10042 the Validation process area are developed or purchased. [PA149.EL111]

10043 Examples of tools used to perform the activities of the Validation
10044 process area include the following: [PA149.EL103]

- 10045 • Test management tools
 - 10046 • Test case generators
 - 10047 • Test coverage analyzers
 - 10048 • Simulators
 - 10049 • Load, stress and performance tools
- 10050

10051 **GP 2.4 (AB 4) Assign Responsibility**

10052 *Assign responsibility and authority for performing the process,*
10053 *developing the work products, and providing the services of the*
10054 *validation process.* [GP106]

10055 **GP 2.5 (AB 5) Train People**

10056 *Train the people performing or supporting the validation process*
10057 *as needed.* [GP107]

10058 Elaboration:

10059 Examples of training topics include the following: [PA149.EL104]

- 10060 • Application domain
 - 10061 • Validation principles, standards, and methods
 - 10062 • Intended use environment
- 10063

10064 **Directing Implementation**

10065 **GP 2.6 (DI 1) Manage Configurations**

10066 *Place designated work products of the validation process under*
10067 *appropriate levels of configuration management.* [GP109]

10068

Elaboration:

10069

Examples of work products placed under configuration management include the following: [PA149.EL105]

10070

10071

- Validation strategy

10072

- Validation procedures

10073

- Validation reports

10074

10075

GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders

10076

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

10077

10078

Elaboration:

10079

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]

10084

- Establishing the validation strategy

10085

- Reviewing product and product component validation results and resolving issues

10086

10087

- Resolving issues with the customers or end users

10088

10089

Issues with the customers or end users are resolved particularly when there are significant deviations from their baselined needs for the following: [PA149.EL115]

10090

10091

10092

- Waivers on the contract or agreement (what, when, and for which products, services, or manufactured products)

10093

10094

- Additional in-depth studies or trials or test and evaluation

10095

- Possible changes in the contracts or agreements

10096

GP 2.8 (DI 3) Monitor and Control the Process

10097

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

10098

10099 Elaboration:

10100 Examples of measures used in monitoring and controlling the activities
10101 of the Validation process area include the following: [PA149.EL109]
10102

- 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)

10107

10108 **GP 3.2 (DI 4) Collect Improvement Information**

10109 ***Collect work products, measures, measurement results, and***
10110 ***improvement information derived from planning and performing***
10111 ***the validation process to support the future use and improvement***
10112 ***of the organization's processes and process assets.*** [GP117]

10113 Verifying Implementation

10114 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

10115 ***Objectively evaluate adherence of the validation process and the***
10116 ***work products and services of the process to the applicable***
10117 ***requirements, objectives, and standards, and address***
10118 ***noncompliance.*** [GP113]

10119 Elaboration:

10120 Examples of activities reviewed include the following: [PA149.EL110]
10121

- Establishing and maintaining a validation strategy
- Validating product or product components

10123

10124 Examples of work products reviewed include the following: [PA149.EL112]
10125

- Validation strategy
- Validation procedures

10127

10128

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

10129

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

10130

10131 ORGANIZATIONAL PROCESS FOCUS

10132 Maturity Level 3

10133 Purpose

10134 The purpose of Organizational Process Focus is to establish and
10135 maintain an understanding of the organization's processes and process
10136 assets, and to identify, plan, and implement the organization's process
10137 improvement activities. [PA152]

10138 Introductory Notes

10139 The organization's processes include the organization's set of standard
10140 processes and the defined processes derived from them. The
10141 organization's process assets are artifacts that relate to describing,
10142 implementing, and improving processes (e.g., policies, process
10143 descriptions, support environments, and process implementation
10144 support tools). [PA152.N101]

10145 Candidate improvements to the organization's process assets are
10146 obtained from various sources, including measurement of the
10147 processes, lessons learned in implementing the processes, results of
10148 process assessments, results of process and product verification
10149 activities, results of benchmarking against other organizations'
10150 processes, and recommendations from other improvement initiatives in
10151 the organization. [PA152.N102]

10152 Process improvement occurs within the context of the organization's
10153 needs and is used to address the organization's objectives. The
10154 responsibility of facilitating and managing the organization's process
10155 improvement activities is typically assigned to a process group. The
10156 organization provides the long-term commitment and resources
10157 required to sponsor this group. [PA152.N103]

10158 Careful planning is required to ensure that process improvement efforts
 10159 across the organization are adequately managed and implemented. At
 10160 the highest level, the organization's planning for Process Improvement
 10161 results in a Process Improvement Plan. This plan provides the overall
 10162 process improvement strategy that the organization will use. This
 10163 strategy may call for more focused, detailed implementation plans such
 10164 as Assessment Plans, Process Action Plans, Pilot Plans, and
 10165 Deployment Plans. Assessment Plans describe the assessment
 10166 timeline and schedule, the scope of the assessment, the resources
 10167 required to perform the assessment, the reference model against which
 10168 the assessment will be performed, the logistics for the assessment, etc.
 10169 Process Action Plans usually result from assessments or evaluations,
 10170 and document how specific improvements targeting the weaknesses
 10171 uncovered by an assessment will be implemented. In cases in which it
 10172 is determined that the improvement described in the Process Action
 10173 Plan should be tested on a small group before deploying it across the
 10174 organization, a Pilot Plan is generated. Finally, when the improvement
 10175 is ready for deployment, a Deployment Plan is used. This plan
 10176 describes when and how the improvement will be deployed across the
 10177 organization. [PA152.N104]

10178 The organization's process assets are used to establish, maintain,
 10179 implement, and improve the defined processes that are tailored from
 10180 the organization's set of standard processes. [PA152.N105]

10181 Related Process Areas

10182 *Refer to the Organizational Process Definition process area for more*
 10183 *information about the organization's process assets.* [PA152.R101]

10184 Specific and Generic Goals

10185 **SG 1 Determine Process Improvement Opportunities** [PA152.IG101]

10186 ***Strengths, weaknesses, and improvement opportunities for the organization's***
 10187 ***processes are identified periodically and as needed.***

10188 **SG 2 Plan and Implement Process Improvement Activities** [PA152.IG102]

10189 ***Improvements are planned and implemented, process assets are deployed,***
 10190 ***and process-related experiences are incorporated into the organization's***
 10191 ***process assets.***

10192 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

10193 ***The process is institutionalized as a defined process.***

10194 Practice to Goal Relationship Table

10195	SG 1 Determine Process Improvement Opportunities [PA152.IG101]		
10196	SP 1.1	Establish Organizational Process Needs	
10197	SP 1.2	Assess the Organization's Processes	
10198	SP 1.3	Identify the Organization's Process Improvements	
10199	SG 2 Plan and Implement Process Improvement Activities [PA152.IG102]		
10200	SP 2.1	Establish Process Action Plans	
10201	SP 2.2	Implement Process Action Plans	
10202	SP 2.3	Deploy Process and Related Process Assets	
10203	SP 2.4	Incorporate Process-Related Experiences into the Organization's Process Assets	
10204			
10205	GG 3 Institutionalize a Defined Process		
10206	GP 2.1	(CO 1)	Establish an Organizational Policy
10207	GP 3.1	(AB 1)	Establish a Defined Process
10208	GP 2.2	(AB 2)	Plan the Process
10209	GP 2.3	(AB 3)	Provide Resources
10210	GP 2.4	(AB 4)	Assign Responsibility
10211	GP 2.5	(AB 5)	Train People
10212	GP 2.6	(DI 1)	Manage Configurations
10213	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
10214	GP 2.8	(DI 3)	Monitor and Control the Process
10215	GP 3.2	(DI 4)	Collect Improvement Information
10216	GP 2.9	(VE 1)	Objectively Evaluate Adherence
10217	GP 2.10	(VE 2)	Review Status with Higher-Level Management

10218 Specific Practices by Goal

10219 **SG 1 Determine Process Improvement Opportunities** [PA152.IG101]

10220 ***Strengths, weaknesses, and improvement opportunities for the organization's processes are identified periodically and as needed.***

10221

10222 Strengths, weaknesses, and improvement opportunities may be

10223 determined relative to a process standard or model such as a Capability

10224 Maturity Model-Integrated (CMMI) model or International Organization

10225 for Standardization (ISO) standard. The process improvements should

10226 be selected specifically to address the organization's needs.

10227 [PA152.IG101.N101]

10228 **SP 1.1 Establish Organizational Process Needs**

10229 ***Establish and maintain the description of the process needs and***

10230 ***objectives for the organization.*** [PA152.IG101.SP101]

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For Integrated Product and Process Development

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

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For Integrated Product and Process Development

Examples of processes for effective teamwork include:

[PA152.IG101.SP101.AMP102]

- *Communications*
- *Collaborative decision-making*
- *Issue resolution*
- *Team-building*

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

[PA152.IG101.SP101.N101]

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

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- Characteristics of the processes
- Process performance objectives, such as time-to-market and product quality
- Process effectiveness

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Typical Work Products

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

10264

Subpractices

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1. Identify the policies, standards, and business objectives that are applicable to the organization's processes. [PA152.IG101.SP101.SubP101]

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2. Examine relevant process standards and models for standard and best practices. [PA152.IG101.SP101.SubP102]

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3. Determine the organization's process performance objectives.

[PA152.IG101.SP101.SubP103]

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

Examples of process performance objectives include the following:
[PA152.IG101.SP101.SubP103.N102]

- Cycle time
- Defect removal rates
- Productivity

4. Define the essential characteristics of the organization's processes.

[PA152.IG101.SP101.SubP104]

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

- 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

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

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

5. Document the organization's process needs and objectives.

[PA152.IG101.SP101.SubP105]

6. Revise the organization's process needs and objectives as needed.

[PA152.IG101.SP101.SubP106]

SP 1.2 Assess the Organization's Processes

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

Process assessments may be performed for the following reasons:

[PA152.IG101.SP102.N101]

- To identify processes that should be improved

- 10303 • To verify progress and make the benefits of process improvement
10304 visible
- 10305 • To satisfy the needs of a customer-supplier relationship
- 10306 • To motivate and facilitate buy-in
- 10307 The buy-in gained during a process assessment can be eroded
10308 significantly if it is not followed by an assessment-based action plan.
10309 [PA152.IG101.SP102.N102]
- 10310 **Typical Work Products**
- 10311 1. Plans for the organization's process assessments
10312 [PA152.IG101.SP102.W101]
- 10313 2. Assessment findings that address strengths and weaknesses of
10314 the organization's processes [PA152.IG101.SP102.W102]
- 10315 3. Improvement recommendations for the organization's processes
10316 [PA152.IG101.SP102.W103]
- 10317 **Subpractices**
- 10318 1. Obtain sponsorship of the process assessment from senior
10319 management. [PA152.IG101.SP102.SubP101]
- 10320 Senior management sponsorship includes the commitment to have the
10321 organization's managers and staff participate in the process assessment and to
10322 provide the resources and funding to analyze and communicate the findings of the
10323 assessment. [PA152.IG101.SP102.SubP101.N101]
- 10324 2. Define the scope of the process assessment. [PA152.IG101.SP102.SubP102]
- 10325 Process assessments may be performed on the entire organization or may be
10326 performed on a smaller part of an organization such as a single project or
10327 business area. [PA152.IG101.SP102.SubP102.N101]
- 10328 The scope of the process assessment addresses the following:
10329 [PA152.IG101.SP102.SubP102.N102]
- 10330 • Definition of the organization (e.g., sites or business areas) that will be covered by
10331 the assessment
- 10332 • Identification of the project and support functions that will represent the
10333 organization in the assessment
- 10334 • Processes or process areas that will be assessed
- 10335 3. Determine the method and criteria for process assessment.
10336 [PA152.IG101.SP102.SubP103]

10337 Process assessments can occur in many forms. Process assessments need to
10338 address the needs and objectives of the organization, which may change over
10339 time. For example, the assessment may be based on a process model, such as a
10340 CMMI model, or on a national or international standard, such as ISO 9001. The
10341 assessments may also be based on a benchmark comparison with other
10342 organizations. The assessment method may assume a variety of characteristics in
10343 terms of time and effort expended, makeup of the assessment team, and the
10344 method and depth of investigation, for example. [PA152.IG101.SP102.SubP103.N101]

10345 4. Plan, schedule, and prepare for the process assessment.
10346 [PA152.IG101.SP102.SubP104]

10347 5. Conduct the process assessment. [PA152.IG101.SP102.SubP105]

10348 6. Document the assessment activities and findings.
10349 [PA152.IG101.SP102.SubP106]

10350 **SP 1.3 Identify the Organization's Process Improvements**

10351 ***Identify improvements to the organization's processes and related***
10352 ***process assets.*** [PA152.IG101.SP103]

10353 **Typical Work Products**

10354 1. Analysis of candidate process improvements [PA152.IG101.SP103.W101]

10355 2. Identification of improvements for the organization's processes
10356 [PA152.IG101.SP103.W102]

10357 **Subpractices**

10358 1. Determine candidate process improvements. [PA152.IG101.SP103.SubP101]

10359 Candidate process improvements are typically determined by doing the following:
10360 [PA152.IG101.SP103.SubP101.N101]

- 10361 • Measure and analyze the processes
- 10362 • Review the processes for effectiveness and suitability
- 10363 • Review the lessons learned from tailoring the organization's set of standard
10364 processes
- 10365 • Review the lessons learned from implementing the processes
- 10366 • Review process improvement proposals submitted by the organization's
10367 managers and staff, and other stakeholders
- 10368 • Solicit inputs on process improvements from the senior management and leaders
10369 in the organization
- 10370 • Examine the results of process assessments and other process-related reviews
- 10371 • Review results of other organization improvement initiatives

10372 2. Prioritize the candidate process improvements. [PA152.IG101.SP103.SubP102]

10373 Criteria for prioritization are as follows: [PA152.IG101.SP103.SubP102.N101]

- 10374 • Consider the estimated cost and effort to implement the process improvements
- 10375 • Evaluate the expected improvement against the organization's improvement objectives and priorities
- 10376
- 10377 • Determine the potential barriers to the process improvements and strategies for overcoming these barriers
- 10378

10379 Examples of techniques to help determine and prioritize the possible improvements to be implemented include the following: [PA152.IG101.SP103.SubP102.N102]

- 10381 • A gap analysis looking at the current conditions in the organization versus the optimal conditions
- 10382
- 10383 • Force-field analysis of potential improvements to identify potential barriers and strategies for overcoming those barriers Cause/effect analyses to provide information on the potential effects of different improvements that can then be compared
- 10384
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10388 3. Identify and document the process improvements that will be implemented. [PA152.IG101.SP103.SubP103]

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10390 4. Revise the list of planned process improvements to keep it current.

10391 [PA152.IG101.SP103.SubP104]

10392 SG 2 Plan and Implement Process Improvement Activities [PA152.IG102]

10393 ***Improvements are planned and implemented, process assets are deployed, and process-related experiences are incorporated into the organization's process assets.***

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10395

10396 Successful implementation of improvements requires participation in the process definition and improvement activities by process owners, those performing the process, and support organizations. [PA152.IG102.N101]

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10399 SP 2.1 Establish Process Action Plans

10400 ***Establish and maintain process action plans to address improvements to the organization's processes and related process assets.*** [PA152.IG102.SP101]

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10403 Establishing and maintaining process action plans typically involves the following roles: [PA152.IG102.SP101.N101]

10404

- 10405 • Management steering committees to set strategies and oversee process improvement activities
- 10406
- 10407 • Process group staff to facilitate and manage the process improvement activities
- 10408
- 10409 • Process action teams to define and implement the improvement

- 10410
- Process owners to manage the deployment
- 10411
- Practitioners to perform the process
- 10412
- 10413
- This involvement helps to obtain buy-in on the process improvements and increases the likelihood of effective deployment. [PA152.IG102.SP101.N102]
- 10414
- 10415
- 10416
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- 10418
- Process action plans are detailed implementation plans. These plans differ from the Organization's Process Improvement Plan in that they are plans targeting specific improvements that have been defined to address weaknesses usually uncovered by assessments or evaluations. [PA152.IG102.SP101.N103]
- 10419
- Typical Work Products**
- 10420
1. Organization's approved process action plans [PA152.IG102.SP101.W101]
- 10421
- Subpractices**
- 10422
1. Identify strategies, approaches, and actions to address the identified process improvements. [PA152.IG102.SP101.SubP101]
- 10423
- 10424
- 10425
- New, unproven, and major changes are piloted before they are incorporated into normal practice. [PA152.IG102.SP101.SubP101.N101]
- 10426
2. Establish process action teams to implement the actions.
- 10427
- [PA152.IG102.SP101.SubP102]
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- 10430
- The teams and people performing the process improvement actions are called "process action teams." Process action teams typically include process owners and those who perform the process. [PA152.IG102.SP101.SubP102.N101]
- 10431
3. Document process action plans. [PA152.IG102.SP101.SubP103]
- 10432
- Process action plans typically cover the following: [PA152.IG102.SP101.SubP103.N101]
- 10433
- Process improvement infrastructure
- 10434
- Process improvement objectives
- 10435
- Process improvements that will be addressed
- 10436
- Procedures for planning and tracking process actions
- 10437
- Strategies for implementing the process actions
- 10438
- Responsibility and authority for implementing the process actions
- 10439
- Resources, schedules, and assignments for implementing the process actions
- 10440
- Methods for determining the effectiveness of the process actions
- 10441
- Risks associated with process action plans
- 10442
4. Review and negotiate process action plans with relevant stakeholders. [PA152.IG102.SP101.SubP104]
- 10443
- 10444
5. Review process action plans as necessary. [PA152.IG102.SP101.SubP105]

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SP 2.2 Implement Process Action Plans

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Implement process action plans across the organization.

10447

[PA152.IG102.SP102]

10448

Typical Work Products

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1. Commitments among the various process action teams

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[PA152.IG102.SP102.W101]

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2. Status and results of implementing process action plans

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[PA152.IG102.SP102.W102]

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3. Plans for pilots [PA152.IG102.SP102.W103]

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Subpractices

10455

1. Make process action plans readily available to relevant stakeholders. [PA152.IG102.SP102.SubP101]

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2. Negotiate and document commitments among the process action teams and revise their process action plans as necessary.

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[PA152.IG102.SP102.SubP102]

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3. Track progress and commitments against process action plans.

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[PA152.IG102.SP102.SubP103]

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4. Conduct joint reviews with the process action teams and others affected to monitor the progress and results of the process actions.

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[PA152.IG102.SP102.SubP104]

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5. Plan pilots needed to test selected process improvements.

10466

[PA152.IG102.SP102.SubP105]

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6. Review the activities and work products of process action teams.

10468

[PA152.IG102.SP102.SubP106]

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7. Identify, document, and track to closure issues in implementing process action plans. [PA152.IG102.SP102.SubP107]

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8. Ensure that the results of implementing process action plans satisfy the organization's process improvement objectives.

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10473

[PA152.IG102.SP102.SubP108]

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SP 2.3 Deploy Process and Related Process Assets

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

10476

10477 Deployment of a process and related process assets or of changes to
10478 an existing process and related process assets should be performed in
10479 an orderly manner. Some process assets or changes to process assets
10480 may not be appropriate for implementation in some parts of the
10481 organization (for example, because of customer requirements or the
10482 current life-cycle phase being implemented). It is therefore important
10483 that those that are or will be executing the process, as well as other
10484 organization functions (such as training and quality assurance) be
10485 involved in the deployment, as necessary. [PA152.IG102.SP103.N101]

10486 *Refer to the Organizational Process Definition process area for more*
10487 *information about how the deployment of process assets is supported*
10488 *and enabled by the existence of an Organizational Support*
10489 *Environment and an Organizational Process Asset Library .*
10490 [PA152.IG102.SP103.N101.R101]

10491 **Typical Work Products**

- 10492 1. Plans for deploying the process assets and changes to process
10493 assets [PA152.IG102.SP103.W101]
- 10494 2. Training materials for deploying the process assets and changes to
10495 process assets [PA152.IG102.SP103.W102]
- 10496 3. Documentation of changes to the process assets [PA152.IG102.SP103.W103]
- 10497 4. Support materials for deploying the process assets and changes to
10498 process assets [PA152.IG102.SP103.W104]

10499 **Subpractices**

- 10500 1. Deploy process assets and associated methods and tools.
10501 [PA152.IG102.SP103.SubP101]

10502 Typical activities performed as a part of this deployment include the following:
10503 [PA152.IG102.SP103.SubP101.N101]

- 10504 • Planning the deployment
- 10505 • Identifying the process assets that should be adopted by those who will be
10506 performing the process
- 10507 • Ensuring that training for the process assets that are being deployed is available
- 10508 • Identifying the support resources (e.g., tools) needed to transition the deployed
10509 process assets
- 10510 • Determining the schedule for deploying the process assets

10511 *Refer to the Organizational Training process area for more information*
10512 *about coordination of training.* [PA152.IG102.SP103.SubP101.N101.R101]

- 10513 2. Deploy the changes that were made to the process assets.
10514 [PA152.IG102.SP103.SubP102]

10515 Typical activities performed as a part of this deployment include the following:

10516 [PA152.IG102.SP103.SubP102.N101]

10517 • Planning the deployment

10518 • Determining which changes are appropriate for those that are or will be
10519 performing the process

10520 • Determining the time frame for deploying the changes

10521 • Arranging for the associated support needed to successfully transition the
10522 changes

10523 3. Document the changes to the process assets. [PA152.IG102.SP103.SubP103]

10524 The documentation of changes is used to understand the relationship of the
10525 changes to resulting changes in process performance and results.

10526 [PA152.IG102.SP103.SubP103.N101]

10527 4. Provide guidance and consultation on the use of the process
10528 assets. [PA152.IG102.SP103.SubP104]

10529 **SP 2.4 Incorporate Process-Related Experiences into the Organization's**
10530 **Process Assets**

10531 ***Incorporate process-related work products, measures, and***
10532 ***improvement information derived from planning and performing***
10533 ***the process into the organization's process assets.*** [PA152.IG102.SP104]

10534 **Typical Work Products**

10535 1. Process improvement proposals [PA152.IG102.SP104.W101]

10536 2. Process lessons learned [PA152.IG102.SP104.W102]

10537 3. Measurements on the organization process assets

10538 [PA152.IG102.SP104.W103]

10539 4. Improvement recommendations for the organization's process
10540 assets [PA152.IG102.SP104.W104]

10541 5. Records of the organization's process improvement activities

10542 [PA152.IG102.SP104.W105]

10543 6. Information on the organization's process assets and
10544 improvements to them [PA152.IG102.SP104.W106]

10545 **Subpractices**

10546 1. Conduct periodic reviews of the effectiveness and suitability of the
10547 organization's set of standard processes and related process
10548 assets that are relative to the organization's business objectives.

10549 [PA152.IG102.SP104.SubP101]

- 10550 2. Obtain feedback about the use of the process assets.
10551 [PA152.IG102.SP104.SubP102]
- 10552 3. Derive lessons learned from defining, piloting, implementing, and
10553 deploying the process assets. [PA152.IG102.SP104.SubP103]
- 10554 4. Make lessons learned available to the people in the organization as
10555 appropriate. [PA152.IG102.SP104.SubP104]

10556 Actions may have to be taken to ensure that lessons learned are used
10557 appropriately. [PA152.IG102.SP104.SubP104.N101]

10558 Examples of inappropriate use of lessons learned include the following:

10559 [PA152.IG102.SP104.SubP104.N102]

- 10560 • To evaluate the performance of people
10561 • To judge process performance or results

10562

10563 Examples of ways to prevent inappropriate use of lessons learned include the
10564 following: [PA152.IG102.SP104.SubP104.N103]

- 10565 • Controlling access to the lessons learned
10566 • Educating people about the appropriate use of lessons learned

10567

- 10568 5. Analyze the organization's common set of measures.

10569 [PA152.IG102.SP104.SubP105]

10570 *Refer to the Measurement and Analysis process area for more*
10571 *information about analyzing measures.* [PA152.IG102.SP104.SubP105.R101]

10572 *Refer to the Organizational Process Definition process area for more*
10573 *information about establishing an organizational measurement*
10574 *repository, including common measures* [PA152.IG102.SP104.SubP105.R102]

- 10575 6. Evaluate the processes, methods, and tools in use in the
10576 organization and develop recommendations for improving the
10577 organization's process assets. [PA152.IG102.SP104.SubP106]

10578 This evaluation typically includes the following: [PA152.IG102.SP104.SubP106.N101]

- 10579 • Determining which of the processes, methods, and tools are of potential use to
10580 other parts of the organization
- 10581 • Evaluating the quality and effectiveness of the organization's process assets
- 10582 • Identifying candidate improvements to the organization's process assets
- 10583 • Determining compliance with the organization's set of standard processes and
10584 tailoring guidelines

- 10585 7. Make the best use of the organization's processes, methods, and
10586 tools available to the people in the organization as appropriate.
10587 [PA152.IG102.SP104.SubP107]
- 10588 8. Manage process improvement proposals. [PA152.IG102.SP104.SubP108]
- 10589 The activities for managing process improvement proposals typically include the
10590 following: [PA152.IG102.SP104.SubP108.N101]
- 10591 • Soliciting process improvement proposals
 - 10592 • Collecting process improvement proposals
 - 10593 • Reviewing the process improvement proposals
 - 10594 • Selecting the process improvement proposals that will be implemented
 - 10595 • Tracking the implementation of the process improvement proposals
- 10596 Process improvement proposals are documented as process change requests or
10597 problem reports, as appropriate. [PA152.IG102.SP104.SubP108.N102]
- 10598 Some process improvement proposals may be incorporated into the
10599 organization's process action plans. [PA152.IG102.SP104.SubP108.N103]
- 10600 9. Establish and maintain records of the organization's process
10601 improvement activities. [PA152.IG102.SP104.SubP109]

10602 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

10603 ***The process is institutionalized as a defined process.***

10604 **Commitment to Perform**

10605 **GP 2.1 (CO 1) Establish an Organizational Policy**

10606 ***Establish and maintain an organizational policy for planning and***
10607 ***performing the organizational process focus process.*** [GP103]

10608 Elaboration:

10609 This policy establishes organizational expectations for determining
10610 process improvement opportunities of the processes being used, and
10611 planning and implementing process improvement activities across the
10612 organization. [PA152.EL101]

10613 Ability to Perform

10614 **GP 3.1 (AB 1) Establish a Defined Process**

10615 ***Establish and maintain the description of a defined organizational***
 10616 ***process focus process.*** [GP114]

10617 **GP 2.2 (AB 2) Plan the Process**

10618 ***Establish and maintain the requirements and objectives, and plans***
 10619 ***for performing the organizational process focus process.*** [GP104]

10620 Elaboration:

10621 These requirements, objectives, and plans are described in the
 10622 organization's plan for process improvement (Process Improvement
 10623 Plan). This plan for process improvement differs from the process
 10624 action plans described in the specific practices in this PA. The process
 10625 action plans address the tactical, short-term improvements for the
 10626 organization; whereas the plan for process improvement addresses the
 10627 overall process improvement strategy for the organization. [PA152.EL103]

10628 **GP 2.3 (AB 3) Provide Resources**

10629 ***Provide adequate resources for performing the organizational***
 10630 ***process focus process, developing the work products and***
 10631 ***providing the services of the process.*** [GP105]

10632 Elaboration:

10633 Examples of tools used in performing the activities of the Organizational
 10634 Process Focus process area include the following: [PA152.EL106]

- 10635 • Database management systems
- 10636 • Process improvement tools
- 10637 • Web page builders and browsers
- 10638 • Groupware
- 10639 • Quality improvement tools (e.g., quality improvement tools, cause-
 10640 and-effect diagrams, affinity diagrams, Pareto charts)

10641

10642 **GP 2.4 (AB 4) Assign Responsibility**

10643 ***Assign responsibility and authority for performing the process,***
10644 ***developing the work products, and providing the services of the***
10645 ***organizational process focus process.*** [GP106]

10646 Elaboration:

10647 Two groups are typically established and assigned responsibility for
10648 process improvement: (1) a management steering committee for
10649 process improvement to provide senior management sponsorship; and
10650 (2) a Process Group (e.g., the Engineering Process Group or EPG) to
10651 facilitate and manage the process improvement activities. [PA152.EL120]

10652 **GP 2.5 (AB 5) Train People**

10653 ***Train the people performing or supporting the organizational***
10654 ***process focus process as needed.*** [GP107]

10655 Elaboration:

10656 Examples of training topics include the following: [PA152.EL107]

- 10657 • CMMI and other process and process improvement reference
- 10658 models
- 10659 • Planning and managing process improvement
- 10660 • Tools, methods, and analysis techniques
- 10661 • Process modeling
- 10662 • Facilitation techniques
- 10663 • Change management

10664

10665 **Directing Implementation**

10666 **GP 2.6 (DI 1) Manage Configurations**

10667 ***Place designated work products of the organizational process***
10668 ***focus process under appropriate levels of configuration***
10669 ***management.*** [GP109]

10670 Elaboration:

10671 Examples of work products placed under configuration management
10672 include the following: [PA152.EL108]

- 10673 • Process improvement proposals
- 10674 • Organization's approved process action plans
- 10675 • Training materials for deploying process assets
- 10676 • Plans for the organization's process assessments

10677

10678 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

10679 ***Identify and involve the relevant stakeholders of the organizational***
10680 ***process focus process as planned.*** [GP124]

10681 Elaboration:

10682 Examples of activities for stakeholder involvement include: [PA152.EL119]

- 10683 • Coordinating and collaborating on process improvement activities
10684 with process owners, those that are or will be performing the
10685 process, and support organizations (e.g., training staff and quality
10686 assurance representatives)
- 10687 • Establishing the organizational process needs and objectives
- 10688 • Assessing the organization's processes
- 10689 • Implementing process action plans
- 10690 • Coordinating and collaborating on the execution of pilots to test
10691 selected improvements
- 10692 • Deploying process assets and changes to process assets
- 10693 • Communicating the plans, status, activities, and results related to
10694 the implementation of process improvement activities

10695

10696 **GP 2.8 (DI 3) Monitor and Control the Process**

10697 ***Monitor and control the organizational process focus process***
10698 ***against the plan and take appropriate corrective action.*** [GP110]

10699 Elaboration:

10700 Examples of measures used in monitoring and controlling the activities
10701 of the Organizational Process Focus process area include the following:
10702 [PA152.EL113]
10703 • Number of process improvement proposals submitted, accepted or
10704 implemented
10705 • CMMI maturity level or capability level
10706

10707 **GP 3.2 (DI 4) Collect Improvement Information**

10708 *Collect work products, measures, measurement results, and*
10709 *improvement information derived from planning and performing*
10710 *the organizational process focus process to support the future use*
10711 *and improvement of the organization's processes and process*
10712 *assets.* [GP117]

10713 Verifying Implementation

10714 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

10715 *Objectively evaluate adherence of the organizational process*
10716 *focus process and the work products and services of the process*
10717 *to the applicable requirements, objectives, and standards, and*
10718 *address noncompliance.* [GP113]

10719 Elaboration:

10720 Examples of activities reviewed include the following: [PA152.EL115]
10721 • Determining process improvement opportunities
10722 • Planning and coordinating process improvement activities
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10724 Examples of work products reviewed include the following: [PA152.EL118]
10725 • Process improvement plans
10726 • Process action plans
10727 • Plans for the organization's process assessments
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GP 2.10 (VE 2) Review Status with Higher-Level Management

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

Elaboration:

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]

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)

10744 ORGANIZATIONAL PROCESS DEFINITION

10745 Maturity Level 3

10746 Purpose

10747 The purpose of Organizational Process Definition is to establish and
10748 maintain a usable set of organizational process assets. [PA153]

10749 Introductory Notes

10750 These process assets include the organization's set of standard
10751 processes and supporting assets. These assets enable consistent
10752 process performance across the organization and provide a basis for
10753 cumulative, long-term benefits to the organization. [PA153.N101]

10754 The organization's process assets are artifacts that relate to describing,
10755 implementing, and improving processes (e.g., policies, process
10756 descriptions, and process implementation support tools). The term
10757 "process assets" is used to indicate that these artifacts are developed
10758 or acquired to meet the business objectives of the organization, and
10759 they represent investments by the organization that are expected to
10760 provide current and future business value. [PA153.N102]

10761 The organization's process asset library is a collection of items
10762 maintained by the organization, for use by the people in the
10763 organization in developing, tailoring, maintaining, implementing,
10764 managing, and improving their processes. These process assets
10765 include descriptions of processes and process elements, descriptions of
10766 life-cycle models, process tailoring guidelines, process-related
10767 documentation, and data. These process assets support organizational
10768 learning and process improvement by allowing the sharing of "best
10769 practices" process assets, and lessons learned across the organization.
10770 [PA153.N103]

10771 The organization's set of standard processes is tailored by projects to
10772 create their defined processes. The other process assets are used to
10773 support tailoring as well as the implementation of the defined
10774 processes. [PA153.N104]

10775 A standard process is composed of other processes or process
 10776 elements. A process element is the fundamental (e.g., atomic) unit of
 10777 process definition and describes the activities and tasks to consistently
 10778 perform work. Process architecture provides rules for connecting the
 10779 process elements of a standard process. The organization's set of
 10780 standard processes may include multiple process architectures and
 10781 standard processes. [PA153.N105]

10782 The organization's process assets may be organized in many ways,
 10783 depending on the implementation of the Organizational Process
 10784 Definition process area. Examples include the following: [PA153.N106]

- 10785 • Descriptions of life-cycle models may be documented as part of the
 10786 organization's set of standard processes or they may be
 10787 documented separately.
- 10788 • The organization's set of standard processes may be stored in the
 10789 organization's library of process-related assets or they may be
 10790 stored separately.
- 10791 • A single repository may contain both the measurements and the
 10792 process-related documentation, or they may be stored separately.

10794 **Related Process Areas**

10795 *Refer to the Organizational Process Focus process area for more*
 10796 *information about organizational process-related matters.* [PA153.R101]

10797 **Specific and Generic Goals**

10798 **SG 1 Create Organizational Process Assets** [PA153.IG101]

10799 ***A set of organizational process assets is available.***

10800 **SG 2 Make Supporting Process Assets Available** [PA153.IG102]

10801 ***Process assets that support the use of the organization's set of standard***
 10802 ***processes are available.***

10803 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

10804 ***The process is institutionalized as a defined process.***

10805 Practice to Goal Relationship Table

10806	SG 1 Create Organizational Process Assets [PA153.IG101]		
10807	SP 1.1		Establish Standard Processes
10808	SP 1.2		Establish Life-Cycle Model Descriptions
10809	SP 1.3		Establish Tailoring Criteria and Guidelines
10810	SG 2 Make Supporting Process Assets Available [PA153.IG102]		
10811	SP 2.1		Establish an Organizational Measurement Repository
10812	SP 2.2		Establish an Organizational Process Asset Library
10813	GG 3 Institutionalize a Defined Process		
10814	GP 2.1	(CO 1)	Establish an Organizational Policy
10815	GP 3.1	(AB 1)	Establish a Defined Process
10816	GP 2.2	(AB 2)	Plan the Process
10817	GP 2.3	(AB 3)	Provide Resources
10818	GP 2.4	(AB 4)	Assign Responsibility
10819	GP 2.5	(AB 5)	Train People
10820	GP 2.6	(DI 1)	Manage Configurations
10821	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
10822	GP 2.8	(DI 3)	Monitor and Control the Process
10823	GP 3.2	(DI 4)	Collect Improvement Information
10824	GP 2.9	(VE 1)	Objectively Evaluate Adherence
10825	GP 2.10	(VE 2)	Review Status with Higher-Level Management

10826 Specific Practices by Goal

10827 **SG 1 Create Organizational Process Assets** [PA153.IG101]

10828 ***A set of organizational process assets is available.***

10829 *For Integrated Product and Process Development*

10830 *Integrated processes that emphasize parallel, rather than*

10831 *serial development, are a cornerstone of IPPD implementation.*

10832 *Product development processes and product-related process-*

10833 *development processes, such as the manufacturing process*

10834 *development and the support process development*

10835 *processes, are conducted concurrently. Such integrated*

10836 *processes need to accommodate the information provided by*

10837 *stakeholders representing all phases of the product life cycle*

10838 *from both business and technical functions. Processes for*

10839 *effective teamwork are also needed.* [PA153.IG101.AMP101]

10840 **SP 1.1 Establish Standard Processes**

10841 ***Establish and maintain the organization's set of standard***

10842 ***processes.*** [PA153.IG101.SP101]

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For Integrated Product and Process Development

In an IPPD environment, the organization's shared vision is included in the organization's process assets.

[PA153.IG101.SP101.AMP101]

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

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

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

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Typical Work Products

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

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Subpractices

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

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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]

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

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- Template for generating work product size estimates

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- Description of work product design methodology

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- Tailorable peer review methodology

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- Template for conduct of management reviews

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2. Specify the critical attributes of each process element.

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[PA153.IG101.SP101.SubP102]

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

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- Process roles

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- Applicable process and product standards

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- Applicable procedures, methods, tools, and resources

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- Process performance objectives

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- Entry criteria

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- Inputs

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- Product and process measures to be collected and used

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- Verification points (e.g., peer reviews)

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- Outputs

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- Interfaces

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- Exit criteria

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3. Specify the relationships of the process elements.

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[PA153.IG101.SP101.SubP103]

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

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- Ordering of the process elements

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- Interfaces among the process elements

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- Interfaces with external processes

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- Interdependencies among the process elements

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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.

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[PA153.IG101.SP101.SubP103.N102]

10917 4. Ensure that the organization's set of standard processes adhere to
10918 the applicable policies, process standards, and product standards.

10919 [PA153.IG101.SP101.SubP104]

10920 Examples of requirements include the following: [PA153.IG101.SP101.SubP104.N101]

- 10921
- 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
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10930 5. Ensure that the organization's set of standard processes satisfy the
10931 process needs and objectives of the organization.

10932 [PA153.IG101.SP101.SubP105]

10933 *Refer to the Organizational Process Focus process area for more*
10934 *information about establishing and maintaining the organization's*
10935 *process needs and objectives.* [PA153.IG101.SP101.SubP105.R101]

10936 6. Ensure that each of the organization's set of standard processes
10937 integrate appropriately with other standard processes.

10938 [PA153.IG101.SP101.SubP106]

10939 7. Document the organization's set of standard processes.

10940 [PA153.IG101.SP101.SubP107]

10941 8. Conduct peer reviews on the organization's set of standard
10942 processes. [PA153.IG101.SP101.SubP108]

10943 *Refer to the Verification process area for more information about peer*
10944 *review.* [PA153.IG101.SP101.SubP108.R101]

10945 9. Revise the organization's set of standard processes as necessary.

10946 [PA153.IG101.SP101.SubP109]

10947 **SP 1.2 Establish Life-Cycle Model Descriptions**

10948 ***Establish and maintain descriptions of the life-cycle process***
10949 ***models approved for use in the organization.*** [PA153.IG101.SP102]

10950 Life-cycle models may be developed for a variety of customers or in a
10951 variety of situations, since one life-cycle model may not be appropriate
10952 for all situations. The organization may identify more than one life-cycle
10953 model for use. [PA153.IG101.SP102.N101]

10954 Life cycle models partition the product life cycle into phases for which
10955 activities and requirements can be defined to promote a complete
10956 solution from initiating development of the product to its ultimate
10957 disposal. These help guide projects through the major steps of
10958 identifying customer needs; planning; defining and designing the
10959 products and services; developing the products; verifying; validating;
10960 providing the products and services; and installing, operating,
10961 supporting and retiring the product. [PA153.IG101.SP102.N102]

10962 **Typical Work Products**

10963 1. Descriptions of life-cycle models [PA153.IG101.SP102.W101]

10964 **Subpractices**

10965 1. Select life-cycle models based on the process-related needs of the
10966 project and the needs of the organization. [PA153.IG101.SP102.SubP101]

10967 Examples of development life-cycle models include the following:

10968 [PA153.IG101.SP102.SubP101.N101]

- 10969 • Waterfall
- 10970 • Spiral
- 10971 • Evolutionary
- 10972 • Incremental
- 10973 • Iterative

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10975 Examples of project characteristics that could affect the life-cycle models include
10976 the following: [PA153.IG101.SP102.SubP101.N102]

- 10977 • Size of the project
- 10978 • Experience and familiarity of project staff in implementing the process
- 10979 • Developmental constraints such as cycle time and acceptable defect levels

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10981 2. Document the descriptions of the life-cycle models.

10982 [PA153.IG101.SP102.SubP102]

10983 The life-cycle models may be documented as part of the organization's standard
10984 process descriptions or they may be documented separately.

10985 [PA153.IG101.SP102.SubP102.N101]

10986 3. Conduct peer reviews on the life-cycle models. [PA153.IG101.SP102.SubP103]

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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]

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SP 1.3 Establish Tailoring Criteria and Guidelines

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

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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]

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The tailoring criteria and guidelines describe the following:

[PA153.IG101.SP103.N101]

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

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Examples of reasons for tailoring include the following:

[PA153.IG101.SP103.N102]

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- 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

11024 Flexibility in tailoring and defining processes is balanced with ensuring
11025 appropriate consistency in the processes across the organization.
11026 Flexibility is needed to address contextual variables such as the
11027 domain; nature of the customer; cost, schedule, and quality tradeoffs;
11028 technical difficulty of the work; and experience of the people
11029 implementing the process. Consistency across the organization is
11030 needed so that organizational standards, objectives, and strategies are
11031 appropriately addressed, and process data and lessons learned can be
11032 shared. [PA153.IG101.SP103.N103]

11033 For processes performed at the organizational level, the standard
11034 process may be the defined process, so tailoring may not be needed.
11035 [PA153.IG101.SP103.N104]

11036 **Typical Work Products**

- 11037 1. Tailoring guidelines for the organization's set of standard
11038 processes [PA153.IG101.SP103.W101]

11039 **Subpractices**

- 11040 1. Specify the selection criteria and procedures for tailoring the
11041 organization's set of standard processes. [PA153.IG101.SP103.SubP101]

11042 Examples of criteria and procedures include the following: [PA153.IG101.SP103.SubP101.N101]

- 11043 • Criteria for selecting life-cycle models from those approved by the organization
11044 • Criteria for selecting process elements from the organization's set of standard
11045 processes
11046 • Procedures for tailoring the selected life-cycle models and process elements to
11047 accommodate the specific process characteristics and needs

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11049 Examples of tailoring actions include: [PA153.IG101.SP103.SubP101.N102]

- 11050 • Modifying a life-cycle model
11051 • Combining elements of different life-cycle models
11052 • Modifying process elements
11053 • Replacing process elements
11054 • Reordering process elements

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- 11056 2. Specify the standards for documenting the defined processes.
11057 [PA153.IG101.SP103.SubP102]

- 11058 3. Specify the procedures for submitting and obtaining approval of
11059 waivers from the requirements of the organization's set of standard
11060 processes. [PA153.IG101.SP103.SubP103]

- 11061 4. Document the tailoring guidelines for the organization's set of
11062 standard processes. [PA153.IG101.SP103.SubP104]

- 11063 5. Conduct peer reviews on the tailoring guidelines.
11064 [PA153.IG101.SP103.SubP105]
- 11065 *Refer to the Verification process area for more information about*
11066 *conducting peer reviews.* [PA153.IG101.SP103.SubP105.R101]
- 11067 6. Revise the tailoring guidelines as necessary. [PA153.IG101.SP103.SubP106]

11068 **SG 2 Make Supporting Process Assets Available** [PA153.IG102]

11069 ***Process assets that support the use of the organization's set of standard***
11070 ***processes are available.***

11071 **SP 2.1 Establish an Organizational Measurement Repository**

11072 ***Establish and maintain an organizational measurement repository***
11073 ***[PA153.IG102.SP101]***

11074 The repository contains both product and process measures that are
11075 related to the organization's set of standard processes. It also contains
11076 or refers to the information needed to understand and interpret the
11077 measures and assess them for reasonableness and applicability. For
11078 example, the definitions of the measures are used to compare similar
11079 measures from different processes. [PA153.IG102.SP101.N101]

11080 **Typical Work Products**

- 11081 1. Definition of the common set of product and process measures for
11082 the organization's set of standard processes [PA153.IG102.SP101.W101]
- 11083 2. Organization's measurement repository (i.e., the repository
11084 structure and support environment) [PA153.IG102.SP101.W102]
- 11085 3. Organizational measurement data [PA153.IG102.SP101.W103]

11086 **Subpractices**

- 11087 1. Determine the organization's needs for storing, retrieving, and
11088 analyzing measurements. [PA153.IG102.SP101.SubP101]
- 11089 2. Define a common set of process and product measures for the
11090 organization's set of standard processes. [PA153.IG102.SP101.SubP102]

11091 The measures in the common set are selected based on the organization's set of
11092 standard processes. The common set of measures may vary for different standard
11093 processes. [PA153.IG102.SP101.SubP102.N101]

11094 Operational definitions for the measures specify the point in the process where
11095 the data will be collected and the procedures for collecting valid data.
11096 [PA153.IG102.SP101.SubP102.N102]

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Examples of classes of commonly used measures include the following:

[PA153.IG102.SP101.SubP102.N103]

- Estimates of work product size (e.g., pages)
- Estimates of effort and cost (e.g., person hours)
- Actual measures of size, effort, and cost
- Quality measures (e.g., number of defects found, severity of defects)
- Peer review coverage
- Test or verification coverage
- Reliability measures (e.g., mean time to failure)

Refer to the Measurement and Analysis process area for more information about defining measures [PA153.IG102.SP101.SubP102.N103.R101]

3. Design and implement the measurement repository.

[PA153.IG102.SP101.SubP103]

4. Specify the procedures for storing, updating, and retrieving.

[PA153.IG102.SP101.SubP104]

5. Conduct peer reviews on the definitions of the common set of measures and the procedures for storing and retrieving measures.

[PA153.IG102.SP101.SubP105]

Refer to the Verification process area for more information about conducting peer reviews. [PA153.IG102.SP101.SubP105.R101]

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]

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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

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SP 2.2 Establish an Organizational Process Asset Library

Establish and maintain the organization's library of process-related assets. [PA153.IG102.SP102]

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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

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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]

2. Best examples of process-related documentation items

[PA153.IG102.SP102.W102]

3. Catalog of process documentation items [PA153.IG102.SP102.W103]

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Subpractices

1. Design and implement the library of process assets, including the library structure and support environment. [PA153.IG102.SP102.SubP101]

2. Specify the criteria for including documentation items in the library.

[PA153.IG102.SP102.SubP102]

- 11161 The documentation items are selected based primarily on their relationship to the
11162 organization's set of standard processes. [PA153.IG102.SP102.SubP102.N101]
- 11163 3. Specify the procedures for storing and retrieving documentation
11164 items. [PA153.IG102.SP102.SubP103]
- 11165 4. Enter the selected documentation items into the library and catalog
11166 them for easy reference and retrieval. [PA153.IG102.SP102.SubP104]
- 11167 5. Make the documentation items available for use by the projects.
11168 [PA153.IG102.SP102.SubP105]
- 11169 6. Periodically review the use of each documentation item and use
11170 the results to maintain the library contents. [PA153.IG102.SP102.SubP106]
- 11171 7. Revise the library of process-related assets as necessary.
11172 [PA153.IG102.SP102.SubP107]

The following are examples of when the library may need to be revised:

[PA153.IG102.SP102.SubP107.N101]

- New process assets are added
- Process assets are retired
- Current versions of documentation items are changed

11179 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

11180 ***The process is institutionalized as a defined process.***

11181 Commitment to Perform

11182 **GP 2.1 (CO 1) Establish an Organizational Policy**

11183 ***Establish and maintain an organizational policy for planning and***
11184 ***performing the organizational process definition process.*** [GP103]

11185 Elaboration:

11186 This policy establishes organizational expectations for establishing and
11187 maintaining a set of standard processes for use by the organization and
11188 making process assets available across the organization. [PA153.EL101]

11189 Ability to Perform

11190 **GP 3.1 (AB 1) Establish a Defined Process**

11191 *Establish and maintain the description of a defined organizational*
11192 *process definition process.* [GP114]

11193 **GP 2.2 (AB 2) Plan the Process**

11194 *Establish and maintain the requirements and objectives, and plans*
11195 *for performing the organizational process definition process.* [GP104]

11196 Elaboration:

11197 These requirements, objectives, and plans are typically described in the
11198 organization's plan for process improvement. [PA153.EL102]

11199 **GP 2.3 (AB 3) Provide Resources**

11200 *Provide adequate resources for performing the organizational*
11201 *process definition process, developing the work products and*
11202 *providing the services of the process.* [GP105]

11203 Elaboration:

11204 A process group (e.g., an engineering process group or EPG) typically
11205 manages the organizational process definition activities. This group is
11206 typically staffed by a core of engineering professionals whose primary
11207 responsibility is coordinating organizational process improvement. This
11208 group is supported by process owners and people with expertise in
11209 various disciplines such as the following: [PA153.EL108]

- 11210 • Project management
- 11211 • The appropriate engineering disciplines
- 11212 • Configuration management
- 11213 • Quality assurance

11214 Examples of tools used in performing the activities of the Organizational
11215 Process Definition process area include the following: [PA153.EL106]

- 11216 • Database management systems
- 11217 • Process modeling tools
- 11218 • Web page builders and browsers

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11220 **GP 2.4 (AB 4) Assign Responsibility**

11221 ***Assign responsibility and authority for performing the process,***
11222 ***developing the work products, and providing the services of the***
11223 ***organizational process definition process.*** [GP106]

11224 **GP 2.5 (AB 5) Train People**

11225 ***Train the people performing or supporting the organizational***
11226 ***process definition process as needed.*** [GP107]

11227 Elaboration:

11228 Examples of training topics include the following: [PA153.EL107]

- 11229 • CMMI and other process and process improvement reference
- 11230 models
- 11231 • Planning, managing, and monitoring processes
- 11232 • Process modeling and definition
- 11233 • Developing a tailorable standard process

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11235 **Directing Implementation**

11236 **GP 2.6 (DI 1) Manage Configurations**

11237 ***Place designated work products of the organizational process***
11238 ***definition process under appropriate levels of configuration***
11239 ***management.*** [GP109]

11240 Elaboration:

11241 Examples of work products placed under configuration management
11242 include the following: [PA153.EL103]

- 11243 • Organization's set of standard processes
- 11244 • Descriptions of the life-cycle models
- 11245 • Tailoring guidelines for the organization's set of standard
- 11246 processes
- 11247 • Definitions of the common set of product and process measures
- 11248 • Organizational measurement data

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GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders

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

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Elaboration:

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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

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GP 2.8 (DI 3) 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]

- 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 3.2 (DI 4) Collect Improvement Information

Collect work products, measures, measurement results, and improvement information derived from planning and performing the organizational process definition process to support the future use and improvement of the organization's processes and process assets. [GP117]

11279 Verifying Implementation

11280 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

11281 ***Objectively evaluate adherence of the organizational process***
11282 ***definition process and the work products and services of the***
11283 ***process to the applicable requirements, objectives, and standards,***
11284 ***and address noncompliance.*** [GP113]

11285 Elaboration:

11286 Examples of activities reviewed include the following: [PA153.EL105]

- 11287 • Creating organizational process assets
- 11288 • Making supporting process assets available

11289

11290 Examples of work products reviewed include the following: [PA153.EL110]

- 11291 • Organization's set of standard processes
- 11292 • Descriptions of the life-cycle models
- 11293 • Tailoring guidelines for the organization's set of standard
- 11294 processes
- 11295 • Organizational Measurement data

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11297 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

11298 ***Review the activities, status, and results of the organizational***
11299 ***process definition process with higher-level management and***
11300 ***resolve issues.*** [GP112]

11301 ORGANIZATIONAL TRAINING

11302 Maturity Level 3

11303 Purpose

11304 The purpose of Organizational Training is to develop the skills and
11305 knowledge of people so they can perform their roles effectively and
11306 efficiently. [PA158]

11307 Introductory Notes

11308 Organizational Training includes training to support both the
11309 organization's strategic business objectives and the tactical training
11310 needs that are common across projects and support groups. Specific
11311 training needs identified by individual projects and support groups are
11312 handled at the project and support group level and are outside the
11313 scope of Organizational Training. Project and support groups are
11314 responsible for identifying and addressing their specific training needs.
11315 [PA158.N101]

11316 *Refer to the Project Planning process area for more information about*
11317 *the specific training needs identified by projects.* [PA158.N101.R101]

11318 An organizational training program involves the following: [PA158.N102]

- 11319 • Identifying the training needed by the organization
- 11320 • Obtaining and providing training to address those needs
- 11321 • Establishing and maintaining training capability
- 11322 • Establishing and maintaining training records
- 11323 • Assessing training effectiveness

11324 Effective training requires assessment of needs, planning, instructional
11325 design, and appropriate training media (e.g., workbooks, computer
11326 software, etc.), as well as a repository of training process data. As an
11327 organizational process, the main components of training include a
11328 managed training development program, documented plans, personnel
11329 with appropriate mastery of specific disciplines and other areas of
11330 knowledge, and mechanisms for measuring the effectiveness of the
11331 training program. [PA158.N103]

11332 The identification of process training needs is primarily based on the
11333 skills that are required to perform the organization's set of standard
11334 processes. [PA158.N104]

11335 *Refer to the Organizational Process Definition process area for more*
11336 *information about the organization's set of standard processes.*

11337 [PA158.N104.R101]

11338 Certain skills may be effectively and efficiently imparted through
11339 vehicles other than in-class training experiences, (e.g., informal
11340 mentoring). Other skills require more formalized training vehicles, such
11341 as in a classroom, by Web-based training, guided self-study, or a
11342 formalized on-the-job training program. The formal or informal training
11343 vehicles employed for each situation should be based on an
11344 assessment of the need for training and the performance gap to be
11345 addressed. The term "training" used throughout this process area is
11346 used broadly to include all of these learning options. [PA158.N105]

11347 Success in training can be measured in terms of the availability of
11348 opportunities to acquire knowledge and skill needed to perform new and
11349 ongoing enterprise activities. [PA158.N106]

11350 Skills and knowledge may be technical, organizational, or contextual.
11351 Technical skills pertain to the ability to use the equipment, tools,
11352 materials, data, and processes required by a project or process.
11353 Organizational skills pertain to behavior within and according to the
11354 employee's organization structure, role and responsibilities, and general
11355 operating principles and methods. Contextual skills are the self-
11356 management, communication, and interpersonal abilities needed to
11357 successfully perform in the organizational and social context of the
11358 project and support groups. [PA158.N107]

11359 The phrase "projects and support groups" is used frequently in the text
11360 of the process area description to indicate an organization-level
11361 perspective. [PA158.N108]

11362 Related Process Areas

11363 *Refer to the Organizational Process Definition process area for more*
11364 *information about the organization's process assets.* [PA158.R101]

11365 *Refer to the Project Planning process area for more information about*
11366 *the specific training needs identified by projects.* [PA158.R102]

11367 *Refer to the Decision Analysis and Resolution process area for how to*
11368 *apply decision-making criteria when determining training approaches.*

11369 [PA158.R103]

11370 Specific and Generic Goals

11371 **SG 1 Identify Training Needs and Make Training Available** [PA158.IG101]

11372 *Training to support the organization's management and technical roles is*
11373 *identified and made available.*

11374 **SG 2 Provide Necessary Training** [PA158.IG102]

11375 *Training necessary for individuals to perform their roles effectively is*
11376 *provided.*

11377 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

11378 *The process is institutionalized as a defined process.*

11379 Practice to Goal Relationship Table

11380	SG 1 Identify Training Needs and Make Training Available [PA158.IG101]		
11381	SP 1.1		Establish the Strategic Training needs
11382	SP 1.2		Determine Which Training Needs Are the Responsibility of the Organization
11383			
11384	SP 1.3		Establish Organizational Training Tactical Plan
11385	SP 1.4		Establish Training Capability
11386	SG 2 Provide Necessary Training [PA158.IG102]		
11387	SP 2.1		Deliver Training
11388	SP 2.2		Establish Training Records
11389	SP 2.3		Assess Training Effectiveness
11390	GG 3 Institutionalize a Defined Process		
11391	GP 2.1	(CO 1)	Establish an Organizational Policy
11392	GP 3.1	(AB 1)	Establish a Defined Process
11393	GP 2.2	(AB 2)	Plan the Process
11394	GP 2.3	(AB 3)	Provide Resources
11395	GP 2.4	(AB 4)	Assign Responsibility
11396	GP 2.5	(AB 5)	Train People
11397	GP 2.6	(DI 1)	Manage Configurations
11398	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
11399	GP 2.8	(DI 3)	Monitor and Control the Process
11400	GP 3.2	(DI 4)	Collect Improvement Information
11401	GP 2.9	(VE 1)	Objectively Evaluate Adherence
11402	GP 2.10	(VE 2)	Review Status with Higher-Level Management

11403 Specific Practices by Goal

11404 **SG 1 Identify Training Needs and Make Training Available** [PA158.IG101]

11405 ***Training to support the organization's management and technical roles is identified and made available.***

11406

11407 The organization identifies the training required to develop the skills and knowledge necessary to perform enterprise activities. Once the needs are identified, a training program addressing those needs is developed.

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[PA158.IG101.N101]

For Integrated Product and Process Development

11412 *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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11422 **SP 1.1 Establish the Strategic Training needs**

11423 ***Establish and maintain the strategic training needs of the***
11424 ***organization.*** [PA158.IG101.SP101]

11425 Examples of sources of strategic training needs include the following:

11426 [PA158.IG101.SP101.N101]

- 11427 • Organization's standard processes
- 11428 • Organization's strategic business plan
- 11429 • Organization's process improvement plan
- 11430 • Company-level initiatives and standards
- 11431 • Skill appraisals
- 11432 • Risk analyses

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11434 **Typical Work Products**

- 11435 1. Training needs [PA158.IG101.SP101.W101]
- 11436 2. Assessment analysis [PA158.IG101.SP101.W102]

11437 **Subpractices**

- 11438 1. Analyze the organization's strategic business objectives and
11439 process improvement plan to identify potential future training
11440 needs. [PA158.IG101.SP101.SubP101]
- 11441 2. Document the strategic training needs of the organization.

11442 [PA158.IG101.SP101.SubP102]

11443 Examples of categories of training needs include (but are not limited to) the
11444 following: [PA158.IG101.SP101.SubP102.N101]

- 11445 • Process analysis and documentation
- 11446 • Engineering (e.g., requirements analysis, design, testing, configuration
11447 management, and quality assurance)
- 11448 • Selection and management of suppliers
- 11449 • Management (e.g., estimating, tracking, and risk management)

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- 11451 3. Determine the roles and skills needed to perform the organization's
11452 set of standard processes. [PA158.IG101.SP101.SubP103]
- 11453 4. Document the required training needed to perform the roles in the
11454 organization's set of standard processes. [PA158.IG101.SP101.SubP104]
- 11455 5. Revise the organization's strategic needs and required training as
11456 necessary. [PA158.IG101.SP101.SubP105]

SP 1.2 **Determine Which Training Needs Are the Responsibility of the Organization**

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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]

Analysis of project and support group needs is intended to identify common training needs that can be most efficiently addressed organization-wide. These needs analysis activities are used to anticipate future training needs that are first visible at the project and support group level. [PA158.IG101.SP102.SubP101.N101]

2. Negotiate with the various projects and support groups on how their specific training needs will be satisfied. [PA158.IG101.SP102.SubP102]

The support provided by the organization's training staff depends on the training resources available and the organization's training priorities.

[PA158.IG101.SP102.SubP102.N101]

Examples of training appropriately performed by the project or support group include the following: [PA158.IG101.SP102.SubP102.N102]

- Training in the application domain of the project
- Training in the unique tools and methods used by the project or support group

- 11495 3. Document the commitments for providing training support to the
11496 projects and support groups. [PA158.IG101.SP102.SubP103]

11497 **SP 1.3 Establish Organizational Training Tactical Plan**

11498 ***Establish and maintain an organizational training tactical plan.***

11499 [PA158.IG101.SP103]

11500 The Organizational Training Tactical Plan is a periodic, tactical plan for
11501 delivering training and assessing its effectiveness. [PA158.IG101.SP103.N101]

11502 **Typical Work Products**

- 11503 1. Organizational Training Tactical Plan [PA158.IG101.SP103.W101]

11504 **Subpractices**

- 11505 1. Establish plan content [PA158.IG101.SP103.SubP101]

11506 Organizational Training Tactical Plans typically contain the following:

11507 [PA158.IG101.SP103.SubP101.N101]

- 11508 • Training needs
- 11509 • Training topics
- 11510 • Schedules based on training activities and their dependencies
- 11511 • Methods used for training
- 11512 • Requirements and Quality standards for training materials
- 11513 • Training tasks, roles, and responsibilities
- 11514 • Required resources including tools, facilities, environments, staffing, skill and
- 11515 knowledge

- 11516 2. Establish commitments to the plan. [PA158.IG101.SP103.SubP102]

11517 Documented commitments by those responsible for implementing and supporting
11518 the plan are essential for the plan to be effective. [PA158.IG101.SP103.SubP102.N101]

- 11519 3. Revise plan and commitments as necessary. [PA158.IG101.SP103.SubP103]

11520 **SP 1.4 Establish Training Capability**

11521 ***Establish and maintain training capability to address***
11522 ***organizational training needs.*** [PA158.IG101.SP104]

11523 *Refer to the Decision Analysis and Resolution process area for how to*
11524 *apply decision-making criteria when selecting training approaches and*
11525 *developing training materials.* [PA158.IG101.SP104.R101]

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Typical Work Products

1. Training materials and supporting artifacts [PA158.IG101.SP104.W101]

Subpractices

1. Select the appropriate approaches to satisfy specific organizational training needs. [PA158.IG101.SP104.SubP101]

Many factors may affect the selection of training approaches, including audience-specific knowledge, costs and schedule, work environment and so on. Selection of an approach requires consideration of the means to providing skills and knowledge in the most effective way possible given the constraints.

[PA158.IG101.SP104.SubP101.N101]

Examples of training approaches include the following: [PA158.IG101.SP104.SubP101.N102]

- Classroom training
- Computer-aided instruction
- Guided self-study
- Formal apprenticeship and mentoring programs
- Facilitated videos
- Chalk talks
- Brown-bag lunch seminars
- Structured on-the-job training

2. Determine whether to develop training materials internally or acquire them externally. [PA158.IG101.SP104.SubP102]

Determine the costs and benefits of internal training development or of obtaining training externally. [PA158.IG101.SP104.SubP102.N101]

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

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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]

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]

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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.)

11600 **SG 2 Provide Necessary Training** [PA158.IG102]

11601 ***Training necessary for individuals to perform their roles effectively is***
11602 ***provided.***

11603 In selecting people to be trained, the following considerations need to
11604 be made: [PA158.IG102.N101]

- 11605 • Background of the target population of training participants
- 11606 • Prerequisite background to receive training
- 11607 • Skills and abilities needed by people to perform their roles
- 11608 • Need for cross-discipline technical management training to all
11609 disciplines, including project management
- 11610 • Need for managers to have training in appropriate organizational
11611 processes
- 11612 • Need for training in the basic principles of discipline-specific
11613 engineering to support personnel in quality management,
11614 configuration management, and other related support functions
- 11615 • Need to provide competency development for critical functional
11616 areas

11617 **SP 2.1 Deliver Training**

11618 ***Deliver the training following an organizational training plan.***
11619 [PA158.IG102.SP101]

11620 **Typical Work Products**

- 11621 1. Delivered training course [PA158.IG102.SP101.W101]

11622 **Subpractices**

- 11623 1. Select the people who will receive the training. [PA158.IG102.SP101.SubP101]

11624 Training is intended to impart knowledge and skills to people performing various
11625 roles within the organization. Some people already possess the knowledge and
11626 skills required to perform well in their designated roles. Training can be waived for
11627 these people, but care should be taken that training waivers are not abused.

11628 [PA158.IG102.SP101.SubP101.N101]

11629 2. Schedule the training, including any resources as necessary (e.g.,
11630 facilities, instructors, etc.). [PA158.IG102.SP101.SubP102]

11631 Training should be planned and scheduled. Training is provided that has a direct
11632 bearing on the expectations of work performance. Therefore, optimal training
11633 occurs in a timely manner with regards to imminent job-performance expectations.
11634 These expectations often include the following: [PA158.IG102.SP101.SubP102.N101]

- 11635 • Training in the use of specialized tools
- 11636 • Training in procedures that are new to the individual who will perform them

11637 3. Conduct the training. [PA158.IG102.SP101.SubP103]

11638 Experienced instructors should perform training. When possible, training is
11639 conducted in settings that closely resemble actual performance conditions and
11640 includes activities to simulate actual work situations. This approach includes
11641 integration of tools, methods, and procedures for competency development.
11642 Training is tied to work responsibilities so that on-the-job activities or other outside
11643 experiences will reinforce the training within a reasonable time after the training.

11644 [PA158.IG102.SP101.SubP103.N101]

11645 4. Track the delivery of training against the plan. [PA158.IG102.SP101.SubP104]

11646 SP 2.2 Establish Training Records

11647 ***Establish and maintain records of the organizational training.***

11648 [PA158.IG102.SP102]

11649 *Refer to the Project Monitoring and Control process area for information*
11650 *on how project or support group training records are maintained.*

11651 [PA158.IG102.SP102.R101]

11652 The scope of this practice is for the training performed at the
11653 organizational level. Establishment and maintenance of training records
11654 for project or support group-sponsored training is the responsibility of
11655 each individual project or support group. [PA158.IG102.SP102.N101]

11656 **Typical Work Products**

- 11657 1. Training records [PA158.IG102.SP102.W101]
- 11658 2. Training updates to the organizational repository [PA158.IG102.SP102.W102]

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Subpractices

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1. Keep records of all students who successfully complete each training course or other approved training activity as well as those who are unsuccessful. [PA158.IG102.SP102.SubP101]

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2. Keep records of all staff who have been waived from specific training. [PA158.IG102.SP102.SubP102]

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The rationale for granting a waiver should be documented, and the manager responsible should approve the waiver for organizational training as well as by the manager of the excepted individual. [PA158.IG102.SP102.SubP102.N101]

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3. Keep records of all students who successfully complete their designated required training. [PA158.IG102.SP102.SubP103]

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4. Make training records available to the appropriate people for consideration in assignments. [PA158.IG102.SP102.SubP104]

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Training records may be part of a skills matrix developed by the training organization to provide a summary of the experience and education of people, as well as training sponsored by the organization. [PA158.IG102.SP102.SubP104.N101]

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SP 2.3 Assess Training Effectiveness

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Assess the effectiveness of the organization's training program.

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[PA158.IG102.SP103]

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A process should exist to determine the effectiveness of training, i.e., how well the training is meeting the organization's needs.

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[PA158.IG102.SP103.N101]

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Examples of methods used to assess training effectiveness include the following: [PA158.IG102.SP103.N103]

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- Testing in the training context
- Post-training surveys of training participants
- Surveys of managers' satisfaction with post-training effects
- Assessment mechanisms embedded in courseware

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11688 Measures may be taken to assess the added value of the training
 11689 against work objectives of both the project and organization. Particular
 11690 attention should be paid to the need for various training methods, such
 11691 as training teams as integral work units. When used, performance
 11692 objectives should be shared with course participants, and should be
 11693 written unambiguously where the performance requirements are stated
 11694 in a manner that makes them observable and verifiable. The results of
 11695 the training effectiveness assessment should be used to revise training
 11696 materials as described in "Establish Training Capability" above.
 11697 [PA158.IG102.SP103.N102]

11698 **Typical Work Products**

- 11699 1. Training effectiveness surveys [PA158.IG102.SP103.W101]
- 11700 2. Training program performance assessments [PA158.IG102.SP103.W102]
- 11701 3. Instructor evaluation forms [PA158.IG102.SP103.W103]
- 11702 4. Training examinations [PA158.IG102.SP103.W104]

11703 **Subpractices**

- 11704 1. Assess in-progress or completed projects to determine whether
 11705 staff knowledge was adequate for performing project tasks.
 11706 [PA158.IG102.SP103.SubP101]
- 11707 2. Provide a mechanism for assessing the effectiveness of each
 11708 training course with respect to established organizational, project,
 11709 or learning (or performance) objectives. [PA158.IG102.SP103.SubP102]
- 11710 3. Obtain student evaluations of how well training activities met their
 11711 needs. [PA158.IG102.SP103.SubP103]

11712 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

11713 ***The process is institutionalized as a defined process.***

11714 Commitment to Perform

11715 **GP 2.1 (CO 1) Establish an Organizational Policy**

11716 ***Establish and maintain an organizational policy for planning and***
 11717 ***performing the organizational training process.*** [GP103]

11718 Elaboration:

11719 This policy establishes organizational expectations for identifying the
11720 strategic training needs of the organization, and providing that training.

11721 [PA158.EL101]

11722 Ability to Perform

11723 **GP 3.1 (AB 1) Establish a Defined Process**

11724 *Establish and maintain the description of a defined organizational*
11725 *training process.* [GP114]

11726 **GP 2.2 (AB 2) Plan the Process**

11727 *Establish and maintain the requirements and objectives, and plans*
11728 *for performing the organizational training process.* [GP104]

11729 Elaboration:

11730 These requirements, objectives, and plans are typically included in the
11731 plan for the organizational training process. This plan for organizational
11732 training differs from the organizational training plan described in the
11733 specific practice in this process area. The plan for organizational
11734 training addresses strategic high-level planning for all the
11735 organizational training activities. The organizational training plan
11736 addresses periodic, training needs. [PA158.EL102]

11737 **GP 2.3 (AB 3) Provide Resources**

11738 *Provide adequate resources for performing the organizational*
11739 *training process, developing the work products and providing the*
11740 *services of the process.* [GP105]

11741 Elaboration:

11742 Examples of people (full or part-time, internal or external), and skills
11743 needed include the following: [PA158.EL104]

- 11744 • subject matter experts
- 11745 • curriculum designers
- 11746 • instructional designers
- 11747 • instructors
- 11748 • training administrators

11750 Special facilities may be required for training. When necessary, the
11751 facilities required for the activities in the Organizational Training process
11752 area are developed or purchased. [PA158.EL118]

11753 Examples of tools used in performing the activities of the Organizational
11754 Training process area include the following: [PA158.EL106]

- 11755 • Instruments for analyzing training needs
- 11756 • Workstations to be used for training
- 11757 • Instructional design tools
- 11758 • Packages for developing presentation materials

11760 **GP 2.4 (AB 4) Assign Responsibility**

11761 ***Assign responsibility and authority for performing the process,***
11762 ***developing the work products, and providing the services of the***
11763 ***organizational training process.*** [GP106]

11764 **GP 2.5 (AB 5) Train People**

11765 ***Train the people performing or supporting the organizational***
11766 ***training process as needed.*** [GP107]

11767 Elaboration:

11768 Examples of training topics include the following: [PA158.EL108]

- 11769
- Knowledge and skills needs analysis
 - Instructional design
 - Instructional techniques (e.g., train the trainer)
 - Refresher training on subject matter
- 11770
- 11771
- 11772
- 11773

11774 Directing Implementation

11775 **GP 2.6 (DI 1) Manage Configurations**

11776 ***Place designated work products of the organizational training***
11777 ***process under appropriate levels of configuration management.***

11778 [GP109]

11779 Elaboration:

11780 Examples of work products placed under configuration management
11781 include the following: [PA158.EL109]

- 11782
- Organizational training tactical plan
 - Training Records
 - Training materials and supporting artifacts
 - Instructor evaluation forms
- 11783
- 11784
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- 11786

11787 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

11788 ***Identify and involve the relevant stakeholders of the organizational***
11789 ***training process as planned.*** [GP124]

11790 Elaboration:

- 11791 Examples of activities for stakeholder involvement include: [PA158.EL119]
- 11792 • Establishing a collaborative environment for discussion of training
 - 11793 needs and training effectiveness to ensure that the organization's
 - 11794 training needs are met.
 - 11795 • Identifying training needs
 - 11796 • Reviewing the organizational training tactical plan
 - 11797 • Assessing training effectiveness

11798

11799 **GP 2.8 (DI 3) Monitor and Control the Process**

11800 ***Monitor and control the organizational training process against the***
11801 ***plan and take appropriate corrective action.*** [GP110]

11802 Elaboration:

- 11803 Examples of measures used in monitoring and controlling the activities
- 11804 of the Organizational Training process area include the following:
- 11805 [PA158.EL112]
- 11806 • Number of training courses delivered (e.g., planned versus actual)
 - 11807 • Post-training evaluation ratings
 - 11808 • Training program quality survey ratings

11809

11810 **GP 3.2 (DI 4) Collect Improvement Information**

11811 ***Collect work products, measures, measurement results, and***
11812 ***improvement information derived from planning and performing***
11813 ***the organizational training process to support the future use and***
11814 ***improvement of the organization's processes and process assets.***
11815 [GP117]

11816 Verifying Implementation

11817 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

11818 ***Objectively evaluate adherence of the organizational training***
11819 ***process and the work products and services of the process to the***
11820 ***applicable requirements, objectives, and standards, and address***
11821 ***noncompliance.*** [GP113]

11822

Elaboration:

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Examples of activities reviewed include the following: [PA158.EL114]

11824

- Identifying training needs and making training available

11825

- Providing necessary training

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Examples of work products reviewed include the following: [PA158.EL116]

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- Organizational training tactical plan

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- Training materials and supporting artifacts

11830

- Instructor evaluation forms

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

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

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11836 INTEGRATED PROJECT MANAGEMENT (IPPD)

11837 Maturity Level 3

11838 Purpose

11839 The purpose of Integrated Project Management (IPPD) is to establish
11840 and manage the project and the involvement of the relevant
11841 stakeholders according to an integrated and defined process that is
11842 tailored from the organization's set of standard processes. It also covers
11843 the establishment of a shared vision for the project and a team structure
11844 for integrated teams that will carry out the objectives of the project .

11845 [PA167]

11846 Introductory Notes

11847 The integrated and defined process that is tailored from the
11848 organization's set of standard is called the project's defined process.

11849 [PA167.N101]

11850 Integrated Project Management (IPPD) involves the following: [PA167.N102]

- 11851 • Tailoring the project's defined process from the organization's set
11852 of standard processes.
- 11853 • Establishing a shared vision by and for the project.
- 11854 • Establishing a structure of integrated teams that are tasked to
11855 accomplish the objectives of the project.
- 11856 • Managing the project using the project's defined process.
- 11857 • Using and contributing to the organization's process assets.
- 11858 • Enabling each relevant stakeholder's unique expertise and
11859 concerns to be identified, considered, and implemented during the
11860 development of the product.
- 11861 • Ensuring that the relevant stakeholders associated with the project
11862 coordinate their efforts in a timely manner: (1) to address product
11863 and product component requirements, plans, objectives, issues,
11864 and risks; (2) to make their commitments; and (3) to identify, track,
11865 and resolve issues.

11866 Managing the project's effort, cost, schedule, staffing, risks, and other
 11867 factors is tied to the tasks of the project's defined process. The
 11868 implementation and management of the project's defined process is
 11869 typically described in the project plan. Certain activities may be covered
 11870 in other subordinate plans, such as the quality assurance plan,
 11871 verification strategy, risk management strategy, and the configuration
 11872 management plan. [PA167.N103]

11873 Since the defined process for each project is tailored from the
 11874 organization's set of standard processes, variability among projects is
 11875 typically reduced and projects can more easily share process assets,
 11876 data, and lessons learned. [PA167.N104]

11877 This process area also addresses the coordination of all activities
 11878 associated with the project including the following: [PA167.N105]

- 11879 • Technical activities such as requirements development, design,
 11880 and verification
- 11881 • Support activities such as configuration management,
 11882 documentation, marketing, and training

11883 The term relevant stakeholder in this process area refers to a group or
 11884 individual that is affected by or is in some way accountable for the
 11885 outcome of the project. A relevant stakeholder could be an individual
 11886 from another project or team, individuals representing technical or
 11887 support activities, suppliers, customers, or end users. [PA167.N106]

11888 The working interfaces and interactions among relevant stakeholders
 11889 internal and external to the project are planned and managed to ensure
 11890 the quality and integrity of the entire product. Relevant stakeholders
 11891 participate, as appropriate, in defining the project's defined process and
 11892 the project plan. Reviews and exchanges are regularly conducted with
 11893 these relevant stakeholders to ensure that everyone involved in the
 11894 project is appropriately aware of the status and plans of all activities,
 11895 and that project coordination issues receive appropriate attention. In
 11896 defining the project's defined process, formal interfaces are created as
 11897 necessary to ensure that appropriate coordination and collaboration
 11898 occurs. [PA167.N107]

11899 This process area applies in any organizational structure, including
 11900 projects that are structured as line organizations, matrix organizations,
 11901 integrated teams (also known as Integrated Product Teams [IPTs]). The
 11902 terminology should be appropriately interpreted for the organizational
 11903 structure in place. [PA167.N108]

11904 If you are using the continuous representation, the first goal in this
 11905 process area may be redundant when applying the capability level three
 11906 generic practices to project-related process areas. However, the
 11907 practices, subpractices, and notes will provide many details that will
 11908 assist you with this application. [PA167.N109]

11909 Related Process Areas

- 11910 *Refer to the Project Planning process area for more information about*
11911 *practices that cover the planning of the project. [PA167.R101]*
- 11912 *Refer to the Project Monitoring and Control process area for more*
11913 *information about the practices that cover monitoring and controlling the*
11914 *project. [PA167.R102]*
- 11915 *Refer to the Project Planning process area for more information about*
11916 *identifying relevant stakeholders and their appropriate involvement in*
11917 *the project. [PA167.R103]*
- 11918 *Refer to the Verification process area for more information about peer*
11919 *reviews. [PA167.R104]*
- 11920 *Refer to the Organizational Process Definition process area for more*
11921 *information about the organization's set of standard processes, process*
11922 *assets, and tailoring guidelines. [PA167.R105]*
- 11923 *Refer to the Measurement and Analysis process area for more*
11924 *information about measuring and analyzing processes. [PA167.R106]*
- 11925 *Refer to the Integrated Teaming process area for more information*
11926 *about how teams are established and maintained. [PA167.R107]*
- 11927 *Refer to the Organizational Environment for Integration process area for*
11928 *more information about the work environment and the creation of the*
11929 *organization's shared vision, and managing people for integration.*
11930 *[PA167.R108]*

11931 Specific and Generic Goals

11932 **SG 1 Use the Project's Defined Process** [PA167.IG101]

11933 *The project is conducted using a defined process that is tailored from the*
11934 *organization's set of standard processes.*

11935 **SG 2 Coordinate and Collaborate with Relevant Stakeholders** [PA167.IG102]

11936 *Coordination and collaboration of the project with relevant stakeholders is*
11937 *conducted.*

11938 **SG 3 Use the Project's Shared Vision** [PA167.IG103]

11939 *The project is conducted using the project's shared vision.*

11940 **SG 4** **Organize Integrated Teams** [PA167.IG104]

11941 *The integrated teams needed to execute the project are identified, defined,*
11942 *structured, and tasked.*

11943 **GG 3** **Institutionalize a Defined Process** [CL104.GL101]

11944 *The process is institutionalized as a defined process.*

11945 Practice to Goal Relationship Table

11946	SG 1 Use the Project's Defined Process [PA167.IG101]		
11947	SP 1.1	Establish the Project's Defined Process	
11948	SP 1.2	Use Organizational Process Assets for Planning Project Activities	
11949	SP 1.3	Integrate Plans	
11950	SP 1.4	Manage the Project Using the Integrated Plans	
11951	SP 1.5	Contribute to the Organization's Process Assets	
11952	SG 2 Coordinate and Collaborate with Relevant Stakeholders [PA167.IG102]		
11953	SP 2.1	Manage Stakeholder Involvement	
11954	SP 2.2	Manage Dependencies	
11955	SP 2.3	Resolve Coordination Issues	
11956	SG 3 Use the Project's Shared Vision [PA167.IG103]		
11957	SP 3.1	Define Project's Shared Vision Context	
11958	SP 3.2	Establish the Project's Shared Vision	
11959	SG 4 Organize Integrated Teams [PA167.IG104]		
11960	SP 4.1	Determine Integrated Team Structure for the Project	
11961	SP 4.2	Develop a Preliminary Distribution of Requirements to Integrated	
11962		Teams	
11963	SP 4.3	Establish Integrated Teams	
11964	GG 3 Institutionalize a Defined Process		
11965	GP 2.1	(CO 1)	Establish an Organizational Policy
11966	GP 3.1	(AB 1)	Establish a Defined Process
11967	GP 2.2	(AB 2)	Plan the Process
11968	GP 2.3	(AB 3)	Provide Resources
11969	GP 2.4	(AB 4)	Assign Responsibility
11970	GP 2.5	(AB 5)	Train People
11971	GP 2.6	(DI 1)	Manage Configurations
11972	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
11973	GP 2.8	(DI 3)	Monitor and Control the Process
11974	GP 3.2	(DI 4)	Collect Improvement Information
11975	GP 2.9	(VE 1)	Objectively Evaluate Adherence
11976	GP 2.10	(VE 2)	Review Status with Higher-Level Management

11977 Specific Practices by Goal

11978 **SG 1 Use the Project's Defined Process** [PA167.IG101]

11979 ***The project is conducted using a defined process that is tailored from the***
 11980 ***organization's set of standard processes.***

11981 The project's defined process must include those standard processes
 11982 elements from the organization's set of standard processes and
 11983 guidelines that are unique to IPPD. For example the defined processes
 11984 are not only integrated but reflect a parallel, rather than a serial,
 11985 development process. The product-related processes, such as the
 11986 manufacturing and support processes, are developed concurrently with
 11987 the product. [PA167.IG101.N101]

11988

SP 1.1 Establish the Project's Defined Process

11989

Establish and maintain the project's defined process. [PA167.IG101.SP101]

11990

Refer to the Organizational Process Definition process area for more information about the organization's set of standard processes, the library of process assets, life-cycle models, and tailoring guidelines.

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[PA167.IG101.SP101.R101]

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Refer to the Organizational Process Focus process area for more information about organizational process needs and objectives.

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[PA167.IG101.SP101.R102]

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The project's defined process is a set of defined processes and subprocesses that form an integrated, coherent life cycle for the project.

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[PA167.IG101.SP101.N101]

12000

The project's defined process includes the IPPD processes that will be applied by the project (tailored from the organization's IPPD processes). Processes to select the team structure, allocate limited personnel resources, implement cross-integrated team communication, and conduct issue resolution processes are part of the project's defined process. The project's defined process should satisfy the project's contractual and operational needs, opportunities, and constraints. It is designed to provide a best fit for the project's needs. A project's defined process is based on the following: [PA167.IG101.SP101.N102]

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- Customer requirements

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- Product and product component requirements

12011

- Commitments

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- Organizational process needs and objectives

12013

- Operational environment

12014

- Business environment

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Typical Work Products

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1. The project's defined process [PA167.IG101.SP101.W101]

12017

Subpractices

12018

1. Select a life-cycle model from those available from the organization's process assets. [PA167.IG101.SP101.SubP101]

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2. Select the standard processes from the organization's set of standard processes that best fit the needs of the project.

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[PA167.IG101.SP101.SubP102]

12023

3. Tailor the organization's set of standard processes and other process assets according to the tailoring guidelines to produce the project's defined process. [PA167.IG101.SP101.SubP103]

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12026 Sometimes the available life-cycle models and standard processes are
12027 inadequate to meet a specific project's needs. Sometimes the project will be
12028 unable to produce required work products or measures. In such circumstances,
12029 the project will need to seek approval to deviate from what is required by the
12030 organization. Waivers are provided for this purpose. [PA167.IG101.SP101.SubP103.N101]

12031 4. Use other artifacts from the organization's library of process assets
12032 as appropriate. [PA167.IG101.SP101.SubP104]

12033 Other artifacts may include the following: [PA167.IG101.SP101.SubP104.N101]

- 12034 • Lessons learned documents
- 12035 • Templates
- 12036 • Example documents
- 12037 • Estimating models

12038 5. Document the project's defined process. [PA167.IG101.SP101.SubP105]

12039 The project's defined process covers all the engineering, management, and
12040 support activities for the project and its interfaces to relevant stakeholders.

12041 [PA167.IG101.SP101.SubP105.N101]

12042 Examples of project activities include the following: [PA167.IG101.SP101.SubP105.N102]

- 12043 • Project planning
- 12044 • Project monitoring and controlling
- 12045 • Requirements development
- 12046 • Requirements management
- 12047 • Design and implementation
- 12048 • Verification and validation
- 12049 • Product integration
- 12050 • Acquisition management
- 12051 • Configuration management
- 12052 • Quality assurance

12053
12054 6. Conduct peer reviews of the project's defined process.
12055 [PA167.IG101.SP101.SubP106]

12056 *Refer to the Verification process area for more information about*
12057 *conducting peer reviews.* [PA167.IG101.SP101.SubP106.R101]

12058 7. Revise the project's defined process as necessary.
12059 [PA167.IG101.SP101.SubP107]

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SP 1.2 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]

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

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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

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SP 1.3 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]

Refer to the Measurement and Analysis process area for more information about defining measures and measurement activities and using analytic techniques. [PA167.IG101.SP103.R103]

Refer to the Risk Management process area for more information about identifying and analyzing risks. [PA167.IG101.SP103.R104]

Refer to the Organizational Process Focus process area for more information about organizational process needs and objectives.
[PA167.IG101.SP103.R105]

This specific practice extends the practices involved in establishing and maintaining a project plan to address additional planning activities such as incorporating the project's defined process, coordinating with relevant stakeholders, using organizational process assets, incorporating plans for peer reviews, and establishing objective entry and exit criteria for tasks. [PA167.IG101.SP103.N101]

The development of the project plan should account for current and projected needs, objectives, and requirements of the organization, customer, and end users, as appropriate. This plan development also includes accounting for organizational process needs and objectives.
[PA167.IG101.SP103.N102]

12129 The plans of the integrated teams are included in this integration.
12130 Developing a complete project plan and project's defined process may
12131 require an iterative effort if a complex, multi-layered integrated team
12132 structure is being deployed. [PA167.IG101.SP103.N103]

12133 **Typical Work Products**

- 12134 1. Project plan [PA167.IG101.SP103.W101]
12135 2. Subordinate plans [PA167.IG101.SP103.W102]

12136 **Subpractices**

- 12137 1. Integrate the subordinate plans with the project plan.
12138 [PA167.IG101.SP103.SubP101]

12139 The subordinate plans may include the following: [PA167.IG101.SP103.SubP101.N101]

- 12140 • Quality assurance plans
12141 • Configuration management plans
12142 • Risk management strategy
12143 • Verification strategy
12144 • Validation strategy
12145 • Product integration plans
12146 • Documentation plans
12147 2. Incorporate into the project plan the definitions of measures and
12148 measurement activities for managing the project.

12149 [PA167.IG101.SP103.SubP102]

12150 Examples of measures that would be incorporated include the following:

12151 [PA167.IG101.SP103.SubP102.N101]

- 12152 • Organization's common set of measures
12153 • Additional project-specific measures

12154

- 12155 3. Identify and analyze product and project interface risks.

12156 [PA167.IG101.SP103.SubP103]

- 12157 4. Schedule the tasks in a sequence that accounts for critical
12158 development factors and project risks. [PA167.IG101.SP103.SubP104]

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Examples of factors considered in scheduling include the following:
[PA167.IG101.SP103.SubP104.N101]

- Size and complexity of the tasks
- Integration and test issues
- Needs of the customer and end users
- Availability of critical resources
- Availability of key personnel

5. Incorporate the plans for performing peer reviews on the work products of the project's defined process. [PA167.IG101.SP103.SubP105]

Refer to the Verification process area for more information about peer reviews [PA167.IG101.SP103.SubP105.R101]

6. Incorporate the training needed to perform the project's defined process in the project's training plans. [PA167.IG101.SP103.SubP106]

This task typically involves negotiating with the organizational training group the support they will provide. [PA167.IG101.SP103.SubP106.N101]

7. Establish objective entry and exit criteria to authorize the initiation and completion of the tasks described in the work breakdown structure. [PA167.IG101.SP103.SubP107]

8. Ensure that the project plan is appropriately compatible with the plans of relevant stakeholders. [PA167.IG101.SP103.SubP108]

Typically the plan and changes to the plan will be reviewed for compatibility. [PA167.IG101.SP103.SubP108.N101]

9. Identify how conflicts will be resolved that arise between stakeholders involved in the project. [PA167.IG101.SP103.SubP109]

SP 1.4 Manage the Project Using the Integrated Plans

Manage the project using the project plan, the subordinate plans, and the project's defined process. [PA167.IG101.SP104]

Refer to the Organizational Process Definition process area for more information about the library of process assets. [PA167.IG101.SP104.R101]

Refer to the Organizational Process Focus process area for more information about organizational process needs and objectives and coordinating process improvement activities with the rest of the organization. [PA167.IG101.SP104.R102]

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12193 *Refer to the Risk Management process area for more information about*
12194 *managing risks. [PA167.IG101.SP104.R103]*

12195 *Refer to the Project Monitoring and Control process area for more*
12196 *information about monitoring and controlling the project.*
12197 *[PA167.IG101.SP104.R104]*

12198 **Typical Work Products**

12199 1. Work products created by performing the project's defined process
12200 [PA167.IG101.SP104.W101]

12201 2. Collected measures ("actuals") and progress records or reports
12202 [PA167.IG101.SP104.W102]

12203 3. Revised requirements, plans, and commitments [PA167.IG101.SP104.W103]

12204 4. Integrated plans [PA167.IG101.SP104.W104]

12205 **Subpractices**

12206 1. Implement the project's defined process using the organization's
12207 library of process assets. [PA167.IG101.SP104.SubP101]

12208 This task typically includes the following: [PA167.IG101.SP104.SubP101.N101]

- 12209 • Incorporating artifacts from the library into the project as appropriate
- 12210 • Using lessons learned from the library to manage the project

12211 2. Monitor and control the project's activities and work products using
12212 the project's defined process, project plan, and subordinate plans.

12213 [PA167.IG101.SP104.SubP102]

12214 This task typically includes the following: [PA167.IG101.SP104.SubP102.N101]

- 12215 • Using the defined entry and exit criteria to authorize the initiation and determine
12216 the completion of the tasks
- 12217 • Monitoring the activities that could significantly affect the actual values of the
12218 project's planning parameters
- 12219 • Tracking the project's planning parameters using measurable thresholds that will
12220 trigger investigation and appropriate actions
- 12221 • Monitoring product and project interface risks
- 12222 • Managing external and internal commitments based on the plans for the tasks and
12223 work products of implementing the project's defined process

12224 An understanding of the relationships among the various tasks and work products
12225 of the project's defined process, roles to be performed by the relevant
12226 stakeholders, along with well-defined control mechanisms (e.g., peer reviews), are
12227 used to achieve better visibility into the project's performance and better control of
12228 the project. [PA167.IG101.SP104.SubP102.N102]

12229 3. Obtain and analyze the selected measures to manage the project
12230 and support the organization's needs. [PA167.IG101.SP104.SubP103]

12231 *Refer to the Measurement and Analysis process area for more*
12232 *information about obtaining and analyzing measures.*

12233 [PA167.IG101.SP104.SubP103.R101]

12234 4. Periodically review the adequacy of the environment to meet the
12235 project's needs and support coordination. [PA167.IG101.SP104.SubP104]

12236 Examples of actions that might be taken include the following:

12237 [PA167.IG101.SP104.SubP104.N101]

- 12238 • Adding new tools
- 12239 • Acquiring additional networks, equipment, training, and support

12240
12241 5. Periodically review and align the project's performance with the
12242 current and projected needs, objectives, and requirements of the
12243 organization, customer, and end users, as appropriate.

12244 [PA167.IG101.SP104.SubP105]

12245 This review includes alignment with the organizational process needs and
12246 objectives. [PA167.IG101.SP104.SubP105.N101]

12247 Examples of actions that achieve alignment include the following:

12248 [PA167.IG101.SP104.SubP105.N102]

- 12249 • Accelerating the schedule, with appropriate adjustments to other planning
12250 parameters and the project risks
- 12251 • Changing the requirements in response to a change in market opportunities or
12252 customer and end-user needs
- 12253 • Terminating the project

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12255 SP 1.5 Contribute to the Organization's Process Assets

12256 ***Contribute work products, measures, and documented***
12257 ***experiences to the organization's process assets.*** [PA167.IG101.SP105]

12258 *Refer to the Organizational Process Focus process area for more*
12259 *information about process improvement proposals.* [PA167.IG101.SP105.R101]

12260 *Refer to the Organizational Process Definition process area for more*
12261 *information about the organization's process assets, the organization's*
12262 *measurement repository, and the library of process assets.*

12263 [PA167.IG101.SP105.R102]

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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]

Refer to the Project Planning process area for more information about recording planning and re-planning data. [PA167.IG101.SP105.SubP102.R101]

Refer to the Project Monitoring and Control process area for more information about recording measures. [PA167.IG101.SP105.SubP102.R102]

This typically includes the following: [PA167.IG101.SP105.SubP102.N101]

- Planning data
- Re-planning data
- Measures

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

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

4. Document lessons learned from the project for inclusion in the organization's library of process assets. [PA167.IG101.SP105.SubP104]

12307

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 Manage Stakeholder Involvement

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Manage the involvement of the relevant stakeholders in the project. [PA167.IG102.SP101]

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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.SP101.R101]

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Typical Work Products

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1. Agendas and schedules for collaborative activities [PA167.IG102.SP101.W101]
2. Documented issues (e.g. issues with the customer requirements, product and product component requirements, product architecture, and product design) [PA167.IG102.SP101.W102]
3. Recommendations on issues [PA167.IG102.SP101.W103]
4. Documented defects, issues, and action items arising from reviews [PA167.IG102.SP101.W104]
5. Documented product and project interface risks [PA167.IG102.SP101.W105]

12325

Subpractices

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1. Coordinate with the relevant stakeholders that should participate in the project's activities. [PA167.IG102.SP101.SubP101]

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The relevant stakeholders should already be identified in the project plan.
[PA167.IG102.SP101.SubP101.N101]

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12331

2. Participate in reviews of the activities and work products of other projects as appropriate. [PA167.IG102.SP101.SubP102]

- 12332 3. Ensure that work products produced to satisfy commitments meet
12333 the requirements of the receiving projects. [PA167.IG102.SP101.SubP103]

12334 *Refer to the Verification process area for more information about*
12335 *determining acceptability of work products.* [PA167.IG102.SP101.SubP103.R101]

12336 This task typically includes the following: [PA167.IG102.SP101.SubP103.N101]

- 12337 • Reviewing, demonstrating, or testing, as appropriate, each work product produced
12338 by relevant stakeholders
 - 12339 • Reviewing, demonstrating, or testing, as appropriate, each work product produced
12340 by the project for other projects with representatives of the projects receiving the
12341 work product
 - 12342 • Resolving issues related to the acceptance of the work products
- 12343 4. Develop recommendations and coordinate the actions to resolve
12344 misunderstandings and problems with the product and product
12345 component requirements, product and product component
12346 architecture, and product and product component design.

12347 [PA167.IG102.SP101.SubP104]

12348 **SP 2.2 Manage Dependencies**

12349 ***Participate with relevant stakeholders to identify, negotiate, and***
12350 ***track critical dependencies.*** [PA167.IG102.SP102]

12351 *Refer to the Project Planning process area for more information about*
12352 *identifying stakeholders and their appropriate involvement and on*
12353 *establishing and maintaining commitments.* [PA167.IG102.SP102.R101]

12354 **Typical Work Products**

- 12355 1. Agendas and schedules for collaborative activities [PA167.IG102.SP102.W101]
- 12356 2. Defects, issues, and action items arising from reviews
12357 [PA167.IG102.SP102.W102]
- 12358 3. Critical dependencies [PA167.IG102.SP102.W103]
- 12359 4. Commitments to address critical dependencies [PA167.IG102.SP102.W104]
- 12360 5. Status of critical dependencies [PA167.IG102.SP102.W105]

12361 **Subpractices**

- 12362 1. Conduct reviews with relevant stakeholders. [PA167.IG102.SP102.SubP101]
- 12363 2. Identify each critical dependency. [PA167.IG102.SP102.SubP102]
- 12364 3. Establish need dates and plan dates for each critical dependency
12365 based on the project schedule. [PA167.IG102.SP102.SubP103]

12366 4. Review and get agreement on the commitments to address each
12367 critical dependency with the people responsible for providing the
12368 work product and the people receiving the work product.

[PA167.IG102.SP102.SubP104]

12370 5. Document the critical dependencies and commitments.

[PA167.IG102.SP102.SubP105]

Documentation of commitments typically includes the following:

[PA167.IG102.SP102.SubP105.N101]

- 12374 • Describing the commitment
- 12375 • Identifying who made the commitment
- 12376 • Identifying who is responsible for satisfying the commitment
- 12377 • Specifying when the commitment will be satisfied
- 12378 • Specifying the criteria for determining if the commitment has been satisfied

12379 6. Track the critical dependencies and commitments and taking
12380 corrective action as appropriate. [PA167.IG102.SP102.SubP106]

12381 *Refer to the Project Monitoring and Control process area for more*
12382 *information about tracking commitments.* [PA167.IG102.SP102.SubP106.R101]

Tracking the critical dependencies typically includes the following:

[PA167.IG102.SP102.SubP106.N101]

- 12385 • Evaluating the effects of late and early completion for impacts on future activities
12386 and milestones
- 12387 • Resolving actual and potential problems with the responsible people where
12388 possible
- 12389 • Escalating to the appropriate managers the actual and potential problems not
12390 resolvable with the responsible people

12391 SP 2.3 Resolve Coordination Issues

12392 ***Resolve issues with relevant stakeholders.*** [PA167.IG102.SP103]

12393 Examples of coordination issues include the following: [PA167.IG102.SP103.N101]

- 12394 • Late critical dependencies and commitments
- 12395 • Product and product component requirements and design defects
- 12396 • Product-level problems
- 12397 • Unavailability of critical resources or personnel

12398 Typical Work Products

- 12399 1. Documented issues [PA167.IG102.SP103.W101]
- 12400

- 12401 2. Status of issues [PA167.IG102.SP103.W102]
- 12402 **Subpractices**
- 12403 1. Identify and document issues. [PA167.IG102.SP103.SubP101]
- 12404 2. Communicate issues to the relevant stakeholders.
- 12405 [PA167.IG102.SP103.SubP102]
- 12406 3. Resolve issues with the relevant stakeholders. [PA167.IG102.SP103.SubP103]
- 12407 4. Escalate to the appropriate managers those issues not resolvable
- 12408 with the relevant stakeholders. [PA167.IG102.SP103.SubP104]
- 12409 5. Track the issues to closure. [PA167.IG102.SP103.SubP105]
- 12410 6. Communicate with the relevant stakeholders on the status and
- 12411 resolution of the issues. [PA167.IG102.SP103.SubP106]

12412 **SG 3 Use the Project's Shared Vision** [PA167.IG103]

12413 ***The project is conducted using the project's shared vision.***

12414 The purpose of creating a shared vision is to achieve a unity of

12415 purpose. Creating a shared vision requires that all people in the project

12416 have an opportunity to speak and be heard about what really matters to

12417 them. The project's shared vision captures the project's guiding

12418 principles including mission, objectives, expected behavior and values.

12419 The project's guiding principles should be consistent with those of the

12420 organization. The implementation of the project's shared vision in work

12421 can become part of the project's process for doing that work. As a

12422 result, it is subject to the same requirements for measurement, review,

12423 and corrective action as other processes. [PA167.IG103.N101]

12424 The value of a shared vision is that people understand and can adopt

12425 its principles to guide their actions and decisions. Shared visions tend to

12426 focus on an end state while leaving room for personal and team

12427 innovation, creativity, and enthusiasm. The activities of the individuals,

12428 teams, and project are aligned with the shared vision. Aligned means

12429 that the activities contribute to the achievement of the objectives

12430 expressed in the shared vision. [PA167.IG103.N102]

12431 **SP 3.1 Define Project's Shared Vision Context**

12432 ***Identify expectations, constraints, interfaces, and operational***

12433 ***conditions applicable to the project's shared vision.*** [PA167.IG103.SP101]

12434 *Refer to the Organizational Environment for Integration process area for*

12435 *more information about the organization's shared vision as an*

12436 *organizational process asset.* [PA167.IG103.SP101.R101]

12437 A project does not operate in isolation. Understanding organizational
12438 expectations and constraints allows for alignment of the project's
12439 direction, activities and vision with the organization's and helps create a
12440 common purpose within which project activities can be coordinated
12441 Understanding the interfaces with other stakeholders external to the
12442 project, the objectives and expectations of stakeholders (including
12443 members of the project), and conditions within which the project must
12444 operate), is critical to ensure that the project's direction and activities
12445 achieve a fit with any larger objectives. [PA167.IG103.SP101.N101]

12446 The project's shared vision context has both an external and internal
12447 aspect. The external aspect has to do with the overlying vision and
12448 objectives as well as interfaces outside of the project. The internal
12449 aspect is about aligning project member's personal aspirations and
12450 objectives with the project's vision and purpose. [PA167.IG103.SP101.N102]

12451 **Typical Work Products**

- 12452 1. Organizational expectations and constraints that apply to the
12453 project [PA167.IG103.SP101.W101]
- 12454 2. Summary of project members' personal aspirations for the project
12455 [PA167.IG103.SP101.W102]
- 12456 3. External interfaces that the project is required to observe
12457 [PA167.IG103.SP101.W103]
- 12458 4. Operational conditions that affect the project's activities
12459 [PA167.IG103.SP101.W104]
- 12460 5. Project's shared vision context [PA167.IG103.SP101.W105]

12461 **Subpractices**

- 12462 1. Identify behaviors, characteristics, and principles about the
12463 organizational and project situation that affect the project's shared
12464 vision. [PA167.IG103.SP101.SubP101]
- 12465 2. Use appropriate techniques to explore project member's mental
12466 models and personal aspirations for the project. [PA167.IG103.SP101.SubP102]
- 12467 3. Create a description of the project's shared vision context.
12468 [PA167.IG103.SP101.SubP103]

12469 **SP 3.2 Establish the Project's Shared Vision**

12470 ***Establish and maintain a shared vision for the project.*** [PA167.IG103.SP102]

12471 *Refer to the Organizational Environment for Integration process area for*
12472 *more information about the organization's shared vision.*

12473 [PA167.IG103.SP102.R101]

12474 A shared vision is created by the project and for the project, in
12475 alignment with the organization's shared vision. [PA167.IG103.SP102.N101]

12476 When creating a vision consider: [PA167.IG103.SP102.N102]

- 12477 • external stakeholder expectations and requirements
- 12478 • the aspirations and expectations of the leader and project
- 12479 members
- 12480 • the project's objectives
- 12481 • the conditions and outcomes the project will create
- 12482 • interfaces the project needs to maintain
- 12483 • the visions created by the organization and interfacing groups
- 12484 • the constraints imposed by outside authorities (e.g., environmental
- 12485 regulations)
- 12486 • project operation while working to achieve its objectives (both
- 12487 principles and behaviors)

12488 When creating a shared vision, all people in the project should be
12489 invited to participate. Although there may be a draft proposal, the larger
12490 population must have an opportunity to speak and be heard about what
12491 really matters to them. The vision is articulated in terms of both the core
12492 ideology (values, principles, and behaviors) and the desired future to
12493 which each member of the project can commit. [PA167.IG103.SP102.N103]

12494 An effective communications strategy is key to implementing and
12495 focusing the vision throughout the project. Promulgation of the shared
12496 vision is a public declaration of the commitment of the project to their
12497 shared vision and provides the opportunity for others to examine,
12498 understand and align their activities in a common direction. The vision
12499 should be communicated, and agreement and commitment of the
12500 relevant stakeholders should be attained. [PA167.IG103.SP102.N104]

12501 Effective communications are also especially important when
12502 incorporating new project members. New members of the project often
12503 need more or special attention to ensure that they understand the
12504 vision, have a stake in it, and are prepared to follow it in doing their
12505 work. [PA167.IG103.SP102.N105]

12506 **Typical Work Products**

- 12507 1. Meeting minutes for team building exercises [PA167.IG103.SP102.W101]
- 12508 2. Vision and objective statements [PA167.IG103.SP102.W102]
- 12509 3. Statement of values and principles [PA167.IG103.SP102.W103]
- 12510 4. Presentations to stakeholders, observers, and management
- 12511 [PA167.IG103.SP102.W104]

- 12512 5. Communications strategy [PA167.IG103.SP102.W105]
- 12513 6. Handbook for new members of the project [PA167.IG103.SP102.W106]
- 12514 7. Presentations to stakeholders and management [PA167.IG103.SP102.W107]
- 12515 8. Presentations and publications describing principles, vision
- 12516 statement and objectives [PA167.IG103.SP102.W108]
- 12517 9. Published principles, vision statement, mission statement and
- 12518 objectives (e.g., posters, wallet cards published on posters suitable
- 12519 for wall hanging) [PA167.IG103.SP102.W109]

Subpractices

- 12520 1. Hold meetings or workshops to create the project's shared vision.
- 12521 [PA167.IG103.SP102.SubP101]
- 12522
- 12523 2. Articulate the project's shared vision in terms of: purpose or
- 12524 mission, vision, values, and objectives. [PA167.IG103.SP102.SubP102]
- 12525
- 12526 3. Reach consensus on the project's shared vision among those
- 12527 affected by it and participating in its creation. [PA167.IG103.SP102.SubP103]
- 12528
- 12529 4. Establish a strategy to communicate the project's shared vision
- 12530 both externally and internally. [PA167.IG103.SP102.SubP104]
- 12531
- 12532 5. Make presentations suitable for the various audiences that need to
- 12533 be informed about the project's shared vision. [PA167.IG103.SP102.SubP105]
- 12534
- 12535 6. Check that project and individual activities and tasks are aligned
- 12536 with the project's shared vision. [PA167.IG103.SP102.SubP106]

SG 4 Organize Integrated Teams [PA167.IG104]

The integrated teams needed to execute the project are identified, defined, structured, and tasked.

12536 The purpose of this goal and its practices is to create an integrated

12537 team structure that will efficiently meet the project's requirements and

12538 produce a quality product. The integrated team structure partitions

12539 responsibilities, requirements, and resources to teams so that the right

12540 expertise and abilities are available to produce the assigned products.

12541 The integrated teams are organized to facilitate communications

12542 between teams and to honor interfaces between product components.

12543 [PA167.IG104.N101]

12544 Organizing integrated teams to realize Integrated Product and Process
12545 Development (IPPD) requires care and deliberation. As the project
12546 evolves, integrated team structures are reevaluated for continued
12547 applicability. For example, once the product component requirements
12548 are established, it may be appropriate to replace a leader having
12549 expertise in design with one having more expertise in manufacturing or
12550 in verification. [PA167.IG104.N102]

12551 The teams in the structure must be appropriately integrated with each
12552 other. The interface between two integrated teams should be specified
12553 when one team has responsibility for a work product that has an
12554 interface requirement referring to a work product of the other team. An
12555 interface between teams should be specified when one team produces
12556 a work product that will be used by another. An interface should exist
12557 when two teams share responsibility for a general requirement of the
12558 product. Each of these types of interfaces between integrated teams
12559 may require a different type of collaboration as appropriate. [PA167.IG104.N103]

12560 **SP 4.1 Determine Integrated Team Structure for the Project**

12561 ***Determine the integrated team structure that will best meet the***
12562 ***project objectives and constraints.*** [PA167.IG104.SP101]

12563 Product requirements, cost, schedule, risk, resource projections,
12564 business practices, the project's defined process, and organizational
12565 guidelines are evaluated to establish the basis for defining integrated
12566 teams and their responsibilities, authorities, and interrelationships.
12567 [PA167.IG104.SP101.N101]

12568 The simplest integrated team structure from an IPPD perspective
12569 evolves when the WBS is a work product-oriented hierarchy, and
12570 resources are available to staff a team with the expertise needed to
12571 adequately address the entire life cycle of the product for each work
12572 product in that hierarchy. More complex structuring occurs when the
12573 WBS is non-product oriented, product risks are not uniform, and
12574 resources are constrained. [PA167.IG104.SP101.N102]

12575 Structuring integrated teams is dependent on: [PA167.IG104.SP101.N103]

- 12576 • Product risk and complexity
- 12577 • Location and types of risks
- 12578 • Integration risks, including product component interfaces and inter-
12579 team communication
- 12580 • Resources, including availability of appropriately skilled people
- 12581 • Limitations on team size for effective collaboration
- 12582 • Need for team membership of stakeholders external to the project

- 12583 • Business practices
- 12584 • Organizational structure

12585 The integrated team structure can include the whole project as an
 12586 integrated team. In this case the project team would need to satisfy the
 12587 requirements of the Integrated Teaming process area (e.g., it would
 12588 need a vision (created in Specific Goal 3 of this process area), a
 12589 charter, clearly defined responsibilities, operating principles, and
 12590 collaborative interfaces with other teams outside of the project).

12591 [PA167.IG104.SP101.N104]

12592 If a project team has too many members for effective collaboration, the
 12593 project team should be divided into sub teams of appropriate size.

12594 [PA167.IG104.SP101.N105]

12595 **Typical Work Products**

- 12596 1. Assessments of the product and product architectures, including
 12597 risk and complexity [PA167.IG104.SP101.W101]
- 12598 2. Integrated team structures based on work breakdown structure and
 12599 adaptations [PA167.IG104.SP101.W102]
- 12600 3. Alternative concepts for integrated team structures that include
 12601 responsibilities, scope, and interfaces. [PA167.IG104.SP101.W103]
- 12602 4. Selected integrated team structure [PA167.IG104.SP101.W104]

12603 **Subpractices**

- 12604 1. Determine the risks in the products and product suite.
 12605 [PA167.IG104.SP101.SubP101]

12606 *Refer to the Risk Management process area for more information about*
 12607 *practices associated with risk determination.* [PA167.IG104.SP101.SubP101.R101]

- 12608 2. Determine likely resource requirements and availability.
 12609 [PA167.IG104.SP101.SubP102]

12610 *Refer to the Project Planning process area for more information about*
 12611 *resource assignments.* [PA167.IG104.SP101.SubP102.R101]

12612 Constraints on the available assets impact which teams are formed and how the
 12613 teams are structured. [PA167.IG104.SP101.SubP102.N101]

- 12614 3. Establish work product-based responsibilities. [PA167.IG104.SP101.SubP103]

12615 *Refer to the Project Planning process area for more information about*
 12616 *the Work Breakdown Structure (WBS).* [PA167.IG104.SP101.SubP103.R101]

12617 Each team in the team structure should have specified responsibility for tasks and
 12618 work products. The team structure should tie to the work breakdown structure
 12619 (WBS) used by the project. [PA167.IG104.SP101.SubP103.N101]

12620 4. Consider organizational process assets for opportunities,
12621 constraints, and other factors that might influence integrated team
12622 structure. [PA167.IG104.SP101.SubP104]

12623 Organizational process assets can provide guidance to assist the project in
12624 structuring and implementing integrated teams. Such assets may include:

12625 [PA167.IG104.SP101.SubP104.N101]

- 12626 • Team formation and structures
- 12627 • Team authority guidelines
- 12628 • Implementation techniques for IPPD
- 12629 • Guidelines for managing risks in IPPD
- 12630 • Guidelines for establishing lines of communication and authority
- 12631 • Team leader selection criteria
- 12632 • Team responsibility guidelines

12633 5. Develop an understanding of the organization's shared vision, the
12634 project's shared vision, and the organization's standard processes
12635 and process assets applicable to teams and team structures.

12636 [PA167.IG104.SP101.SubP105]

12637 The shared visions for the organization and project are examined. These visions
12638 help the planners focus on attributes critical to the organization and the project.
12639 Organizational processes provide information to streamline the planning process.
12640 These may be particularly useful when establishing reporting mechanisms for
12641 integrated teams and when integrated team structures are constructed in hybrid
12642 situations such as project teams consisting of both functional and product teams.
12643 Additionally, organizational processes about organizing team structures when
12644 influenced by risk and product life cycle may be particularly useful.

12645 [PA167.IG104.SP101.SubP105.N101]

12646 The project's shared vision may evolve when the integrated team structure is
12647 established so that the teams may have some input to the project's shared vision.

12648 [PA167.IG104.SP101.SubP105.N102]

12649 6. Identify alternative integrated team structures. [PA167.IG104.SP101.SubP106]

12650 Alternative integrated team structures are frequently developed for collaborative
12651 evaluation prior to selection of the structure to be employed. Much like any other
12652 set of design alternatives, extreme cases should be included to test the adequacy
12653 of the solution set. Innovative concepts in integrated team structure that promote
12654 integration as well as efficiency can be overlooked if planning is limited to devising
12655 a single team structure. [PA167.IG104.SP101.SubP106.N101]

12656 7. Evaluate alternatives and select an integrated team structure.

12657 [PA167.IG104.SP101.SubP107]

12658 *Refer to the Decision Analysis and Resolution process area for more*
12659 *information about structured decision making for selecting the team*
12660 *structure.* [PA167.IG104.SP101.SubP107.R101]

12661 The integrated team structure that meets the objectives, subject to the constraints
12662 of time, money, and people, is collaboratively evaluated and selected from the
12663 alternative integrated team structures. From a team structure maintenance
12664 perspective, this activity would include assessments of the teams already
12665 deployed and candidate alternative structures. [PA167.IG104.SP101.SubP107.N101]

12666 It may be necessary to return to this specific practice if the development in the
12667 next specific practice proves to be infeasible. [PA167.IG104.SP101.SubP107.N102]

12668 **SP 4.2 Develop a Preliminary Distribution of Requirements to Integrated** 12669 **Teams**

12670 ***Develop a preliminary distribution of requirements,***
12671 ***responsibilities, authorities, tasks, and interfaces to teams in the***
12672 ***selected integrated team structure.*** [PA167.IG104.SP102]

12673 This preliminary distribution of requirements to integrated teams is done
12674 before any teams are formed to verify that the selected team structure
12675 is workable and covers all the necessary requirements, responsibilities,
12676 authorities, tasks, and interfaces. If this check is not satisfied it is
12677 necessary to repeat the selection of team structure to meet this check.
12678 This preliminary distribution is a useful compendium of information that
12679 the integrated teams must know to effectively carry out their tasks in an
12680 integrated way. [PA167.IG104.SP102.N101]

12681 **Typical Work Products**

- 12682 1. Preliminary distribution of integrated team authorities and
12683 responsibilities [PA167.IG104.SP102.W101]
- 12684 2. Preliminary distribution of the work product requirements, technical
12685 interfaces, and business (e.g., cost accounting, project
12686 management) interfaces each integrated team will be responsible
12687 for satisfying. [PA167.IG104.SP102.W102]

12688 **Subpractices**

- 12689 1. Assemble requirements and interfaces for integrated teams.
12690 [PA167.IG104.SP102.SubP101]

12691 Assemble for each integrated team the task and work products, along with their
12692 associated requirements and interfaces, for which the team will be responsible.

12693 [PA167.IG104.SP102.SubP101.N101]

- 12694 2. Check that the preliminary distribution of requirements and
12695 interfaces covers all specified product and other requirements.

12696 [PA167.IG104.SP102.SubP102]

12697 In the event that complete coverage of requirements is not achieved, corrective
12698 action should be taken to redistribute requirements or alter the integrated team
12699 structure. [PA167.IG104.SP102.SubP102.N101]

12700 **3. Define responsibilities and authorities for integrated teams.**

12701 [PA167.IG104.SP102.SubP103]

12702 Business, management and other non-technical responsibilities and authorities for
12703 the integrated team are necessary elements to proper team function. Integrated
12704 team responsibilities and authorities are normally developed by the project and
12705 are consistent with established organization practices. Such factors include:

12706 [PA167.IG104.SP102.SubP103.N101]

- 12707 • Authority of teams to pick their own leader
- 12708 • Authority of teams to implement sub teams (e.g., a product team forming an
12709 integration sub-team)
- 12710 • Reporting chains
- 12711 • Reporting requirements (cost, schedule, and performance status)
- 12712 • Progress reporting metrics and methods

12713 **4. Designate the sponsor for each integrated team.**

12714 [PA167.IG104.SP102.SubP104]

12715 An integrated team sponsor is a manager (individual or team) that is responsible
12716 for establishing an integrated team, monitoring its activities and progress, and
12717 taking corrective action when needed. A manager may sponsor one or many
12718 teams. [PA167.IG104.SP102.SubP104.N101]

12719 **SP 4.3 Establish Integrated Teams**

12720 ***Establish and maintain teams in the integrated team structure.***

12721 [PA167.IG104.SP103]

12722 The teams within the selected and satisfactory integrated team
12723 structure are established. This process encompasses the choosing of
12724 team leaders and the assignment of planned responsibilities and
12725 requirements for each team. It also involves providing the resources
12726 required to accomplish the tasks assigned to the team. [PA167.IG104.SP103.N101]

12727 The integrated team structure is a dynamic entity that must be able to
12728 adjust to changes in people, requirements and the nature of tasks, and
12729 to tackle many difficulties. The integrated team structure should be
12730 continuously monitored to detect malfunctions, mismanaged interfaces,
12731 and mismatches of the work to the staff. Corrective action should be
12732 taken when performance does not meet expectations. [PA167.IG104.SP103.N102]

12733 **Typical Work Products**

- 12734 1. A list of project integrated teams [PA167.IG104.SP103.W101]

- 12735 2. List of team leaders [PA167.IG104.SP103.W102]
- 12736 3. Responsibilities and authorities for each integrated team
- 12737 [PA167.IG104.SP103.W103]
- 12738 4. Requirements allocated to each integrated team [PA167.IG104.SP103.W104]
- 12739 5. Performance measures of integrated teams [PA167.IG104.SP103.W105]
- 12740 6. PPQA reports [PA167.IG104.SP103.W106]
- 12741 7. Periodic status reports [PA167.IG104.SP103.W107]
- 12742 8. New integrated team structures [PA167.IG104.SP103.W108]
- 12743 **Subpractices**
- 12744 1. Choose integrated team leaders. [PA167.IG104.SP103.SubP101]
- 12745 Integrated team leaders are selected who can achieve the expectations of the
- 12746 product in the context of organizational limitations (project priority and the needs
- 12747 of other projects). Integrated teams need a great deal of autonomy to faithfully
- 12748 implement IPPD. That autonomy is at risk if project or organizational leadership
- 12749 does not have confidence in the leader. The extent of organizational and project
- 12750 direction in selecting the leader is often a function of product risk and complexity.
- 12751 It can also be related to an organization's need to "grow" new leaders.
- 12752 [PA167.IG104.SP103.SubP101.N101]
- 12753 2. Allocate responsibilities and requirements to each integrated team.
- 12754 [PA167.IG104.SP103.SubP102]
- 12755 The planned responsibilities and requirements are issued to the integrated team.
- 12756 These items are discussed with the team to encourage collaborative buy-in. Some
- 12757 adjustments may be made at this time. [PA167.IG104.SP103.SubP102.N101]
- 12758 3. Allocate resources to each integrated team. [PA167.IG104.SP103.SubP103]
- 12759 The people and other resources are allocated to each integrated team. These
- 12760 items are discussed with the team to assure that the resources are adequate and
- 12761 that the people are adequate to carry out the tasks and that they are compatible
- 12762 with other members of the team. [PA167.IG104.SP103.SubP103.N101]
- 12763 4. Create each integrated team. [PA167.IG104.SP103.SubP104]
- 12764 *Refer to the Integrated Teaming process area for more information*
- 12765 *about forming and sustaining each of the integrated teams in the team*
- 12766 *structure.* [PA167.IG104.SP103.SubP104.R101]

12767	<p>For each integrated team in the selected structure, create a team that has a shared vision, charter, and operating principles as described in the Integrated Teaming process area. Creating the integrated team is a collaborative effort of the team sponsor and the members of the team. Other stakeholders may be involved in accord with the plan for stakeholder involvement. The teams that interface with the target team should be involved to assure that the specified interfaces are honored. [PA167.IG104.SP103.SubP104.N101]</p>
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12774	<p>5. Integrated team composition and structures are periodically evaluated and modified to best reflect project needs.</p> <p>[PA167.IG104.SP103.SubP105]</p> <p>Changes in team structure could include: [PA167.IG104.SP103.SubP105.N101]</p> <ul style="list-style-type: none"> • Retiring a team for a period of time (e.g., while long duration manufacturing or verifications are done) • Disbanding a team when it is no longer cost-effective in serving the project • Combining teams to achieve operating efficiencies • Adding teams as new product components are identified for development.
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12778	<p>6. When a change of team leader or a significant change of membership of the team occurs, review the integrated team composition and its place in the integrated team structure.</p> <p>[PA167.IG104.SP103.SubP106]</p> <p>A change of this kind may significantly affect the ability of the team to accomplish its objectives. A review of the match between the new composition and the current responsibilities should be made. If the match is not satisfactory then the team composition should be changed or the team's responsibility should be modified. One complication of changed responsibility is that other teams may have to adjust and add tasks to cover the change. This fact may cause a domino effect in the team structure. Such a change should be undertaken carefully.</p> <p>[PA167.IG104.SP103.SubP106.N101]</p>
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12787	<p>7. When a change in team responsibility occurs, review the team composition and its tasking. [PA167.IG104.SP103.SubP107]</p> <p>These changes often occur as the project moves from one phase to the next. For example, from completion of detailed design and move into fabrication and integration of product components is sometimes chosen as a transition point where less design expertise on teams may be necessary. [PA167.IG104.SP103.SubP107.N101]</p>
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12795	<p>8. Manage the overall performance of the teams. [PA167.IG104.SP103.SubP108]</p> <p><i>Refer to the Use the Project's Defined Process specific goal of the Integrated Project Management (IPPD) process area for more information about practices to manage the overall performance of the teams. [PA167.IG104.SP103.SubP108.R101]</i></p>
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12806 Refer to Project Monitor and Control process area for more information
12807 about monitoring the performance of the teams. [PA167.IG104.SP103.SubP108.R102]

12808 Refer to the Measurement and Analysis process area for more
12809 information about collecting and analyzing performance of the teams.
12810 [PA167.IG104.SP103.SubP108.R103]

12811 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

12812 ***The process is institutionalized as a defined process.***

12813 Commitment to Perform

12814 **GP 2.1 (CO 1) Establish an Organizational Policy**

12815 ***Establish and maintain an organizational policy for planning and***
12816 ***performing the integrated project management (IPPD) process.***

12817 [GP103]

12818 Elaboration:

12819 This policy establishes organizational expectations for using the
12820 project's defined process and coordinating and collaborating with
12821 relevant stakeholders. It also establishes organizational expectations
12822 for using Integrated Product and Process Development concepts for
12823 carrying out the objectives of the organization. [PA167.EL101]

12824 Ability to Perform

12825 **GP 3.1 (AB 1) Establish a Defined Process**

12826 ***Establish and maintain the description of a defined integrated***
12827 ***project management (IPPD) process.*** [GP114]

12828 **GP 2.2 (AB 2) Plan the Process**

12829 ***Establish and maintain the requirements and objectives, and plans***
12830 ***for performing the integrated project management (IPPD) process.***

12831 [GP104]

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Elaboration:

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These requirements, objectives, and plans are described in the plan for integrated project management. This plan differs from the project plan and subordinate plans described in the specific practices in this process area. The project and subordinate plans address the specific needs and objectives for the project; whereas the plan for integrated project management addresses the overall planning of this process area and how the specific practices will be performed. [PA167.EL107]

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GP 2.3 (AB 3) Provide Resources

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Provide adequate resources for performing the integrated project management (IPPD) 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 to perform project management are given in the Project Planning and Project Monitoring and Control process areas. In addition, examples of tools used in performing the activities of the Integrated Project Management (IPPD) process area include the following: [PA167.EL102]

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- Problem tracking and trouble reporting packages
- Groupware
- Video conferencing
- Integrated decision database
- Integrated product support environments

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GP 2.4 (AB 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 integrated project management (IPPD) process. [GP106]

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GP 2.5 (AB 5) Train People

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Train the people performing or supporting the integrated project management (IPPD) process as needed. [GP107]

12863 Elaboration:

- 12864 Examples of training topics include the following: [PA167.EL103]
- 12865 • Tailoring the organization's set of standard processes to meet the
 - 12866 needs of the project
 - 12867 • Procedures for managing the project based on the project's defined
 - 12868 process
 - 12869 • Using the organization's measurement repository
 - 12870 • Using the organization's process assets
 - 12871 • Building the project's shared vision
 - 12872 • Team building
 - 12873 • Integrated management
 - 12874 • Intergroup coordination
 - 12875 • Group problem solving
 - 12876

12877 Directing Implementation

12878 **GP 2.6 (DI 1) Manage Configurations**

12879 *Place designated work products of the integrated project*

12880 *management (IPPD) process under appropriate levels of*

12881 *configuration management.* [GP109]

12882 Elaboration:

- 12883 Examples of work products placed under configuration management
- 12884 include the following: [PA167.EL104]
- 12885 • The project's defined process
 - 12886 • Project plans
 - 12887 • Subordinate plans
 - 12888 • Integrated plans
 - 12889 • Actual process and product measures collected from the project
 - 12890 • Integrated team structure
 - 12891

12892

GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders

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Identify and involve the relevant stakeholders of the integrated project management (IPPD) process as planned. [GP124]

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Elaboration:

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This generic practice is different from managing stakeholder involvement for the project, which is covered by specific practices within this process area. [PA167.EL108]

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Examples of activities for stakeholder involvement include: [PA167.EL110]

12900

- Resolving issues about the tailoring of the process assets
- Resolving issues among the project plan and the subordinate plans
- Reviewing project performance to align with current and projected needs, objectives, and requirements
- Creating the project's shared vision
- Defining the integrated team structure for the project

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GP 2.8 (DI 3) Monitor and Control the Process

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Monitor and control the integrated project management (IPPD) process against the plan and take appropriate corrective action.

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[GP110]

12911 Elaboration:

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Examples of measures used in monitoring and controlling the activities of the Integrated Process Management process area include the following: [PA167.EL105]

- Number of changes to the project's defined process
- Schedule and effort to tailor the organization's set of standard processes
- Interface coordination issue trends (i.e., number identified and number closed)
- Project's shared vision usage and effectiveness
- Integrated team structure usage and effectiveness - Select indicators of shared vision effectiveness that show there is unity of purpose within the project, and that the project is working together and meeting its objectives. Indicators should also show that behaviors and principles have been established and are being used while working to achieve the objective and that the shared vision of the project align with the existing visions of the organization and other projects, particularly those with which close interaction is expected.

12931 **GP 3.2**

(DI 4) Collect Improvement Information

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Collect work products, measures, measurement results, and improvement information derived from planning and performing the integrated project management (IPPD) process to support the future use and improvement of the organization's processes and process assets. [GP117]

12937 Verifying Implementation

12938 **GP 2.9**

(VE 1) Objectively Evaluate Adherence

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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]

12943

Elaboration:

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Examples of activities reviewed include the following: [PA167.EL106]

12945

- Establishing, maintaining, and using the project's defined process

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- Coordinating and collaborating with relevant stakeholders

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- Using the project's shared vision

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Examples of work products reviewed include the following: [PA167.EL109]

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- Project's defined process

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- Project plans

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- Subordinate plans

12953

- Integrated plans

12954

- Shared vision statements

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

12957

Review the activities, status, and results of the integrated project management (IPPD) process with higher-level management and resolve issues. [GP112]

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12959

12960 RISK MANAGEMENT

12961 Maturity Level 3

12962 Purpose

12963 The purpose of Risk Management is to identify potential problems
12964 before they occur, so that risk-handling activities may be planned and
12965 invoked as needed across the life cycle to mitigate adverse impacts on
12966 achieving objectives. [PA148]

12967 Introductory Notes

12968 Risk Management is a continuous, forward-looking process that is an
12969 important part of business and technical management processes. Risk
12970 management needs to address issues that could endanger critical
12971 objectives. A continuous risk management approach is applied to
12972 ensure effective anticipation and mitigation of risks with critical impact
12973 across the project life cycle. [PA148.N101]

12974 Effective risk management includes early and aggressive risk
12975 identification through the collaboration and involvement of relevant
12976 stakeholders, as described in the stakeholder involvement plan
12977 developed in the Project Planning process area. Strong leadership
12978 across all affected parties is needed to establish an environment for the
12979 free and open disclosure and discussion of risk. [PA148.N102]

12980 While technical issues are a primary concern both early on and
12981 throughout all project phases, risk management must consider both
12982 internal and external sources for cost, schedule, and technical risk.
12983 Early and aggressive detection of risk is important because it is typically
12984 easier, less costly, and less disruptive to make changes and correct
12985 work efforts than to modify or revise products or project elements at the
12986 middle or end of the development process. [PA148.N103]

12987 Risk management may be divided into three parts: defining a risk
12988 management strategy; identifying and analyzing risks; and handling
12989 identified risks, including the implementation of risk mitigation plans
12990 when needed. [PA148.N104]

12991 As represented in the Project Planning process area and Project
12992 Monitoring and Control process area, organizations may initially focus
12993 simply on risk identification for awareness, and react to the realization
12994 of these risks as they occur. The Risk Management process area
12995 describes an evolution of these practices to systematically plan,
12996 anticipate, and mitigate risks to proactively minimize their impact to the
12997 project. [PA148.N105]

12998 Although the primary emphasis of the Risk Management process area
12999 is on the project, the concepts may also be applied to manage
13000 organizational risks. Risk mitigation strategies should be guided by a
13001 shared product vision to ensure the product's perspective is maintained.
13002 [PA148.N106]

13003 Related Process Areas

13004 *Refer to the Project Planning Process Area for more information about*
13005 *identification of project risks and planning for involvement of relevant*
13006 *stakeholders.* [PA148.R101]

13007 *Refer to the Project Monitoring and Control process area for more*
13008 *information about monitoring project risks.* [PA148.R102]

13009 *Refer to the Decision Analysis and Resolution process area for more*
13010 *information about using a structured decision-making approach to*
13011 *evaluate alternatives for selection and mitigation of identified risks.*
13012 [PA148.R103]

13013 Specific and Generic Goals

13014 **SG 1 Prepare for Risk Management** [PA148.IG101]

13015 ***Preparation for risk management is conducted.***

13016 **SG 2 Identify and Analyze Risks** [PA148.IG102]

13017 ***Risks are identified and analyzed to determine their relative importance.***

13018 **SG 3 Mitigate Risks** [PA148.IG103]

13019 ***Risks are handled and mitigated, where appropriate, to reduce adverse***
13020 ***impacts on achieving objectives.***

13021 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

13022 ***The process is institutionalized as a defined process.***

13023 Practice to Goal Relationship Table

13024	SG 1 Prepare for Risk Management [PA148.IG101]		
13025	SP 1.1	Determine Risk Sources and Categories	
13026	SP 1.2	Define Risk Parameters	
13027	SP 1.3	Establish a Risk Management Strategy	
13028	SG 2 Identify and Analyze Risks [PA148.IG102]		
13029	SP 2.1	Identify Risks	
13030	SP 2.2	Evaluate, Classify, and Prioritize Risks	
13031	SG 3 Mitigate Risks [PA148.IG103]		
13032	SP 3.1	Develop Risk Mitigation Plans	
13033	SP 3.2	Implement Risk Mitigation Plans	
13034	GG 3 Institutionalize a Defined Process		
13035	GP 2.1	(CO 1)	Establish an Organizational Policy
13036	GP 3.1	(AB 1)	Establish a Defined Process
13037	GP 2.2	(AB 2)	Plan the Process
13038	GP 2.3	(AB 3)	Provide Resources
13039	GP 2.4	(AB 4)	Assign Responsibility
13040	GP 2.5	(AB 5)	Train People
13041	GP 2.6	(DI 1)	Manage Configurations
13042	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
13043	GP 2.8	(DI 3)	Monitor and Control the Process
13044	GP 3.2	(DI 4)	Collect Improvement Information
13045	GP 2.9	(VE 1)	Objectively Evaluate Adherence
13046	GP 2.10	(VE 2)	Review Status with Higher-Level Management

13047 Specific Practices by Goal

13048 **SG 1 Prepare for Risk Management** [PA148.IG101]

13049 ***Preparation for risk management is conducted.***

13050 The strategy used to identify, analyze, and mitigate risks is established
 13051 and maintained. This is typically documented in a project risk
 13052 management plan. The risk management strategy addresses the
 13053 specific actions, resources, and management approach used to apply
 13054 and control the risk management program. This includes planning for
 13055 the sources of risk, the scheme used to categorize risks, and the
 13056 parameters used to evaluate, bound, and control risks for effective
 13057 handling. [PA148.IG101.N101]

13058 **SP 1.1 Determine Risk Sources and Categories**

13059 ***Determine risk sources and categories.*** [PA148.IG101.SP101]

13060 Identification of risk sources provides a basis for systematically
13061 examining changing situations over time to uncover circumstances that
13062 impact the ability of the project to meet its objectives. Risk sources are
13063 both internal and external to the project. As the project progresses,
13064 additional sources of risk may be identified. Establishing categories for
13065 risks provides a mechanism for collecting and organizing risks as well
13066 as ensuring appropriate scrutiny and management attention for those
13067 risks that can have more serious consequences on meeting project
13068 objectives. [PA148.IG101.SP101.N101]

13069 **Typical Work Products**

- 13070 1. Risk source lists (external and internal) [PA148.IG101.SP101.W101]
13071 2. Risk categories list [PA148.IG101.SP101.W102]

13072 **Subpractices**

- 13073 1. Determine risk sources. [PA148.IG101.SP101.SubP101]

13074 There are many sources of risks, both internal (e.g., the ability to produce a
13075 design, known weaknesses in a process application such as requirements
13076 allocation) and external (e.g., funding stability, natural environment) to the project.
13077 Some typical important risk areas are as follows: [PA148.IG101.SP101.SubP101.N101]

- 13078 • uncertain requirements
- 13079 • design feasibility
- 13080 • test and evaluation adequacy
- 13081 • technology availability
- 13082 • support concept
- 13083 • producibility
- 13084 • overlap of essential activities
- 13085 • developer capability
- 13086 • cost or funding issues
- 13087 • insufficient monitoring
- 13088 • unrealistic schedule estimates or allocation
- 13089 • inadequate personnel resources
- 13090 • safety issues
- 13091 • health issues
- 13092 • security

13093 Often accepted without adequate planning are many external sources of risk,
13094 such as single, limited, and diminishing sources of supply, or the natural
13095 environment. Early identification of internal and external sources of risk can result
13096 in simple mitigation plans that can be implemented early in the project to preclude
13097 occurrence of the risk or reduce the consequences of its occurrence.

[PA148.IG101.SP101.SubP101.N102]

13099 **2. Determine risk categories** [PA148.IG101.SP101.SubP102]

13100 Risk categories reflect the "bins" for collecting and organizing risks as well as
13101 establishing a common set of levels (or categories) that can be applied in
13102 assessing each risk. Categories include sources of risk (e.g., technology,
13103 environment, manufacturing, and design), and impacts of risk (cost, schedule, and
13104 performance). A risk taxonomy framework can be used to collect and organize
13105 risks according to common risk classes, elements, and attributes.

[PA148.IG101.SP101.SubP102.N101]

13107 **SP 1.2 Define Risk Parameters**

13108 ***Define the parameters used to analyze and classify risks, and the***
13109 ***parameters used to control the risk management effort.***

13110 [PA148.IG101.SP102]

13111 Parameters for evaluating, classifying, and prioritizing risks include
13112 criteria for risk likelihood and consequence levels, thresholds (or control
13113 points) by category, and the bounds that define the extent those
13114 thresholds are applied. Control parameters for the risk management
13115 effort include the level of control for risks, the approval levels for
13116 implementing mitigation and accepting the results of that mitigation, risk
13117 reassessment intervals, and rules used to consolidate risks.

13118 [PA148.IG101.SP102.N101]

13119 **Typical Work Products**

- 13120 1. Risk evaluation, classification, and prioritization criteria

13121 [PA148.IG101.SP102.W101]

- 13122 2. Risk management requirements (control and approval levels,
13123 reassessment intervals, etc.) [PA148.IG101.SP102.W102]

13124 **Subpractices**

- 13125 1. Define consistent criteria for evaluating and quantifying risk
13126 likelihood and severity levels. [PA148.IG101.SP102.SubP101]

13127 Consistently used criteria (e.g., the bands on the likelihood and severity levels)
13128 allows the impacts of different risks to be commonly understood, receive the
13129 appropriate level of scrutiny, and obtain the management attention warranted. In
13130 managing dissimilar risks (for example, personnel safety versus environmental
13131 pollution), it is important to ensure consistency in end result (e.g., a high risk of
13132 environmental pollution is as important as a high risk to personnel safety).

13133 [PA148.IG101.SP102.SubP101.N101]

13134 2. Define thresholds for each risk category. [PA148.IG101.SP102.SubP102]

13135 For each risk category, thresholds (or control points) can be established to
13136 determine acceptability or unacceptability of risks, prioritization of risks, or triggers
13137 for management action. For example, project wide thresholds could be
13138 established such as when product costs exceed 10% of the target cost. These
13139 may be refined later, for each identified risk, to establish points at which more
13140 aggressive risk monitoring is employed or to signal the implementation of
13141 mitigation plans. [PA148.IG101.SP102.SubP102.N101]

13142 3. Define bounds on the extent to which thresholds are applied
13143 against or within a category. [PA148.IG101.SP102.SubP103]

13144 There are few limits to what risks can be assessed in either a quantitative or
13145 qualitative fashion. Definition of bounds (or boundary conditions) can be used to
13146 help scope the extent of the risk management effort and avoid excessive resource
13147 expenditures. Bounds may include exclusion of a risk source from a category, for
13148 example, not including asteroids under environment risks. These bounds may
13149 also exclude any condition that occurs less than a given frequency, for example,
13150 exclude any events that have a likelihood of occurrence of less than 10% over the
13151 expected lifetime of the product. [PA148.IG101.SP102.SubP103.N101]

13152 SP 1.3 Establish a Risk Management Strategy

13153 ***Establish and maintain the strategy and methods to be used for***
13154 ***risk management.*** [PA148.IG101.SP103]

13155 A comprehensive risk management strategy addresses items such as
13156 the following: [PA148.IG101.SP103.N101]

- 13157 • The scope used to bound the risk management effort
- 13158 • Methods and tools to be used for risk identification, risk analysis,
13159 risk mitigation, risk monitoring, and communication
- 13160 • Project-specific sources of risks
- 13161 • How these risks are to be organized, classified, bounded and
13162 consolidated
- 13163 • Global thresholds, parameters and criteria for taking action on
13164 identified risks

- 13165 • Risk mitigation techniques to be used, such as prototyping,
13166 simulation, alternative designs, or evolutionary development
 - 13167 • Responsibilities such as control or approval levels
 - 13168 • Definition of risk measures to monitor the status of the risks
 - 13169 • Time intervals for risk monitoring or reassessment
- 13170 The risk management strategy should be guided by a common vision of
13171 success that describes the desired future project outcomes, in terms of
13172 the product that is delivered, its cost, and its fitness for the task.

13173 [PA148.IG101.SP103.N102]

13174 The risk management strategy is often captured in a project risk
13175 management plan. The risk management strategy is reviewed with
13176 relevant stakeholders in order to promote commitment and
13177 understanding. [PA148.IG101.SP103.N103]

13178 **Typical Work Products**

- 13179 1. Project risk management plan [PA148.IG101.SP103.W101]

13180 **SG 2 Identify and Analyze Risks** [PA148.IG102]

13181 ***Risks are identified and analyzed to determine their relative importance.***

13182 The degree of risk impacts the resources assigned to handle an
13183 identified risk and in determining when appropriate management
13184 attention is required. [PA148.IG102.N101]

13185 Analyzing risks entails the identification of risks from the internal and
13186 external sources identified and then evaluating each identified risk to
13187 determine its likelihood and consequences. Classification of the risk,
13188 based on an evaluation against the established risk categories and
13189 criteria developed for the risk management strategy, provides the
13190 information needed for risk handling. Related risks may be grouped for
13191 efficient handling and effective use of risk management resources.

13192 [PA148.IG102.N102]

13193 **SP 2.1 Identify Risks**

13194 ***Identify and document the risks.*** [PA148.IG102.SP101]

13195 ***For Integrated Product and Process Development***

13196 *The particular risks associated with conducting the project*
13197 *using integrated teams need to be considered. For example,*
13198 *risks associated with loss of inter-team or intra-team*
13199 *coordination.* [PA148.IG102.SP101.AMP101]

13200

13201 The identification of potential issues, hazards, threats, vulnerabilities,
13202 etc., that could negatively affect work efforts or plans is the basis for
13203 sound and successful risk management. Risks must be identified, and
13204 described in an understandable way before they can be analyzed and
13205 managed properly. Risks are documented in a concise statement that
13206 includes the context, conditions, and consequences of risk occurrence.

[PA148.IG102.SP101.N101]

13208 Risk identification should be an organized, thorough approach to seek
13209 out probable or realistic risks in achieving objectives. To be effective,
13210 risk identification should not be an attempt to address every possible
13211 event regardless of how highly improbable it may be. Use of the
13212 categories and parameters developed in the risk management strategy,
13213 along with the identified sources of risk, can provide the discipline and
13214 streamlining appropriate to risk identification. The identified risks form a
13215 baseline to initiate risk management activities. The list of risks should
13216 be reviewed periodically to re-examine possible sources of risk and
13217 changing conditions to uncover sources and risks previously overlooked
13218 or non-existent when the risk management strategy was last updated.

[PA148.IG102.SP101.N102]

13220 Risk identification activities focus on the identification of risks, not
13221 placement of blame. The results of risk identification activities are not
13222 used by management to evaluate the performance of individuals.

[PA148.IG102.SP101.N104]

13224 There are many methods for identifying risks. Typical identification
13225 methods include the following: [PA148.IG102.SP101.N103]

- 13226 • Examine each element of the project work breakdown structure to
- 13227 uncover risks.
- 13228 • Conduct a risk assessment using a risk taxonomy.
- 13229 • Interview subject matter experts.
- 13230 • Review risk management efforts from similar products.
- 13231 • Examine lessons-learned documents or databases.
- 13232 • Examine design specifications and agreement requirements.

13233 **Typical Work Products**

- 13234 1. List of identified risks, including the context, conditions, and
- 13235 consequences of risk occurrence [PA148.IG102.SP101.W101]

13236 **Subpractices**

- 13237 1. Identify the risks associated with cost, schedule, and performance
- 13238 in all appropriate product life-cycle phases. [PA148.IG102.SP101.SubP101]

13239 Cost, schedule, and performance risks should be examined during all phases of
13240 the product life cycle to the extent they impact project objectives. There may be
13241 potential risks discovered that are outside the scope of the project's objectives but
13242 vital to customer interests. For example, the risks in development costs, product
13243 acquisition costs, cost of spare (or replacement) products, and product disposition
13244 (or disposal) costs have design implications during development. The customer
13245 may not have provided requirements for the cost of supporting the fielded product.
13246 The customer should be informed of such risks but actively managing those risks
13247 may not be necessary. The mechanisms for making such decisions should be
13248 examined at project and organization levels and put in place if deemed
13249 appropriate, especially for risks that impact product validation.

[PA148.IG102.SP101.SubP101.N101]

13251 In addition to the cost risks identified above, development cost risks can include
13252 those associated with funding levels, funding estimates, and distributed budget.

13253 [PA148.IG102.SP101.SubP101.N102]

13254 Development schedule risks can include those risks associated with planned
13255 activities, key events, and milestones. [PA148.IG102.SP101.SubP101.N103]

13256 Performance risks may include risks associated with the following:

13257 [PA148.IG102.SP101.SubP101.N104]

- 13258 • Requirements
- 13259 • Analysis and design
- 13260 • Application of new technology
- 13261 • Physical size
- 13262 • Shape
- 13263 • Weight
- 13264 • Manufacturing and fabrication
- 13265 • Functional performance and operation
- 13266 • Verification
- 13267 • Performance maintenance attributes

13268 Performance maintenance attributes are those characteristics that enable an in-
13269 use product to provide originally required performance, for example, maintaining
13270 safety and security performance. [PA148.IG102.SP101.SubP101.N105]

13271 There are other risks that do not fall "neatly" into cost, schedule, or performance
13272 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 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]

13307 The rating of risks is needed to assign relative importance to each
13308 identified risk, to be used in determining when appropriate management
13309 attention is required. Often it is useful to aggregate risks based on their
13310 inter-relationships, and develop options at an aggregate level. When an
13311 aggregate risk is formed by a roll-up of lower-level risks, care must be
13312 taken to assure that important lower-level risks are not ignored.

13313 [PA148.IG102.SP102.N101]

13314 Risks are quantified using parameters such as likelihood (probability),
13315 and consequence (impact), but may also include additional parameters.
13316 A combination of these rated values is typically used to determine
13317 overall priority for risk handling. [PA148.IG102.SP102.N102]

13318 Collectively, the activities of risk evaluation, classification, and
13319 prioritization are sometimes called risk assessment or risk analysis.

13320 [PA148.IG102.SP102.N103]

13321 **Typical Work Products**

- 13322 1. List of risks, with a rating of parameter values for each risk

13323 [PA148.IG102.SP102.W101]

13324 **Subpractices**

- 13325 1. Evaluate the identified risks using the defined risk parameters.

13326 [PA148.IG102.SP102.SubP101]

13327 Each risk is evaluated and assigned values in accordance with the defined risk
13328 evaluation parameters, which may include likelihood, consequence (severity, or
13329 impact), and timeframe. The assigned risk parameter values can be integrated to
13330 produce additional measures, such as risk exposure, which can be used to
13331 prioritize risks for handling. [PA148.IG102.SP102.SubP101.N101]

13332 Often a scale with three to five values is used to rate both likelihood and
13333 consequence. Likelihood, for example, can be categorized as remote, unlikely,
13334 likely, highly likely, or a near certainty. [PA148.IG102.SP102.SubP101.N102]

13335 Examples for consequences include: [PA148.IG102.SP102.SubP101.N104]

- 13336
- Low
 - Medium
 - High
 - Negligible
 - Marginal
 - Significant
 - Critical
 - Catastrophic
- 13337
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13345 Probability values are frequently used to quantify likelihood. Consequences are
13346 generally related to cost, schedule, environmental impact, or human measures
13347 (such as labor hours lost and severity of injury). [PA148.IG102.SP102.SubP101.N105]

13348 This evaluation is often a difficult and time-consuming task. Specific expertise or
13349 group techniques may be needed to assess the risks and gain confidence in the
13350 ratings. In addition, ratings may require reevaluation as time progresses.
13351 [PA148.IG102.SP102.SubP101.N103]

13352 2. Classify and group risks according to the defined risk categories.
13353 [PA148.IG102.SP102.SubP102]

13354 Risks are classified into the defined risk categories, providing a means to look at
13355 risks according to their source, taxonomy, or project component. Related or
13356 equivalent risks may be grouped for efficient handling. The cause and effect
13357 relationships between related risks are captured. [PA148.IG102.SP102.SubP102.N101]

13358 3. Prioritize risks for mitigation. [PA148.IG102.SP102.SubP103]

13359 A relative priority is determined for each risk, based on the assigned risk
13360 parameters. Clear criteria should be used to determine the risk priority. The intent
13361 of prioritization is to determine the most effective areas to apply resources for
13362 mitigation of risks with the greatest impact to the project. [PA148.IG102.SP102.SubP103.N101]

13363 **SG 3 Mitigate Risks** [PA148.IG103]

13364 ***Risks are handled and mitigated, where appropriate, to reduce adverse***
13365 ***impacts on achieving objectives.***

13366 The steps in handling risks include developing risk-handling options,
13367 monitoring risks, and performing risk-handling activities when defined
13368 thresholds are exceeded. Mitigation plans are developed and
13369 implemented for selected risks to proactively reduce the potential
13370 impact of risk occurrence. This may also include contingency plans to
13371 deal with the impact of selected risks that may occur despite attempts to
13372 mitigate them. The criteria, thresholds, and parameters used to trigger
13373 risk-handling activities are defined by the risk management strategy.
13374 [PA148.IG103.N101]

13375 **SP 3.1 Develop Risk Mitigation Plans**

13376 ***Develop a risk mitigation plan for the most important risks to the***
13377 ***project, as defined by the risk management strategy.*** [PA148.IG103.SP101]

13378 A risk mitigation plan determines the levels and thresholds that define
13379 when an identified risk becomes unacceptable, and triggers risk-
13380 handling activity. Mitigation plans are often generated only for selected
13381 risks of high consequence; other risks may be accepted and simply
13382 monitored. [PA148.IG103.SP101.N101]

13383 A critical component of a risk mitigation plan is to develop alternative
13384 courses of action, workarounds, and fallback positions, with a
13385 recommended course of action for each critical risk. The risk mitigation
13386 plan for a given risk includes techniques and methods to avoid, reduce,
13387 and control the probability of occurrence of the risk, the extent of
13388 damage incurred should the risk occur (sometimes called a contingency
13389 plan), or both. These mitigation plans are deployed upon exceeding the
13390 established thresholds in order to return the impacted effort to an
13391 acceptable risk level. The risk management strategy defines the criteria,
13392 thresholds and parameters to be used in determining when risk-
13393 handling actions are necessary. [PA148.IG103.SP101.N102]

13394 Options for handling risks typically include alternatives such as the
13395 following: [PA148.IG103.SP101.N103]

- 13396 • Risk avoidance: Changing or lowering requirements while still
13397 meeting the user's needs
- 13398 • Risk control: Taking active steps to minimize risks
- 13399 • Risk transfer: Reallocating design requirements to lower the risks
- 13400 • Risk monitor: Watching and periodically reevaluating the risk for
13401 changes to the assigned risk parameters
- 13402 • Risk acceptance: Acknowledgment of risk but deciding not to take
13403 any action

13404 Often, especially for "high" risks, more than one approach to handling a
13405 risk should be generated. [PA148.IG103.SP101.N104]

13406 In many cases, risks will be accepted or watched, Risk acceptance is
13407 usually done when the risk is judged too low for formal mitigation, or
13408 when there appears to be no viable way to reduce the risk. If a risk is
13409 accepted, the rationale for this decision should be documented. Risks
13410 are watched when there is an objectively defined, verifiable and
13411 documented threshold of performance, time, or risk exposure (the
13412 combination of likelihood and consequence) that will trigger risk
13413 mitigation planning or invoke a contingency plan if it is needed.

13414 [PA148.IG103.SP101.N105]

13415 Adequate consideration should be given early to technology
13416 demonstrations, models, simulations, and prototypes as part of risk
13417 mitigation planning. [PA148.IG103.SP101.N106]

13418 **Typical Work Products**

- 13419 1. Documented handling options for each identified risk
13420 [PA148.IG103.SP101.W101]
- 13421 2. Mitigation plans [PA148.IG103.SP101.W102]
- 13422 3. List of those responsible for tracking and addressing each risk
13423 [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]

13463 Some risk management literature may consider contingency plans a synonym or
13464 subset of mitigation plans. They also may be addressed together termed as risk
13465 handling or risk action plans. [PA148.IG103.SP101.SubP105.N102]

13466 SP 3.2 Implement Risk Mitigation Plans

13467 ***Monitor the status of each risk periodically and implement the risk***
13468 ***mitigation plan as appropriate.*** [PA148.IG103.SP102]

13469 To effectively control and manage risks through the duration of the work
13470 effort, follow a proactive program to regularly monitor risks and the
13471 status and results of the risk-handling actions. The risk management
13472 strategy defines the intervals at which the risk status should be
13473 revisited. This activity may result in the discovery of new risks or new
13474 risk-handling options that may require re-planning and reassessment.
13475 In either event, the acceptability thresholds associated with the risk
13476 should be compared against the status to determine the need for
13477 implementing a mitigation plan. [PA148.IG103.SP102.N101]

13478 Typical Work Products

- 13479 1. Updated lists of risk status [PA148.IG103.SP102.W101]
- 13480 2. Updated assessments of risk likelihood, consequence, ratings, and
13481 thresholds [PA148.IG103.SP102.W102]
- 13482 3. Updated lists of risk-handling options [PA148.IG103.SP102.W103]
- 13483 4. Updated list of actions taken to handle risks [PA148.IG103.SP102.W104]
- 13484 5. Mitigation plans [PA148.IG103.SP102.W105]

13485 Subpractices

- 13486 1. Monitor risk status. [PA148.IG103.SP102.SubP101]

13487 After a risk mitigation plan is initiated, the risk is still monitored.

13488 [PA148.IG103.SP102.SubP101.N101]

13489 A periodic mechanism for monitoring should be employed. [PA148.IG103.SP102.SubP101.N102]

- 13490 2. Provide a method for tracking open risk-handling action items to
13491 closure. [PA148.IG103.SP102.SubP102]

13492 *Refer to the Project Monitoring and Control process area for more*
13493 *information about tracking action items.* [PA148.IG103.SP102.SubP102.R101]

- 13494 3. Invoke selected risk-handling options when monitored risks exceed
13495 the defined thresholds. [PA148.IG103.SP102.SubP103]

13496 Quite often, risk-handling is only performed for those risks judged to be "high" and
 13497 "medium." The risk-handling strategy for a given risk may include techniques and
 13498 methods to avoid, reduce and control the likelihood of the risk or the extent of
 13499 damage incurred should the risk (anticipated event or situation) occur or both. In
 13500 this context, risk handling includes both risk mitigation plans and contingency
 13501 plans. [PA148.IG103.SP102.SubP103.N101]

13502 Risk handling techniques are developed to avoid, reduce, and control adverse
 13503 impact to project objectives and to bring about acceptable outcomes in light of
 13504 probable impacts. Actions generated to handle a risk require proper resource
 13505 loading and scheduling within plans and baseline schedules. This re-planning
 13506 effort needs to closely consider the effects on adjacent or dependent work
 13507 initiatives or activities. [PA148.IG103.SP102.SubP103.N102]

13508 *Refer to the Project Monitoring and Control process area for more*
 13509 *information about revising the project plan.* [PA148.IG103.SP102.SubP103.N102.R101]

13510 4. Establish a schedule or period of performance for each risk-
 13511 handling plan or activity that includes the start date and anticipated
 13512 completion date. [PA148.IG103.SP102.SubP104]

13513 5. Provide continued commitment of resources for each plan to allow
 13514 successful execution of the risk-handling strategy.

13515 [PA148.IG103.SP102.SubP105]

13516 6. Collect performance metrics on the risk handling activities.

13517 [PA148.IG103.SP102.SubP106]

13518 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

13519 ***The process is institutionalized as a defined process.***

13520 **Commitment to Perform**

13521 **GP 2.1 (CO 1) Establish an Organizational Policy**

13522 ***Establish and maintain an organizational policy for planning and***
 13523 ***performing the risk management process.*** [GP103]

13524 Elaboration:

13525 This policy establishes organizational expectations for defining a risk
 13526 management strategy and identifying, analyzing, and mitigating risks.

13527 [PA148.EL101]

13528 Ability to Perform

13529 **GP 3.1 (AB 1) Establish a Defined Process**

13530 ***Establish and maintain the description of a defined risk***
13531 ***management process.*** [GP114]

13532 **GP 2.2 (AB 2) Plan the Process**

13533 ***Establish and maintain the requirements and objectives, and plans***
13534 ***for performing the risk management process.*** [GP104]

13535 Elaboration:

13536 These requirements, objectives, and plans are described in the plan for
13537 risk management. This plan for risk management differs from the risk
13538 management strategy described in the specific practice in this process
13539 area. The risk management strategy addresses risk sources,
13540 categories, parameters, and management control and reporting
13541 requirements; whereas the plan for risk management addresses high
13542 level planning for all the risk management activities. [PA148.EL103]

13543 **GP 2.3 (AB 3) Provide Resources**

13544 ***Provide adequate resources for performing the risk management***
13545 ***process, developing the work products and providing the services***
13546 ***of the process.*** [GP105]

13547 Elaboration:

13548 Examples of tools used in performing the activities of the Risk
13549 Management process area include the following: [PA148.EL106]

- 13550 • Risk management databases
- 13551 • Risk mitigation tools
- 13552 • Prototyping tools
- 13553 • Modeling and simulation

13555 **GP 2.4 (AB 4) Assign Responsibility**

13556 ***Assign responsibility and authority for performing the process,***
13557 ***developing the work products, and providing the services of the***
13558 ***risk management process.*** [GP106]

13559

GP 2.5 (AB 5) Train People

13560

Train the people performing or supporting the risk management process as needed. [GP107]

13561

13562

Elaboration:

13563

Examples of training topics include the following: [PA148.EL108]

13564

- Risk management concepts and practices (e.g., risk identification, evaluation, monitoring, mitigation)

13565

13566

- Metric selection for risk mitigation

13567

13568

Directing Implementation

13569

GP 2.6 (DI 1) Manage Configurations

13570

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

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13572

Elaboration:

13573

Examples of work products placed under configuration management include the following: [PA148.EL110]

13574

13575

- Risk management strategy

13576

- Identified risk items

13577

- Risk mitigation plans

13578

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GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders

13580

Identify and involve the relevant stakeholders of the risk management process as planned. [GP124]

13581

13582 Elaboration:

- 13583 Examples of activities for stakeholder involvement include: [PA148.EL120]
- 13584 • Establishing a collaborative environment for free and open
 - 13585 discussion of risk
 - 13586 • Reviewing the risk strategy and risk management plan
 - 13587 • Participating in risk identification, analysis, and mitigation activities
 - 13588 • Communicating and reporting risk management status
 - 13589

13590 **GP 2.8 (DI 3) Monitor and Control the Process**

13591 ***Monitor and control the risk management process against the plan***
13592 ***and take appropriate corrective action.*** [GP110]

13593 Elaboration:

- 13594 Examples of measures used in monitoring and controlling the activities
- 13595 of the Risk Management process area include the following: [PA148.EL113]
- 13596 • Number of risks identified, managed, tracked, and controlled
 - 13597 • Risk exposure and changes to the risk exposure for each assessed
 - 13598 risk, and as a summary percentage of management reserve
 - 13599 • Change activity for the risk management plan (e.g., processes,
 - 13600 schedule, funding)
 - 13601 • Occurrence of unanticipated risks
 - 13602 • Risk categorization volatility
 - 13603 • Comparison of estimated vs. actual risk mitigation effort and impact
 - 13604

13605 **GP 3.2 (DI 4) Collect Improvement Information**

13606 ***Collect work products, measures, measurement results, and***
13607 ***improvement information derived from planning and performing***
13608 ***the risk management process to support the future use and***
13609 ***improvement of the organization's processes and process assets.***

13610 [GP117]

13611 Verifying Implementation

13612 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

13613 ***Objectively evaluate adherence of the risk management process***
13614 ***and the work products and services of the process to the***
13615 ***applicable requirements, objectives, and standards, and address***
13616 ***noncompliance.*** [GP113]

13617 Elaboration:

13618 Examples of activities reviewed include the following: [PA148.EL116]

- 13619
- Establishing and maintaining a risk management strategy
 - Identifying and analyzing risks
 - Mitigating risks
- 13620
- 13621

13622

13623 Examples of work products reviewed include the following: [PA148.EL117]

- 13624
- Risk management strategy
 - Risk mitigation plans
- 13625

13626

13627 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

13628 ***Review the activities, status, and results of the risk management***
13629 ***process with higher-level management and resolve issues.*** [GP112]

13630 Elaboration:

13631 Reviews of the project risk status are held on a periodic and event-
13632 driven basis with appropriate levels of management, to provide visibility
13633 into the potential for project risk exposure and appropriate corrective
13634 action. [PA148.EL118]

13635 Typically, this will include a summary of the most critical risks, key risk
13636 parameters (such as likelihood and consequence of these risks), and
13637 the status of risk mitigation efforts. [PA148.EL119]

13638 INTEGRATED TEAMING

13639 Maturity Level 3

13640 Purpose

13641 The purpose of Integrated Teaming is to form and sustain an integrated
13642 team for the development of work products. [PA170]

13643 Introductory Notes

13644 Integrated team members: [PA170.N101]

- 13645 • provide the needed skills and expertise to accomplish the team's
13646 tasks
- 13647 • provide the advocacy and representation necessary to address all
13648 essential phases of the product life cycle
- 13649 • collaborate internally among themselves and externally with other
13650 teams and stakeholders as appropriate
- 13651 • share a common understanding of the team's tasks and objectives.

13652 An integrated team (also known as an Integrated Product Team or IPT)
13653 is composed of stakeholders who generate and implement decisions for
13654 the work product being developed. The members of the integrated team
13655 are collectively responsible for delivering the work product. The
13656 integrated team receives its assignment from its sponsor. The sponsor
13657 of an integrated team is a person or a group (e.g., project manager or
13658 even another integrated team) who can assign work tasks and provide
13659 resources. [PA170.N102]

13660 The following characteristics distinguish an integrated team in an IPPD
13661 environment from other forms of specialty work or task groups:

13662 [PA170.N103]

- 13663 • Team members include empowered representatives from both
13664 technical and business functional organizations involved with the
13665 product. Within defined boundaries, these representatives have
13666 decision-making authority and the responsibility to act for their
13667 respective organizations during product development.
- 13668 • Team members may include customers, suppliers, and other
13669 stakeholders outside of the organization as appropriate to the
13670 product being developed.
- 13671 • An integrated team consists of people skilled in the functions that
13672 need to be performed to develop required work products. Some of
13673 them may be representing a functional organization. These people

- 13674 have a dual responsibility to focus on the product, while
 13675 maintaining their connections with the functional organization that
 13676 can assist the development with additional expertise and advice.
- 13677 • An integrated team is focused on the product life cycle to the extent
 13678 required by the project. Team members share and integrate
 13679 considerations, expectations, and requirements of the product life-
 13680 cycle phases.
 - 13681 • An integrated team understands its role in the structure of teams
 13682 for the overall project.
- 13683 Clearly defined and commonly understood objectives, tasks,
 13684 responsibilities, authority, and context (of vertical and horizontal
 13685 interfaces) provide a strong basis for implementing integrated teams.
 13686 [PA170.N104]

13687 **Related Process Areas**

13688 *Refer to the Project Planning process area for more information about*
 13689 *planning for project execution within an IPPD environment where*
 13690 *integrated teaming is involved. [PA170.R101]*

13691 *Refer to the Organization Environment for Integration process area for*
 13692 *more information about establishing and maintaining an integrated work*
 13693 *environment and creating organizational process assets for IPPD,*
 13694 *including an organizational shared vision. [PA170.R102]*

13695 *Refer to the Integrated Project Management (IPPD) process area for*
 13696 *more information about coordinating and collaborating with*
 13697 *stakeholders, establishing the team structure, and considering IPPD*
 13698 *organizational process assets. [PA170.R103]*

13699 **Specific and Generic Goals**

13700 **SG 1 Establish Team Composition** [PA170.IG101]

13701 ***Team composition that provides the knowledge and skills required to deliver***
 13702 ***the team's product is established and maintained.***

13703 **SG 2 Govern Team Operation** [PA170.IG102]

13704 ***Operation of the integrated team is governed according to established***
 13705 ***principles.***

13706 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

13707 ***The process is institutionalized as a defined process.***

13708 Practice to Goal Relationship Table

13709	SG 1 Establish Team Composition [PA170.IG101]		
13710	SP 1.1	Identify Team Tasks	
13711	SP 1.2	Identify Needed Knowledge and Skills	
13712	SP 1.3	Assign Appropriate Team Members	
13713	SG 2 Govern Team Operation [PA170.IG102]		
13714	SP 2.1	Establish a Shared Vision	
13715	SP 2.2	Establish a Team Charter	
13716	SP 2.3	Define Roles and Responsibilities	
13717	SP 2.4	Establish Operating Procedures	
13718	SP 2.5	Collaborate among Interfacing Teams	
13719	GG 3 Institutionalize a Defined Process		
13720	GP 2.1	(CO 1)	Establish an Organizational Policy
13721	GP 3.1	(AB 1)	Establish a Defined Process
13722	GP 2.2	(AB 2)	Plan the Process
13723	GP 2.3	(AB 3)	Provide Resources
13724	GP 2.4	(AB 4)	Assign Responsibility
13725	GP 2.5	(AB 5)	Train People
13726	GP 2.6	(DI 1)	Manage Configurations
13727	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
13728	GP 2.8	(DI 3)	Monitor and Control the Process
13729	GP 3.2	(DI 4)	Collect Improvement Information
13730	GP 2.9	(VE 1)	Objectively Evaluate Adherence
13731	GP 2.10	(VE 2)	Review Status with Higher-Level Management

13732 Specific Practices by Goal

13733 **SG 1 Establish Team Composition** [PA170.IG101]

13734 ***Team composition that provides the knowledge and skills required to deliver the team's product is established and maintained.***

13735

13736 Because one of the main attributes of an integrated team is to be self-

13737 managed and empowered, team membership is intended to be

13738 composed of people who can plan, execute, and implement life-cycle

13739 decisions for the work product being acquired and developed. Team

13740 member selection and skill mix should be based on its product-focused

13741 and life cycle objectives and, therefore, should be cross functional and

13742 involve relevant stakeholders. [PA170.IG101.N101]

13743 **SP 1.1 Identify Team Tasks**

13744 ***Identify and define the team's specific internal tasks to generate***

13745 ***the team's expected output.*** [PA170.IG101.SP101]

13746 The sponsor of an integrated team typically provides the assigned
13747 product requirements, the initial technical and business interfaces, and
13748 the high-level task(s) each team will be responsible for satisfying.
13749 Integrated team tasks are based on these product requirements and
13750 interfaces. An integrated team understands its relationship to both the
13751 project and the organization, and structures its tasks accordingly to
13752 develop the work products. [PA170.IG101.SP101.N101]

13753 *Refer to the Establish Project Tasks and Responsibilities specific*
13754 *practice in the Project Planning process area to see how this is done at*
13755 *the project level.* [PA170.IG101.SP101.N101.R101]

13756 **Typical Work Products**

- 13757 1. Descriptions of internal work tasks [PA170.IG101.SP101.W101]
- 13758 2. List of results the team is expected to achieve for all work tasks
13759 [PA170.IG101.SP101.W102]

13760 **Subpractices**

- 13761 1. Define team tasks required to deliver the assigned work products.
13762 [PA170.IG101.SP101.SubP101]
- 13763 2. Decide which tasks need team or individual member input.
13764 [PA170.IG101.SP101.SubP102]

13765 Not all work efforts require efforts of the entire team, but review and judgment is a
13766 team responsibility. [PA170.IG101.SP101.SubP102.N101]

13767 **SP 1.2 Identify Needed Knowledge and Skills**

13768 ***Identify the knowledge, skills, and functional expertise needed to***
13769 ***perform team tasks.*** [PA170.IG101.SP102]

13770 *Refer to the Plan for Needed Knowledge and Skills specific practice in*
13771 *the Project Planning process area. Staffing a team is similar to staffing*
13772 *a project, just at a lower level with respect to a work breakdown*
13773 *hierarchy.* [PA170.IG101.SP102.R101]

13774 The functional knowledge and related job skills within the integrated
13775 team are directly related to the specific team tasks and responsibilities.
13776 A fully effective integrated team is able to perform to all its tasks and is
13777 comprised of all the necessary technical and business specialties,
13778 expertise, and advocates to ensure appropriate coverage for all phases
13779 of the work product life cycle. A profile of essential skill mixes that are
13780 required at all team functions describes the core team, which can be
13781 supplemented with additional skill sets as needed for the extended
13782 team. [PA170.IG101.SP102.N101]

- 13783 **Typical Work Products**
- 13784 1. List of disciplines or functions required to perform the tasks
- 13785 [PA170.IG101.SP102.W101]
- 13786 2. List of the knowledge, key skills, and critical expertise
- 13787 [PA170.IG101.SP102.W102]
- 13788 3. Initial profiles of team skills and knowledge for the core team and
- 13789 the extended team [PA170.IG101.SP102.W103]

- 13790 **Subpractices**
- 13791 1. Identify the business functions or processes that the integrated
- 13792 team must maintain competence in to perform to its objectives.
- 13793 [PA170.IG101.SP102.SubP101]
- 13794 2. Identify the core competencies on which to base the integrated
- 13795 team's activities in order to sustain or achieve desired capability.
- 13796 [PA170.IG101.SP102.SubP102]
- 13797 3. Establish knowledge and skills profiles underlying each core and
- 13798 extended team competency. [PA170.IG101.SP102.SubP103]
- 13799 4. Define staffing and competency requirements. [PA170.IG101.SP102.SubP104]

13800 **SP 1.3 Assign Appropriate Team Members**

13801 ***Assign the appropriate personnel to be team members based on***

13802 ***required knowledge and skills.*** [PA170.IG101.SP103]

13803 Team members are selected and positioned to perform team tasks

13804 based on their ability to satisfy required knowledge, skills, and

13805 functional expertise, and compliment those of other team members.

13806 Team membership may not stay the same throughout the integrated

13807 team's period of performance. Selecting and assigning appropriate new

13808 members to the team, to perform team tasks, is an important element in

13809 maintaining proper team composition and output as members leave,

13810 team expectations change, or the team has evolved to the point where

13811 a different mix of personnel is necessary. [PA170.IG101.SP103.N101]

13812 Examples of relevant criteria for evaluating potential team members

13813 include: [PA170.IG101.SP103.N102]

- 13814 • Knowledge and skills related to tasks and responsibilities
- 13815 associated with the team's assigned work products
- 13816 • Interpersonal skills and ability to work in a team environment
- 13817 • Ability to complement the mix of knowledge and skills in the team
- 13818 • Potential to fulfill a significant responsibility on the team

- 13819 • Ability to acquire additional knowledge, skills, or expertise related
- 13820 to the team's tasks
- 13821 • Existing work load and time available to fulfill responsibilities to the
- 13822 team
- 13823 • Educational and cultural background
- 13824 • Personal (self) motivation
- 13825 • Ability to represent a functional area appropriately

13826 Individual team members are empowered, within defined limits, by their
 13827 respective functional leadership/managers to make decisions. Team
 13828 members can be selected from both within or outside of the
 13829 organization and can include suppliers, customers and end users.
 13830 Their roles and responsibilities in the team operation and product
 13831 development process need to be clearly defined. [PA170.IG101.SP103.N103]

13832 **Typical Work Products**

- 13833 1. Set of selection criteria [PA170.IG101.SP103.W101]
- 13834 2. Revised skills matrix and knowledge profiles [PA170.IG101.SP103.W102]
- 13835 3. List of team members [PA170.IG101.SP103.W103]
- 13836 4. List of the level of effort and resources, including access to staff, to
- 13837 perform each team function [PA170.IG101.SP103.W104]

13838 **Subpractices**

- 13839 1. Establish relevant criteria for evaluating team members against
- 13840 established knowledge and skills profiles. [PA170.IG101.SP103.SubP101]
- 13841 2. Utilize the criteria to qualify appropriate candidates against the
- 13842 knowledge and skills profiles. [PA170.IG101.SP103.SubP102]
- 13843 3. Identify and orient team members to best contribute to the team's
- 13844 capability. [PA170.IG101.SP103.SubP103]
- 13845 4. Assess and determine the integrated team's capability to meet its
- 13846 objectives based on initial staffing and positioning.
- 13847 [PA170.IG101.SP103.SubP104]

13848 It may be required to supplement the team's internal capability with external
 13849 sources to maximize the team's ability. [PA170.IG101.SP103.SubP104.N101]

13850 **SG 2 Govern Team Operation** [PA170.IG102]

13851 ***Operation of the integrated team is governed according to established***
 13852 ***principles.***

13853 An integrated team operates in a disciplined way that brings about
13854 effectiveness and productivity in meeting its objectives. Established
13855 principles and operating practices help both the team leader and team
13856 members to manage group dynamics and to ensure successful
13857 interplay among the multiple functions within the team. [PA170.IG102.N101]

13858 SP 2.1 Establish a Shared Vision

Establish and maintain a shared vision for the integrated team that is aligned with any overarching or higher-level vision.

[PA170.IG102.SP101]

13862 *Refer to the Provide IPPD Infrastructure specific goal in the*
13863 *Organizational Environment for Integration process area for more*
13864 *information on the organization's shared vision.* [PA170.IG102.SP101.R101]

13865 *Refer to the Use the Project's Shared Vision specific goal in the*
13866 *Integrated Project Management (IPPD) process area for more*
13867 *information about the project's shared vision.* [PA170.IG102.SP101.R102]

13868 The purpose of a shared vision is to provide a statement of an
13869 envisioned future and establish common understanding of the
13870 aspirations and governing ideals of the team in the context of that
13871 desired end state. The shared vision anchors the team's governing
13872 ideas and principles and captures the objectives to be achieved. The
13873 shared vision guides the activities of the team and helps drive the team
13874 to achieve their mission and objectives. A shared vision facilitates
13875 working together and helps to attain unity of purpose among team
13876 members. [PA170.IG102.SP101.N101]

13877 No team operates in isolation and a shared vision for the integrated
13878 team is critical to ensure the team's charter, direction, and activities
13879 achieve a fit with any larger project objectives or other interfacing
13880 teams. A team's sponsor(s) or leader may establish the vision for the
13881 organization or a project for which the integrated team is a part. An
13882 integrated team's shared vision, if developed on their own, must be
13883 aligned with and support achievement of the project's and
13884 organization's higher-level objectives as well as its own. When one
13885 team falls short of or strays from of its objectives and vision, it is likely to
13886 cause significant impact to the overall success of the project.

[PA170.IG102.SP101.N102]

13888 Shared vision context has both an external and internal aspect. The
 13889 external aspect has to do with the overlying plan, objectives, and
 13890 interfaces of the team's sponsor and overall organization, while the
 13891 internal aspect is about aligning the group member's personal interests
 13892 and vision with the team's mission and purpose. The shared vision must
 13893 ensure a commitment of the integrated team members to both their
 13894 team and to other interfacing teams and project responsibilities.

13895 [PA170.IG102.SP101.N103]

13896 Aligning personal perceptions of the people within the team is an
 13897 important part of understanding and accepting the shared vision. As
 13898 such, a shared vision is usually not the product of one person's effort,
 13899 however, the team's sponsor(s) or leader may begin the discussion of
 13900 the vision for a team. It is important that all integrated team members
 13901 understand and commit to a shared vision. The team population should
 13902 openly discuss and be given the opportunity to provide feedback on the
 13903 vision and address inconsistencies and make revisions as appropriate.
 13904 This openness creates a vision that belongs to everyone (shared),
 13905 provides an end-state view of the implementation of the team's
 13906 responsibilities, is the basis for the team's charter, and is applied to all
 13907 work. Benefits of a shared vision are that people understand and can
 13908 adopt its principles to guide their own, as well as the whole team's,
 13909 actions and decisions. [PA170.IG102.SP101.N104]

13910 **Typical Work Products**

- 13911 1. Documented stakeholder exceptions and conclusions
 13912 [PA170.IG102.SP101.W101]
- 13913 2. Boundary conditions and interfaces within which the team must
 13914 operate. [PA170.IG102.SP101.W102]
- 13915 3. Documented vision statement [PA170.IG102.SP101.W103]
- 13916 4. Presentation material of the vision statement suitable for team
 13917 members and various audiences that need to be informed
 13918 [PA170.IG102.SP101.W104]

13919 **Subpractices**

- 13920 1. Convey the shared vision context to team members to align
 13921 personal aspirations and objectives with the team's expectations
 13922 and envisioned future outcome. [PA170.IG102.SP101.SubP101]
- 13923 2. Conduct meetings or workshops to discuss the shared vision.
 13924 [PA170.IG102.SP101.SubP102]
- 13925 3. Articulate the shared vision in terms of both core ideology and the
 13926 desired future end state that each member can commit to.
 13927 [PA170.IG102.SP101.SubP103]
- 13928 4. Reinforce the relevance of the shared vision in performing
 13929 individual and team activities and tasks. [PA170.IG102.SP101.SubP104]

- 13930 5. Check effectiveness of the shared vision and that individual and
13931 team activities or tasks are aligned with the shared vision.
13932 [PA170.IG102.SP101.SubP105]
- 13933 6. Periodically reexamine clarity and applicability of the shared vision
13934 and revise or realign as necessary to better meet present reality of
13935 the team or project. [PA170.IG102.SP101.SubP106]

13936 **SP 2.2 Establish a Team Charter**

13937 ***Establish and maintain a team charter based on the integrated***
13938 ***team's shared vision and overall team objectives.*** [PA170.IG102.SP102]

13939 The team charter is the contract among the team members and
13940 between the team and the sponsor of the team for the expected work
13941 effort and level of performance. Charters solidify the rights, guarantees,
13942 privileges, and permissions for organizing and performing the team's
13943 objectives and tasks. Development of the team charter is a negotiated
13944 process between the sponsor of team and the integrated team. When
13945 approved by both the team and the sponsor, the team charter
13946 constitutes a recognized agreement with the management authority.
13947 The complexity of the team charter can vary depending on the scope of
13948 effort and the team objectives. Team objectives may be directly related
13949 to the assigned product requirements from the sponsor, specific project
13950 requirements, or identified internal team tasks. The charter typically
13951 identifies team responsibilities and authority and the metrics by which
13952 the team's progress will be evaluated. [PA170.IG102.SP102.N101]

13953 It is important that integrated teams exercise a level of authority in
13954 managing their activities and in making decisions in pursuit of their
13955 objectives. Team members need to assess whether the amount of
13956 power and control over decision and actions has been properly
13957 delegated from upper management. The team decides whether the
13958 decision-making authority is appropriate to meet expectations and the
13959 tasks accepted by the team. The team negotiates any disagreements
13960 with the organizations or entities that assigned them. [PA170.IG102.SP102.N102]

13961 **Typical Work Products**

- 13962 1. Team charter [PA170.IG102.SP102.W101]
- 13963 2. Procedures for setting the expectations for the work to be done and
13964 for measuring the performance [PA170.IG102.SP102.W102]
- 13965 3. List of critical success factors [PA170.IG102.SP102.W103]
- 13966 4. List of specific strategies the team expects to employ
13967 [PA170.IG102.SP102.W104]

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Subpractices

1. Define and list the team objectives. [PA170.IG102.SP102.SubP101]
2. Identify specific strategies for achieving the team objectives.
[PA170.IG102.SP102.SubP102]
3. Establish the team’s level of empowerment and independence.
[PA170.IG102.SP102.SubP103]

Empowerment is not likely to be unlimited. Every team must operate within some constraints, and these limits on authority must be identified and defined up front.

[PA170.IG102.SP102.SubP103.N101]

Refer to the Manage People for Integration specific goal in the Organizational Environment for Integration process area for more information on the organization’s guidelines for the degree of empowerment for people and integrated teams.

[PA170.IG102.SP102.SubP103.N101.R101]

4. Identify how team and individual performance and accomplishment are measured. [PA170.IG102.SP102.SubP104]

Refer to the Organizational Environment for Integration process area for more information about recognizing team as well as individual accomplishments. [PA170.IG102.SP102.SubP104.R101]

5. Identify critical success factors. [PA170.IG102.SP102.SubP105]

SP 2.3 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

- 14005 • Maintaining interfaces with their functional area
- 14006 **Typical Work Products**
- 14007 1. Descriptions of roles and responsibilities [PA170.IG102.SP103.W101]
- 14008 2. Assignment statements [PA170.IG102.SP103.W102]
- 14009 3. Responsibility matrix [PA170.IG102.SP103.W103]
- 14010 **Subpractices**
- 14011 1. Map the roles, responsibilities, and expertise of the team members
- 14012 to the team tasks and expected deliverables. [PA170.IG102.SP103.SubP101]
- 14013 Ensure that assignments are made to integrate complementary knowledge and
- 14014 skills. [PA170.IG102.SP103.SubP101.N101]
- 14015 2. Define the working relationship and reporting structure for team
- 14016 members. [PA170.IG102.SP103.SubP102]
- 14017 Team members may have the responsibility to report to both the team leader and
- 14018 a functional organization and management chain. [PA170.IG102.SP103.SubP102.N101]

SP 2.4 Establish Operating Procedures

Establish and maintain integrated team operating procedures.

[PA170.IG102.SP104]

14022 Operating practices and ground rules serve to define and control how

14023 the team will interact and work together and promote effective

14024 integration of efforts, high performance, and productivity for

14025 accomplishing objectives. Members especially need to understand the

14026 intended standards for work and to participate according to those

14027 precepts. [PA170.IG102.SP104.N101]

Typical Work Products

- 14028 1. Operating practices and ground rules [PA170.IG102.SP104.W101]
- 14029 2. Procedures for work expectations and performance measures
- 14030 [PA170.IG102.SP104.W102]
- 14031

Subpractices

- 14032 1. Define the expectations and rules that will guide how the team
- 14033 works together and what the team members will use to moderate
- 14034 participation and interpersonal interaction. [PA170.IG102.SP104.SubP101]
- 14035
- 14036 2. Define the degree of collective decision-making and level of
- 14037 consensus needed for team decisions. [PA170.IG102.SP104.SubP102]

14038 *Refer to the Organizational Environment for Integration process area for*
14039 *more information about establishing a process for setting the context for*
14040 *decision-making.* [PA170.IG102.SP104.SubP102.R101]

14041 3. Define how conflicts and differences in opinion within the team are
14042 addressed and resolved. [PA170.IG102.SP104.SubP103]

14043 *Refer to the Organizational Environment for Integration process area for*
14044 *more information about establishing a process for resolving conflicts*
14045 *and differences in opinion.* [PA170.IG102.SP104.SubP103.R101]

14046 **SP 2.5 Collaborate among Interfacing Teams**

14047 ***Establish and maintain collaboration among interfacing teams.***

14048 [PA170.IG102.SP105]

14049 The success of a team-based project will be a function of how
14050 effectively and successfully the integrated teams collaborate with each
14051 other while achieving their own and the project's objectives.

14052 [PA170.IG102.SP105.N101]

14053 *Refer to the Integrated Project Management (IPPD) process area for*
14054 *more information about operating in an integrated environment, and*
14055 *about coordinating and collaborating with stakeholders.*

14056 [PA170.IG102.SP105.N101.R101]

14057 **Typical Work Products**

14058 1. Work product and process deployment charts [PA170.IG102.SP105.W101]

14059 2. Input to the integrated master plan and integrated schedules

14060 [PA170.IG102.SP105.W102]

14061 3. Team Work plans for the team's life cycle [PA170.IG102.SP105.W103]

14062 4. Commitment lists [PA170.IG102.SP105.W104]

14063 **Subpractices**

14064 1. Collaboratively establish and maintain the work product ownership
14065 boundaries among interfacing teams within the project or
14066 organization. [PA170.IG102.SP105.SubP101]

14067 2. Collaboratively establish and maintain interfaces and processes
14068 among interfacing teams for the exchange of inputs, outputs, or
14069 work products. [PA170.IG102.SP105.SubP102]

14070 *Refer to the Integrated Project Management (IPPD) process area for*
14071 *more information about coordinating and collaborating with*
14072 *stakeholders.* [PA170.IG102.SP105.SubP102.R101]

- 14073 3. Collaboratively develop, communicate, and distribute among
14074 interfacing teams commitment lists and work plans related to the
14075 work product or team interfaces. [PA170.IG102.SP105.SubP103]

14076 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

14077 ***The process is institutionalized as a defined process.***

14078 Commitment to Perform

14079 **GP 2.1 (CO 1) Establish an Organizational Policy**

14080 ***Establish and maintain an organizational policy for planning and***
14081 ***performing the integrated teaming process.*** [GP103]

14082 Elaboration:

14083 This policy establishes organizational expectations for establishing and
14084 maintaining team composition and governing team operation. [PA170.EL101]

14085 Ability to Perform

14086 **GP 3.1 (AB 1) Establish a Defined Process**

14087 ***Establish and maintain the description of a defined integrated***
14088 ***teaming process.*** [GP114]

14089 **GP 2.2 (AB 2) Plan the Process**

14090 ***Establish and maintain the requirements and objectives, and plans***
14091 ***for performing the integrated teaming process.*** [GP104]

14092 Elaboration:

14093 These requirements, objectives, and plans are described in the
14094 organization's plan for integrated teaming. [PA170.EL102]

14095 **GP 2.3 (AB 3) Provide Resources**

14096 ***Provide adequate resources for performing the integrated teaming***
14097 ***process, developing the work products and providing the services***
14098 ***of the process.*** [GP105]

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Elaboration:

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Examples of special equipment and facilities include: [PA170.EL103]

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- Team war rooms (for regular strategy development and communication meetings)

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Examples of tools used in performing the activities of the Integrated Teaming process area include the following: [PA170.EL104]

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- Interactive electronic communication and data presentation tools (Groupware)

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- Team building tools

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GP 2.4 (AB 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 integrated teaming process. [GP106]

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GP 2.5 (AB 5) Train People

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Train the people performing or supporting the integrated teaming process as needed. [GP107]

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Elaboration:

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Examples of training topics include the following: [PA170.EL105]

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- Use of integrated work environments

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- Interpersonal skills

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- Communication skills

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- Team building

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- Collaborative problem solving and decision making

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14125 **Directing Implementation**

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GP 2.6 (DI 1) Manage Configurations

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

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Elaboration:

Examples of work products placed under configuration management include the following: [PA170.EL106]

- List of team members
- List of the level of effort and resources, including access to staff, to perform each team function
- Work task formal commitment lists
- Team shared vision statement
- Team charter

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GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders

Identify and involve the relevant stakeholders of the integrated teaming process as planned. [GP124]

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Elaboration:

Examples of activities for stakeholder involvement include: [PA170.EL107]

- Establishing and maintaining the team’s shared vision
- Establishing and maintaining the team’s charter
- Establishing and maintaining the team’s operating procedures
- Collaborating with interfacing teams

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GP 2.8 (DI 3) Monitor and Control the Process

Monitor and control the integrated teaming process against the plan and take appropriate corrective action. [GP110]

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Elaboration:

Examples of measures used in monitoring and controlling the activities of the Integrated Teaming process area include the following: [PA170.EL108]

- Performance to and deviations from expected plans, commitments, and procedures for the integrated team
- Ability to achieve team objectives

14159 **GP 3.2 (DI 4) Collect Improvement Information**

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Collect work products, measures, measurement results, and improvement information derived from planning and performing the integrated teaming process to support the future use and improvement of the organization's processes and process assets.
[GP117]

14165 Verifying Implementation

14166 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

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

14171 Elaboration:

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Examples of activities reviewed include the following: [PA170.EL109]

- Defining roles and responsibilities
- Communication activities within and among integrated teams

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Examples of work products reviewed include the following: [PA170.EL110]

- Descriptions of roles and responsibilities
- Descriptions of product ownership boundaries and team interfaces

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14180 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

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

14183 DECISION ANALYSIS AND RESOLUTION

14184 Maturity Level 3

14185 Purpose

14186 The purpose of Decision Analysis and Resolution is to make decisions
14187 using a structured approach that evaluates identified alternatives
14188 against established criteria. [PA156]

14189 Introductory Notes

14190 Decision Analysis and Resolution involves making good decisions by
14191 (1) selecting a decision-making technique and level of structure, (2)
14192 identifying criteria that will be the basis of the decision, (3) identifying
14193 alternatives, and (4) evaluating the alternatives against the criteria.
14194 [PA156.N101]

14195 A structured decision-making process reduces the subjective nature of
14196 the decision and has a higher probability of selecting a solution that
14197 meets the multiple demands of the stakeholder community. [PA156.N102]

14198 While the primary application of a structured decision-making process is
14199 technical concerns, the decision analysis and resolution processes also
14200 applicable to many non-technical issues. Issues that have multiple
14201 alternative solutions and evaluation criteria lend themselves to
14202 structured decision-making. Binary decisions are not as appropriate.
14203 [PA156.N103]

14204 Trade studies of equipment or software are typical examples of
14205 structured decision-making. [PA156.N111]

14206
14207 During project planning, project staff identify which specific issues will
14208 require a structured decision-making process. Typical issues include
14209 selection among architectural or design alternatives, use of reusable or
14210 commercial off-the-shelf (COTS) components, supplier selection,
14211 engineering support environments or associated tools, test
14212 environments, and logistics and production issues. In production,
14213 project staff can use the Decision Analysis and Resolution process area
14214 to address a make-or-buy decision, the development of manufacturing
14215 processes, the selection of distribution locations, and other decisions.
14216 [PA156.N104]

14217 Project planning activities also frequently involve non-technical issues
14218 that would benefit from structured decision analysis. [PA156.N105]

14219 During project planning, guidelines are also created for deciding when
14220 to use a structured decision-making process to address unplanned
14221 issues. Guidelines often suggest using a structured decision-making
14222 process when issues are associated with medium to high risks or when
14223 issues affect the ability to achieve project objectives. [PA156.N106]

14224 A structured decision-making process can vary in its formality, type of
14225 criteria, and technique. Less formal decisions can be performed in a
14226 few hours, use only a few criteria (e.g., effectiveness and cost to
14227 implement), and result in a one or two page report. More formal
14228 decisions may require separate plans, months of person-hours,
14229 meetings to develop and approve criteria, simulations, prototypes,
14230 piloting, and extensive documentation. [PA156.N107]

14231 Both numeric and non-numeric criteria can be used in a structured
14232 decision-making process. Numeric criteria use weights to reflect the
14233 relative importance of the criteria. Non-numeric criteria use a more
14234 subjective ranking scale (e.g., high, medium, low). More formal
14235 decisions may require a full trade study. [PA156.N108]

14236 A structured decision-making process identifies and evaluates
14237 alternative solutions. The eventual selection of a final solution may
14238 involve iterative activities of identification and evaluation. Portions of
14239 identified alternatives may be combined, emerging technologies may
14240 change alternatives, and the business situation for vendors may change
14241 during the evaluation period. [PA156.N109]

14242 A final selection of an alternative is accompanied by documentation of
14243 the selected technique, criteria, and alternatives; and the rationale for
14244 the selection of the final solution. The documentation is distributed to
14245 the stakeholders; it provides a record of the decision and rationale that
14246 is useful to other projects that encounter a similar issue. [PA156.N110]

14247 Related Process Areas

14248 *Refer to the Project Planning process area for more information about*
14249 *general planning for projects. The Project Planning process area*
14250 *determines the issues that undergo a structured decision-making*
14251 *process and develops guidelines for deciding when to apply a structure*
14252 *decision-making process to unforeseen issues. [PA156.R101]*

14253 *Refer to the Integrated Project Management (IPPD) process area for*
14254 *more information about establishing the project's defined process. The*
14255 *project's defined process includes a structured decision-making process*
14256 *for each selected issue and incorporates the use of guidelines for*
14257 *applying a structured decision-making process to unforeseen issues.*
14258 [PA156.R102]

14259 Refer to the Risk Management process area for more information about
14260 identifying and mitigating risks. A structured decision-making process
14261 often addresses issues with identified risks. Selected solutions typically
14262 impact risk mitigation strategies. [PA156.R103]

14263 Specific and Generic Goals

14264 **SG 1 Evaluate Alternatives** [PA156.IG101]

14265 ***Decisions are based on an evaluation of alternatives using established***
14266 ***criteria.***

14267 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

14268 ***The process is institutionalized as a defined process.***

14269 Practice to Goal Relationship Table

14270 **SG 1 Evaluate Alternatives** [PA156.IG101]

14271	SP 1.1	Establish and Use Guidelines for Decision Analysis
14272	SP 1.2	Select Decision-Making Techniques
14273	SP 1.3	Establish Evaluation Criteria
14274	SP 1.4	Identify Alternative Solutions
14275	SP 1.5	Evaluate Alternatives
14276	SP 1.6	Select Solutions

14277 **GG 3 Institutionalize a Defined Process**

14278	GP 2.1	(CO 1)	Establish an Organizational Policy
14279	GP 3.1	(AB 1)	Establish a Defined Process
14280	GP 2.2	(AB 2)	Plan the Process
14281	GP 2.3	(AB 3)	Provide Resources
14282	GP 2.4	(AB 4)	Assign Responsibility
14283	GP 2.5	(AB 5)	Train People
14284	GP 2.6	(DI 1)	Manage Configurations
14285	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
14286	GP 2.8	(DI 3)	Monitor and Control the Process
14287	GP 3.2	(DI 4)	Collect Improvement Information
14288	GP 2.9	(VE 1)	Objectively Evaluate Adherence
14289	GP 2.10	(VE 2)	Review Status with Higher-Level Management

14290 Specific Practices by Goal

14291 **SG 1 Evaluate Alternatives** [PA156.IG101]

14292 ***Decisions are based on an evaluation of alternatives using established***
14293 ***criteria.***

14294 Issues requiring a decision-making process may be identified during
14295 any phase of a product or project life cycle. The objective should be to
14296 identify issues as early as possible to maximize the time available to
14297 resolve the issue. [PA156.IG101.N101]

14298 **SP 1.1 Establish and Use Guidelines for Decision Analysis**

14299 ***Establish and use guidelines to determine which issues are***
14300 ***subject to a structured decision analysis and resolution process.***

14301 [PA156.IG101.SP101]

14302 *Refer to the Project Planning process area for more information about*
14303 *planning which issues will undergo a structured decision-making*
14304 *process.* [PA156.IG101.SP101.R101]

14305 *Refer to the Risk Management process area for more information about*
14306 *determining which topics are medium or high risk.* [PA156.IG101.SP101.R102]

14307 Most decisions do not require structured decision making, but
14308 somewhere between the trivial and the clearly important, the choice
14309 may be unclear without explicit criteria. Whether an issue is significant
14310 or not is dependent on the project and circumstances, and is
14311 determined by the established guidelines. [PA156.IG101.SP101.N101]

14312 Typical guidelines for determining when to require structured decision-
14313 making include the following: [PA156.IG101.SP101.N102]

- 14314 • When a decision is directly related to topics assessed as being of
14315 medium or high risk
- 14316 • When a decision is related to changing work products under
14317 configuration management
- 14318 • When a decision would cause schedule delays over a certain
14319 percent or specific amount of time
- 14320 • When a decision affects the ability to achieve project objectives
- 14321 • When the costs of the decision process are reasonable when
14322 compared to the decision's impact

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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)

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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]

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Refer to the Integrated Project Management (IPPD) process area for more information about establishing the project's defined process.
[PA156.IG101.SP101.SubP102.R101]

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SP 1.2 Select Decision-Making Techniques

Select the decision-making techniques. [PA156.IG101.SP102]

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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]

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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]

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Typical Work Products

1. Selected decision-making techniques [PA156.IG101.SP102.W101]

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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

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]

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]

3. Determine the level of structure of the decision-making process.

[PA156.IG101.SP102.SubP103]

Consider the impact on cost, schedule, performance, and existing risk strategies.

[PA156.IG101.SP102.SubP103.N101]

SP 1.3 Establish Evaluation Criteria

Establish the evaluation criteria and their relative ranking.

[PA156.IG101.SP103]

The evaluation criteria provide the basis for the rest of the decision-making process. These criteria must reflect the various stakeholder needs and objectives. The criteria are ranked so that the highest ranked criteria exert the most influence on the decision.

[PA156.IG101.SP103.N101]

Document evaluation criteria to alleviate the possibility of second-guessing decisions, or simply forgetting why decisions were made. Decisions based on criteria that are explicitly defined and established remove barriers to stakeholder buy-in. [PA156.IG101.SP103.N102]

- 14392 **Typical Work Products**
- 14393 1. Documented evaluation criteria [PA156.IG101.SP103.W101]
- 14394 2. Rankings of criteria importance [PA156.IG101.SP103.W102]
- 14395 **Subpractices**
- 14396 1. Develop evaluation criteria and their validity. [PA156.IG101.SP103.SubP101]
- 14397 Criteria should be traceable to requirements, scenarios, business case
- 14398 assumptions, business objectives, or other documented sources.
- 14399 [PA156.IG101.SP103.SubP101.N101]
- 14400 Types of criteria to consider include: [PA156.IG101.SP103.SubP101.N102]
- 14401 • Technology limitations
 - 14402 • Environmental impact
 - 14403 • Risks
 - 14404 • Total ownership and life-cycle costs
- 14405 2. Define the range and scale for ranking the evaluation criteria.
- 14406 [PA156.IG101.SP103.SubP102]
- 14407 Scales of relative importance for evaluation criteria can be established with non-
- 14408 numeric values or with formulas that relate the evaluation parameter to a
- 14409 numerical weight. [PA156.IG101.SP103.SubP102.N101]
- 14410 3. Rank the criteria. [PA156.IG101.SP103.SubP103]
- 14411 The criteria are ranked according to the defined range and scale to reflect the
- 14412 needs, objectives, and priorities of the stakeholders. [PA156.IG101.SP103.SubP103.N101]
- 14413 4. Document the rationale for the selection and rejection of evaluation
- 14414 criteria. [PA156.IG101.SP103.SubP104]
- 14415 Documentation of selection criteria and rationale may be needed to justify
- 14416 solutions or for future reference and use. [PA156.IG101.SP103.SubP104.N101]
- 14417 5. Test the criteria and their relative importance. [PA156.IG101.SP103.SubP105]
- 14418 Untested criteria, their relative importance, and supporting data or functions may
- 14419 cause the validity of solutions to be questioned. Criteria and their relative priorities
- 14420 and scales can be tested with trial runs against a set of alternatives. This test
- 14421 allows the cumulative impact of a set of criteria on the solution to be evaluated. In
- 14422 such cases, the alternatives may be different than the proposed alternatives, to
- 14423 avoid biases. [PA156.IG101.SP103.SubP105.N101]

14424 **SP 1.4 Identify Alternative Solutions**

14425 ***Identify alternative solutions to issues.*** [PA156.IG101.SP104]

14426 A wider range of alternatives can surface by soliciting as many
 14427 stakeholders as practical for input. Inputs from stakeholders with
 14428 diverse skills and backgrounds can help identify and address
 14429 assumptions, constraints, and biases. Brainstorming sessions may
 14430 stimulate innovative alternatives through rapid interaction and feedback.
 14431 Sufficient candidate solutions may not be furnished for analysis. As the
 14432 analysis proceeds, other alternatives should be added to the list of
 14433 potential candidate solutions. The generation and consideration of
 14434 multiple alternatives early in a decision-making process increases the
 14435 likelihood that an acceptable decision will be made, and that
 14436 consequences of the decision will be understood. [PA156.IG101.SP104.N101]

14437 **Typical Work Products**

- 14438 1. Identified alternatives [PA156.IG101.SP104.W101]

14439 **Subpractices**

- 14440 1. Perform a literature search. [PA156.IG101.SP104.SubP101]

14441 A literature search can uncover what others have done both inside and outside
 14442 the organization. It may provide a deeper understanding of the problem,
 14443 alternatives to consider, barriers to implementation, existing trade studies, and
 14444 lessons learned from similar decisions. [PA156.IG101.SP104.SubP101.N101]

- 14445 2. Identify alternatives for consideration in addition to those that may
 14446 be provided with the issue. [PA156.IG101.SP104.SubP102]

14447 Evaluation criteria are an effective starting point for identifying alternatives. The
 14448 evaluation criteria identify the priorities of the stakeholders and the importance of
 14449 technical challenges. [PA156.IG101.SP104.SubP102.N101]

14450 Combining key attributes of existing alternatives can generate additional and
 14451 sometimes stronger alternatives. [PA156.IG101.SP104.SubP102.N102]

14452 Solicit alternatives from stakeholders and staff. Brainstorming sessions,
 14453 interviews, and working groups can be used effectively to uncover alternatives.
 14454 [PA156.IG101.SP104.SubP102.N103]

- 14455 3. Document the proposed alternatives. [PA156.IG101.SP104.SubP103]

14456 **SP 1.5 Evaluate Alternatives**

14457 ***Evaluate alternative solutions using the documented criteria.***

14458 [PA156.IG101.SP105]

14459 Evaluating alternative solutions involves synthesizing analysis,
 14460 discussion, and review. Iterative cycles of analysis are sometimes
 14461 necessary. Supporting analyses, experimentation, prototyping or
 14462 simulations may be needed to substantiate scoring and conclusions.

14463 [PA156.IG101.SP105.N101]

14464 Often the relative importance of criteria is imprecise and the total effect
14465 on a solution is not apparent until after the analysis is performed. In
14466 these cases, the best selection among alternative solutions may not be
14467 clear-cut when the resulting scores differ by relatively small amounts.
14468 Challenges to criteria and assumptions should be encouraged.

14469 [PA156.IG101.SP105.N102]

14470 **Typical Work Products**

14471 1. Evaluation results [PA156.IG101.SP105.W101]

14472 2. Documented evaluation results [PA156.IG101.SP105.W102]

14473 **Subpractices**

14474 1. Evaluate the proposed alternative solutions using the documented
14475 evaluation criteria. [PA156.IG101.SP105.SubP101]

14476 2. Evaluate the assumptions related to the selection criteria and the
14477 evidence that supports the assumptions. [PA156.IG101.SP105.SubP102]

14478 3. Evaluate whether uncertainty in the values for alternative solutions
14479 affects the evaluation and address as appropriate.

14480 [PA156.IG101.SP105.SubP103]

14481 For instance, if the score can vary between two values, is the difference
14482 significant enough to make a difference in the final solution set? Does the
14483 variation in score represent a high risk? To address these concerns, simulations
14484 may be run, further studies may be performed, or evaluation criteria may be
14485 modified, among other things. [PA156.IG101.SP105.SubP103.N101]

14486 4. Perform simulations, modeling, prototypes, and pilots as necessary
14487 to test the selection criteria. [PA156.IG101.SP105.SubP104]

14488 5. Consider new alternative solutions if the proposed alternatives do
14489 not test well. [PA156.IG101.SP105.SubP105]

14490 6. Document the results of the evaluation. [PA156.IG101.SP105.SubP106]

14491 Document the rationale for the addition of new alternatives or studies and
14492 changes to criteria, as well as the results of interim evaluations.

14493 [PA156.IG101.SP105.SubP106.N101]

14494 **SP 1.6 Select Solutions**

14495 ***Select solutions from the alternatives based on the evaluation***
14496 ***criteria.*** [PA156.IG101.SP106]

14497 Selecting solutions involves weighing the results from the evaluation of
14498 alternatives. Risks associated with the solutions or execution of the
14499 structured decision-making process must be assessed. The final
14500 selection of the solutions is contingent upon the approval of the
14501 stakeholder community. [PA156.IG101.SP106.N101]

14502 **Typical Work Products**

14503 1. Solutions to significant problems or issues [PA156.IG101.SP106.W101]

14504 **Subpractices**

14505 1. Assess the risks associated with making a decision.

14506 [PA156.IG101.SP106.SubP101]

14507 *Refer to the Risk Management process area for more information about*
14508 *how to follow up on risks.* [PA156.IG101.SP106.SubP101.R101]

14509 Decisions must often be made with incomplete information. There can be
14510 substantial risk associated with the decision as a result of having incomplete
14511 information. [PA156.IG101.SP106.SubP101.N101]

14512 When decisions must be made according to a specific schedule, time and
14513 resources may not be available for gathering complete information. Consequently,
14514 risky decisions made with incomplete information may require re-evaluation at a
14515 later time. Identified risks should be monitored. [PA156.IG101.SP106.SubP101.N102]

14516 2. Document the results and rationale of the decision.

14517 [PA156.IG101.SP106.SubP102]

14518 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

14519 ***The process is institutionalized as a defined process.***

14520 **Commitment to Perform**

14521 **GP 2.1 (CO 1) Establish an Organizational Policy**

14522 ***Establish and maintain an organizational policy for planning and***
14523 ***performing the decision analysis and resolution process.*** [GP103]

14524 Elaboration:

14525 This policy establishes organizational expectations for making decisions
14526 using a structured approach that evaluates identified alternatives
14527 against established criteria. The policy should also provide guidance on
14528 which decisions require a structured decision-making approach.

14529 [PA156.EL101]

14530 Ability to Perform

14531 **GP 3.1 (AB 1) Establish a Defined Process**

14532 *Establish and maintain the description of a defined decision*
14533 *analysis and resolution process.* [GP114]

14534 **GP 2.2 (AB 2) Plan the Process**

14535 *Establish and maintain the requirements and objectives, and plans*
14536 *for performing the decision analysis and resolution process.* [GP104]

14537 **GP 2.3 (AB 3) Provide Resources**

14538 *Provide adequate resources for performing the decision analysis*
14539 *and resolution process, developing the work products and*
14540 *providing the services of the process.* [GP105]

14541 Elaboration:

14542 Examples of tools used to perform the activities of the Decision Analysis
14543 and Resolution process area include the following: [PA156.EL102]

- 14544 • Simulators and modeling tools
- 14545 • Prototyping tools
- 14546 • Support tools for group decision-making

14548 **GP 2.4 (AB 4) Assign Responsibility**

14549 *Assign responsibility and authority for performing the process,*
14550 *developing the work products, and providing the services of the*
14551 *decision analysis and resolution process.* [GP106]

14552 **GP 2.5 (AB 5) Train People**

14553 *Train the people performing or supporting the decision analysis*
14554 *and resolution process as needed.* [GP107]

14555 Elaboration:

14556 Examples of training topics include the following: [PA156.EL103]

- 14557
- Formal decision analysis
 - Decision-making techniques (e.g., trade studies, Delphi methods, quality function deployment, group decision-making techniques)
- 14558
- 14559

14560

14561 Directing Implementation

14562 **GP 2.6 (DI 1) Manage Configurations**

14563 ***Place designated work products of the decision analysis and***
14564 ***resolution process under appropriate levels of configuration***
14565 ***management.*** [GP109]

14566 Elaboration:

14567 Examples of work products placed under configuration management
14568 include the following: [PA156.EL104]

- 14569
- Guidelines for when to apply structured decision-making
 - Evaluation report
- 14570

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14572 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

14573 ***Identify and involve the relevant stakeholders of the decision***
14574 ***analysis and resolution process as planned.*** [GP124]

14575 Elaboration:

14576 Examples of activities for stakeholder involvement include: [PA156.EL109]

- 14577
- Establishing guidelines for which issues are subject to a structured decision analysis and resolution process
 - Developing evaluation criteria
 - Identifying and evaluating alternatives
 - Selecting a solution
- 14578
- 14579
- 14580
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14583 **GP 2.8 (DI 3) Monitor and Control the Process**

14584 ***Monitor and control the decision analysis and resolution process***
14585 ***against the plan and take appropriate corrective action.*** [GP110]

14586 Elaboration:

14587 Examples of measures used in monitoring and controlling the activities
14588 of the decision analysis and resolution process area include the
14589 following: [PA156.EL105]

- 14590 • Cost to benefit ratio of an instance of the Decision and Analysis
14591 and Resolution process

14592 **GP 3.2 (DI 4) Collect Improvement Information**

14593 ***Collect work products, measures, measurement results, and***
14594 ***improvement information derived from planning and performing***
14595 ***the decision analysis and resolution process to support the future***
14596 ***use and improvement of the organization's processes and process***
14597 ***assets.*** [GP117]

14598 Verifying Implementation

14599 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

14600 ***Objectively evaluate adherence of the decision analysis and***
14601 ***resolution process and the work products and services of the***
14602 ***process to the applicable requirements, objectives, and standards,***
14603 ***and address noncompliance.*** [GP113]

14604 Elaboration:

14605 Examples of activities reviewed include the following: [PA156.EL106]

- 14606 • Evaluating alternatives

14608 Examples of work products reviewed include the following: [PA156.EL108]

- 14609 • Guidelines for when to apply structured decision-making
- 14610 • Evaluation report

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

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

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14616 ORGANIZATIONAL ENVIRONMENT FOR INTEGRATION

14617 Maturity Level 3

14618 Purpose

14619 The purpose of Organizational Environment for Integration is to provide
14620 an IPPD infrastructure and manage people for integration. [PA169]

14621 Introductory Notes

14622 Successful integration of business and technical elements in projects is
14623 dependent upon substantive and proactive organizational processes
14624 and guidelines. The organization is an integrated system capable of
14625 providing and sustaining the people, products, and processes
14626 necessary for the effective and efficient execution of its projects. The
14627 organization must raise performance expectations from all projects
14628 while providing mechanisms that stimulate both team and individual
14629 excellence. [PA169.N101]

14630 Important characteristics of effective environments for integration
14631 include people trained to exploit the collaborative environment, a
14632 workplace that provides resources to maximize the productivity of
14633 people and facilitate integrated teams; and organizational standard
14634 processes and process assets that culturally enable an IPPD
14635 environment that promotes and rewards team as well as individual
14636 excellence. [PA169.N102]

14637 Related Process Areas

14638 *Refer to the Integrated Project Management (IPPD) process area for*
14639 *more information about managing stakeholder involvement, resolving*
14640 *coordination issues, establishing the project's shared vision, and*
14641 *organizing integrated teams.* [PA169.R101]

14642 *Refer to the Organizational Process Definition process area for more*
14643 *information about establishing the organization's set of standard*
14644 *processes and library of process assets.* [PA169.R102]

14645 *Refer to the Organizational Training process area for more information*
14646 *about identifying training needs and providing the necessary training.*
14647 [PA169.R103]

14648 Specific and Generic Goals

14649 **SG 1** **Provide IPPD Infrastructure** [PA169.IG101]

14650 *An infrastructure that maximizes the productivity of people and effects the*
14651 *collaboration necessary for integration is provided.*

14652 **SG 2** **Manage People for Integration** [PA169.IG102]

14653 *People are managed to nurture the integrative and collaborative behaviors of*
14654 *an IPPD environment.*

14655 **GG 3** **Institutionalize a Defined Process** [CL104.GL101]

14656 *The process is institutionalized as a defined process.*

14657 Practice to Goal Relationship Table

14658	SG 1 Provide IPPD Infrastructure [PA169.IG101]		
14659	SP 1.1	Establish the Organization's Shared Vision	
14660	SP 1.2	Establish an Integrated Work Environment	
14661	SP 1.3	Identify IPPD-Unique Skill Requirements	
14662	SG 2 Manage People for Integration [PA169.IG102]		
14663	SP 2.1	Establish Leadership Mechanisms	
14664	SP 2.2	Establish Incentives for Integration	
14665	SP 2.3	Establish Mechanisms to Balance Team and Home Organization Re-	
14666		sponsibilities	
14667	GG 3 Institutionalize a Defined Process		
14668	GP 2.1	(CO 1)	Establish an Organizational Policy
14669	GP 3.1	(AB 1)	Establish a Defined Process
14670	GP 2.2	(AB 2)	Plan the Process
14671	GP 2.3	(AB 3)	Provide Resources
14672	GP 2.4	(AB 4)	Assign Responsibility
14673	GP 2.5	(AB 5)	Train People
14674	GP 2.6	(DI 1)	Manage Configurations
14675	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
14676	GP 2.8	(DI 3)	Monitor and Control the Process
14677	GP 3.2	(DI 4)	Collect Improvement Information
14678	GP 2.9	(VE 1)	Objectively Evaluate Adherence
14679	GP 2.10	(VE 2)	Review Status with Higher-Level Management

14680 Specific Practices by Goal

14681 **SG 1 Provide IPPD Infrastructure** [PA169.IG101]

14682 ***An infrastructure that maximizes the productivity of people and effects the***
 14683 ***collaboration necessary for integration is provided.***

14684 An organizational infrastructure that supports and promotes IPPD
 14685 concepts is critical if IPPD is to be successfully sustained over the long
 14686 term. An IPPD infrastructure includes: [PA169.IG101.N101]

- 14687 • An organization shared vision that promotes IPPD concepts such
- 14688 as concurrent development and integrated teaming
- 14689 • A work environment that enables efficient and effective
- 14690 collaboration and integration
- 14691 • People trained to collaborate, integrate, and lead others, as
- 14692 necessary

14693 **SP 1.1 Establish the Organization's Shared Vision**

14694 ***Establish and maintain a shared vision for the organization.***

14695 [PA169.IG101.SP101]

14696 Establishing and maintaining the organization's shared vision involves
14697 creating, communicating, using, and periodically evaluating and revising
14698 the shared vision. A shared vision captures the organization's guiding
14699 principles including mission, objectives, expected behavior, and values.
14700 The shared vision of a project's integrated teams should be consistent
14701 with the project's shared vision, which in turn should be consistent with
14702 the organization's shared vision. [PA169.IG101.SP101.N101]

14703 Creating a shared vision involves establishing, and actively maintaining
14704 agreement and commitment about what is to be done and how it will be
14705 accomplished, both procedurally and behaviorally. A shared vision is a
14706 result of an ongoing dialogue among all the people who will make it
14707 real. It continues to evolve as more ideas are shared. [PA169.IG101.SP101.N102]

14708 The organization's shared vision facilitates people working together,
14709 helps to attain unity of purpose, and creates a common understanding
14710 of the end state the organization is aiming to achieve. The
14711 organization's shared vision must speak to every element of the
14712 organization. Effectively impacting the lowest levels of the organization
14713 necessitates impacting the highest levels as well. The organization's
14714 leaders need to be role models for the actions of the organization.
14715 Their commitment to IPPD is critical to its success in the organization.
14716 They must clearly communicate their expectations for the organization's
14717 projects and integrated teams and what the projects and integrated
14718 teams can expect from the management. [PA169.IG101.SP101.N103]

14719 The organization's shared vision needs to be grounded in reality.
14720 Organizations may be tempted to include in their vision broad
14721 statements about integrated teaming and employee empowerment. It is
14722 more important, however to use the vision to set reasonable
14723 expectations on the rate of change in an organization. Unrealistic
14724 proclamations can transform the vision into a source of frustration and
14725 cause the organization to retreat from it after initial pilot demonstrations.
14726 [PA169.IG101.SP101.N104]

14727 The shared vision should be articulated in sufficient detail to provide
14728 criteria against which the project and integrated teams' shared visions
14729 can be aligned. For example, the organization's shared vision should
14730 address the use of integrated teams for projects, the focus on the
14731 customer, and the concurrent development of both product-related life
14732 cycle processes and the product. These concepts should in turn be
14733 reflected in the project and integrated team shared visions. Guidelines
14734 for how projects and integrated teams should develop their shared
14735 visions should be made part of the organization's process asset library.
14736 [PA169.IG101.SP101.N105]

14737 Maintenance of the organization's shared vision involves evaluating its
14738 use and currency. Results of evaluations may indicate the need to
14739 update the organization's shared vision or to establish and maintain
14740 organizational practices and structures that implement the shared
14741 vision. [PA169.IG101.SP101.N106]

14742 **Typical Work Products**

- 14743 1. Organization's shared vision [PA169.IG101.SP101.W101]
- 14744 2. Evaluations of the organization's shared vision [PA169.IG101.SP101.W102]
- 14745 3. Guidelines for shared vision building within projects and integrated
14746 teams [PA169.IG101.SP101.W103]

14747 **Subpractices**

- 14748 1. Identify expectations, constraints, interfaces, and boundary
14749 conditions applicable to the organization's shared vision.
14750 [PA169.IG101.SP101.SubP101]
- 14751 2. Create a shared vision for the organization. [PA169.IG101.SP101.SubP102]
- 14752 The shared vision can include project, integrated team, and people expectations
14753 from the organization (for example, some organizations have developed an
14754 "employee's bill of rights"). [PA169.IG101.SP101.SubP102.N101]
- 14755 3. Communicate the shared vision both externally and internally.
14756 [PA169.IG101.SP101.SubP103]
- 14757 4. Ensure that organizational practices and structures are aligned with
14758 the shared vision. [PA169.IG101.SP101.SubP104]
- 14759 5. Periodically review the shared vision and update it as necessary.
14760 [PA169.IG101.SP101.SubP105]
- 14761 Reexamine the vision to determine weaknesses and misunderstood parts.
14762 Revise the vision to improve its clarity and applicability to the present reality of the
14763 organization. Periodically reinforce the clarity and reality of the vision.
14764 [PA169.IG101.SP101.SubP105.N101]
- 14765 6. Provide guidelines for shared vision building for use by projects
14766 and integrated teams. [PA169.IG101.SP101.SubP106]

14767 These guidelines should establish the context for the project and integrated team
14768 shared visions. [PA169.IG101.SP101.SubP106.N101]

14769 Project visions should be focused on product and contribute to the organizational
14770 vision achievement. Project visions could relate the minimum competencies, or
14771 demonstrated capabilities, for people assigned to integrated teams such as
14772 individual leadership capabilities. Proposed products, activities, partnerships,
14773 organizational and project structures, and project visions are tested against the
14774 organizational vision. [PA169.IG101.SP101.SubP106.N102]

14775 For the integrated teams, nurturing integration necessitates special attention to
14776 the objectives, values, and behaviors that are needed to effect integrated
14777 teamwork throughout the life cycle. Aspects such as team operations, team
14778 behaviors, team responsibilities, and collaboration with interfacing teams can be
14779 addressed. [PA169.IG101.SP101.SubP106.N103]

14780 **SP 1.2 Establish an Integrated Work Environment**

14781 ***Establish and maintain an integrated work environment that***
14782 ***supports IPPD by enabling collaboration and concurrent***
14783 ***development.*** [PA169.IG101.SP102]

14784 An integrated work environment includes the physical infrastructure
14785 (e.g., facilities, tools, equipment, and support needed to effectively use
14786 them) that people need to perform their jobs effectively. Properly
14787 functioning environments help people communicate clearly and
14788 efficiently about the product, processes, people needs, and
14789 organization. An integrated work environment helps integrate the
14790 business and technical functions and the interfaces among teams,
14791 projects, and organizations. [PA169.IG101.SP102.N101]

14792 The integrated work environment must accommodate both collocated
14793 and distributed integrated teams as required. Two-way communications
14794 media should be easily accessible by all relevant stakeholders.
14795 [PA169.IG101.SP102.N102]

14796 Encouraging open dialogue by providing communication mechanisms
14797 enables everyone to effectively engage in and contribute to the
14798 information sharing. This can improve effectiveness, especially early in
14799 the product life cycle. Appropriate mechanisms might include meeting
14800 rooms, email, fax, ftp or Web sites, video teleconferencing capabilities
14801 and others depending on the organization's culture and project and
14802 integrated team preferences for efficient and effective information
14803 sharing. The types of information needed, which agents (projects,
14804 integrated teams, or individuals), and how many of them produce, own,
14805 and need that information should be considered in deciding the
14806 mechanisms to be used. [PA169.IG101.SP102.N103]

14807 Integrated communication tool sets reduce wasted time spent
14808 converting information from one medium or platform to another, and
14809 correcting transcription or misunderstandings when people do the
14810 conversions. Requirements for product and process information
14811 usability across the product life cycle are important characteristics to
14812 consider in the selection of information exchange tools. In an IPPD
14813 environment, it is particularly important that the tools for designing and
14814 developing the product-related life cycle processes are integrated with
14815 the tools for designing and developing the product and product
14816 components. [PA169.IG101.SP102.N104]

14817 Integrated work environments are developed with the same, or greater,
14818 rigor as that used to develop a specific product or service. Integrated
14819 work environments are capital assets that are often expensive, have
14820 unique implementations, are irreversible (their implementation can
14821 destroy or make unusable the assets being replaced), and whose
14822 modification disrupts on-going activities. The rigor appropriate to the
14823 development should be matched to the magnitude of the needs to be
14824 resolved and the deployment risks. [PA169.IG101.SP102.N105]

14825 **Typical Work Products**

- 14826 1. Requirements for the integrated work environment [PA169.IG101.SP102.W101]
- 14827 2. Design of the integrated work environment [PA169.IG101.SP102.W102]
- 14828 3. Integrated work environment [PA169.IG101.SP102.W103]

14829 **Subpractices**

- 14830 1. Determine requirements for the integrated work environment.

14831 [PA169.IG101.SP102.SubP101]

14832 Requirements for the integrated work environment are typically based on the
14833 following: [PA169.IG101.SP102.SubP101.N101]

- 14834 • The organization's set of standard processes
- 14835 • The objectives of the organization articulated in the organization's shared vision
- 14836 • The needs associated with developing, maintaining, and delivering the products
14837 and services of the organization

- 14838 2. Regularly evaluate the effectiveness of the existing environment
14839 and forecast the need for additional, upgraded, or new tools or
14840 integrated work environment components. [PA169.IG101.SP102.SubP102]

- 14841 3. Maintain awareness of current and emerging technologies, tools,
14842 and resources that are related to the integrated work environment.

14843 [PA169.IG101.SP102.SubP103]

14844 Maintaining awareness may be accomplished through industry journals,
14845 professional societies, conferences, trade shows, and benchmarking.

14846 [PA169.IG101.SP102.SubP103.N101]

14847 Examples of technologies, tools, and resources include: [PA169.IG101.SP102.SubP103.N102]

- 14848 • Computing resources and software productivity tools
- 14849 • Communications systems, tools, and resources
- 14850 • Communication tools (e-mail, telephone, databases, archives, etc.)
- 14851 • Manufacturing and production facilities
- 14852 • Engineering or simulation tools
- 14853 • Proprietary engineering tools

- 14854 • Prototyping or production equipment
 - 14855 • Work space
 - 14856 • Office equipment and supplies
 - 14857 • Raw or stock input materials
 - 14858 • Transportation resources
 - 14859 • "Hot-lines" and "help-desks"
 - 14860 • Information brokerage services
 - 14861 • Support staff and/or services
 - 14862 • Information technology capabilities
 - 14863 • Process enactment and management tools
- 14864 4. Plan, design, and implement an integrated work environment.
- 14865 [PA169.IG101.SP102.SubP104]
- 14866 The critical aspects of the work environment are, like any other system,
- 14867 requirements driven. Work environment functionality (stimulated by customer
- 14868 needs and requirements) is explored with the same rigor as any other system
- 14869 development. Are the performance improvements (for example, timely
- 14870 interoperable communications; safety; security; maintainability) worth the costs
- 14871 (for example, capital outlays; training; support structure; disassembly and disposal
- 14872 of existing environments; performance maintenance of the environment) and risks
- 14873 (for example, work flow and project disruptions)? Requirements are developed for
- 14874 the life cycle of the work environment and address, as appropriate, the three
- 14875 different cases for work environment improvements: development of a new
- 14876 environment, migrating an existing environment to new capabilities, and
- 14877 maintaining awareness of new and evolving technologies to exploit improvement
- 14878 opportunities. As required, the integrated work environment or some of its
- 14879 components can be developed in-house or acquired from external sources.
- 14880 [PA169.IG101.SP102.SubP104.N101]
- 14881 5. Provide ongoing maintenance and operational support for the
- 14882 integrated work environment. [PA169.IG101.SP102.SubP105]
- 14883 Maintenance and support of the integrated work environment can be
- 14884 accomplished either with capabilities inside the organization or hired from outside
- 14885 the organization. [PA169.IG101.SP102.SubP105.N101]
- 14886 Examples of maintenance and support methods include the following:
- 14887 [PA169.IG101.SP102.SubP105.N102]
- 14888 • Hiring people to perform the maintenance and support
 - 14889 • Training people to perform the maintenance and support
 - 14890 • Contracting the maintenance and support
 - 14891 • Developing expert users for selected automation tools
- 14892 6. Monitor and evaluate the adequacy of the integrated work
- 14893 environment to satisfy user needs. [PA169.IG101.SP102.SubP106]

14894 *Refer to the Project Monitoring and Control process area for more*
14895 *information about practices for monitoring and controlling the work*
14896 *environment.* [PA169.IG101.SP102.SubP106.R101]

14897 The work environment should be monitored throughout its life cycle to ascertain if,
14898 and when, its performance degrades below that expected (or specified) as well as
14899 to identify opportunities for improvements. The key operating characteristics of
14900 the integrated work environment should be identified. The key operating
14901 characteristics are those performance, product, and process characteristics that
14902 can be measured and compared against expected capabilities of the integrated
14903 work environment. End users should be surveyed to determine the adequacy of
14904 the current environment and to identify potential improvements. Changes should
14905 be planned and implemented based on the analysis of usage and performance
14906 data and on identified real and potential problems. [PA169.IG101.SP102.SubP106.N101]

14907 7. Revise the integrated work environment as necessary, by adding,
14908 deleting, or replacing components. [PA169.IG101.SP102.SubP107]

14909 **SP 1.3 Identify IPPD-Unique Skill Requirements**

14910 ***Identify the unique skills needed to support the IPPD environment.***

14911 [PA169.IG101.SP103]

14912 *Refer to the Organizational Training process area for more information*
14913 *about determining training needs and delivering the training*

14914 [PA169.IG101.SP103.R101]

14915 IPPD is a sufficiently different view of product development that the
14916 organization's leadership and work force will need to develop new skills.
14917 IPPD requires integrative, leadership and interpersonal skills beyond
14918 those typically experienced in traditional environments where people
14919 tend to work alone or primarily interact with others from their own, or
14920 similar, functions or disciplines. Specific skills emphasized in an IPPD
14921 environment include: [PA169.IG101.SP103.N101]

- 14922 • The skills to integrate all appropriate business and technical
- 14923 functions and their processes
- 14924 • The interpersonal skills to coordinate and collaborate with others
- 14925 • The leadership skills to act, and successfully influence others to
- 14926 act, to achieve the shared vision

14927 Training to support these new skills needs to be established and
14928 maintained to sustain the ongoing adoption of IPPD in the organization.

14929 [PA169.IG101.SP103.N102]

14930 Each integrated team member needs to understand what is vital to
14931 other team members in terms of product characteristics and the
14932 capabilities, expectations, and interfaces of the processes associated
14933 with the other functions represented on the team. This understanding
14934 can often be augmented through cross training of individuals across
14935 their function or discipline boundaries. [PA169.IG101.SP103.N103]

14936 Collaboration among integrated team members is essential to create a
14937 team product rather than a collection of independent products.
14938 Enhanced interpersonal skills can help bridge not only the differences
14939 between disparate functions and disciplines, but also the differences in
14940 cultures, values, and backgrounds. [PA169.IG101.SP103.N104]

14941 The leadership demands also increase under IPPD. Leadership
14942 challenges include: ensuring all team members mutually understand
14943 their roles and responsibilities; employing people in their intended roles;
14944 and effectively accessing and integrating the depth and wealth of
14945 specific expertise resident in the organization into the overall integrated
14946 team effort. [PA169.IG101.SP103.N105]

14947 **Typical Work Products**

- 14948 1. IPPD strategic training needs [PA169.IG101.SP103.W101]
14949 2. IPPD tactical training needs [PA169.IG101.SP103.W102]

14950 **Subpractices**

- 14951 1. Provide requirements for IPPD skills to the organization's strategic
14952 training plan. [PA169.IG101.SP103.SubP101]
14953 2. Provide requirements for IPPD skills to the organization's tactical
14954 training plan. [PA169.IG101.SP103.SubP102]
14955 3. Ensure that IPPD skills are being provided. [PA169.IG101.SP103.SubP103]

14956 **SG 2 Manage People for Integration** [PA169.IG102]

14957 *People are managed to nurture the integrative and collaborative behaviors of*
14958 *an IPPD environment.*

14959 In an IPPD environment, special attention needs to be paid to aspects
14960 of organizational leadership and management. Nurturing integration
14961 necessitates focus on the objectives, values, and behaviors that are
14962 needed to effect integrated teamwork throughout the life cycle. The
14963 organization establishes the IPPD guidelines and processes that
14964 become part of the organization's process assets and the project's
14965 defined process. The organization's standard processes enable,
14966 promote, and reinforce the integrative behaviors expected from
14967 projects, integrated teams, and people. For all IPPD processes and
14968 guidelines, people are recognized not as the tool or means to the end,
14969 but as part of a mutually beneficial collaboration to achieve the
14970 objectives. [PA169.IG102.N101]

14971 In stimulating the integration needed, team-related incentives may be
14972 appropriate for people who work together. However, the value of
14973 individual excellence should not be overlooked. A balanced approach
14974 that addresses both individual performance as well as team
14975 performance would help maintain high standards of both team and
14976 individual achievement. Expectations from projects, integrated teams,
14977 and people are typically communicated in the form of policies, operating
14978 procedures, guidelines, and other process assets. [PA169.IG102.N102]

14979 **SP 2.1 Establish Leadership Mechanisms**

14980 ***Establish and maintain leadership mechanisms to enable timely***
14981 ***collaboration.*** [PA169.IG102.SP101]

14982 Implementation of IPPD introduces challenges to leadership practices
14983 because of the cultural changes required when people and integrated
14984 teams are empowered and decisions are driven to the lowest level
14985 appropriate. The effectiveness and efficiency of communications
14986 mechanisms in the integrated work environment are critical to timely
14987 and sound decision-making. Once an integrated work environment is
14988 established and training is provided, mechanisms to handle
14989 empowerment, decision-making, and issue resolution also need to be
14990 provided to effect the timely collaboration of relevant stakeholders
14991 required for IPPD. [PA169.IG102.SP101.N101]

14992 In an IPPD environment, it is particularly important that clear channels
14993 of responsibility and authority be established. Within the projects and
14994 the organization, issues can arise when individuals or integrated teams
14995 assume too much or too little authority and when the level at which
14996 decisions are made, or who owns what decisions, is unclear.
14997 Organizational guidelines that scope the degree of empowerment for
14998 integrated teams serve an issue prevention role. Best practices promote
14999 documented and deployed organizational guidelines that can preclude
15000 issues arising from empowerment and authority misinterpretation.
15001 [PA169.IG102.SP101.N102]

15002 Empowerment does not necessarily mean that every decision in an
15003 IPPD environment needs to occur at the lowest level or needs to be
15004 done collaboratively or even reflect consensus among all integrated
15005 team members or project participants. Decisions on the style and
15006 procedures for leadership and decision-making for projects and among
15007 integrated teams need to be made in collaboration with the relevant
15008 stakeholders. In establishing the context for decision-making, the
15009 various kinds of issues are described and agreements are reached on
15010 the decision type that will be used to resolve each kind of issue.

15011 [PA169.IG102.SP101.N103]

15012 Some examples of decision types are: [PA169.IG102.SP101.N104]

- 15013 • Command The leader examines the issue and make a decision
15014 alone.
- 15015 • Consultative The leader receives and examines inputs on the
15016 issue from relevant stakeholders and makes the decision
- 15017 • Collaborative Issues are raised by any of the stakeholders,
15018 including the leader, the issues are discussed, and solutions voted
15019 upon. Rules are needed to determine whether this vote is binding
15020 on the leader.
- 15021 • Consensus -- Issues are raised by any of the stakeholders,
15022 including the leader, and discussed until all members of the
15023 integrated team can live with and support the decision.
- 15024 • Structured A major issue to be decided by structured decision
15025 making. The steps in structured decision making may be carried
15026 out in a collaborative way.

15027 For many issues, the command decision type may be adequate. For
15028 issues that require several different areas of expertise or that have far-
15029 reaching consequences, the collaborative decisions may be more
15030 appropriate. Defining decision types and the authority of those
15031 entrusted to make decisions enables efficient operations.

15032 [PA169.IG102.SP101.N105]

15033 Mechanisms that grow leadership talent enable lower organizational
15034 unit delegation, and that in turn enables faster, better responses to
15035 changing customer needs, technology, and environmental conditions.

15036 [PA169.IG102.SP101.N106]

15037 Leadership characteristics cannot be viewed as solely embodied in the
15038 manager/leader. When leadership characteristics are evident in more
15039 than the leader, individual group members lead decision-making and
15040 activities that heavily involve their area of expertise. This flexibility can
15041 result in improved group efficiency and effectiveness. [PA169.IG102.SP101.N107]

15042 Even with well-intentioned empowerment, leadership, and decision-
15043 making, issues will arise that cannot be resolved at the same level. An
15044 organizational process for issue resolution can form the basis for
15045 project- and integrated team-specific procedures and help ensure that
15046 basic issue resolution avenues are available to projects and integrated
15047 teams when unresolved issues need to be escalated. An organizational
15048 process for issue resolution can serve both issue resolution and issue
15049 prevention roles. [PA169.IG102.SP101.N108]

15050 **Typical Work Products**

- 15051 1. Guidelines for determining the degree of empowerment of people
15052 and integrated teams [PA169.IG102.SP101.W101]
- 15053 2. Guidelines for setting leadership and decision-making context
15054 [PA169.IG102.SP101.W102]
- 15055 3. Organizational process documentation for issue resolution
15056 [PA169.IG102.SP101.W103]

15057 **Subpractices**

- 15058 1. Establish and maintain guidelines for the degree of empowerment
15059 provided to people and integrated teams. [PA169.IG102.SP101.SubP101]
- 15060 2. Collaboratively determine rules for the use of different decision
15061 types in making various kinds of decisions. [PA169.IG102.SP101.SubP102]

15062 *Refer to the Decision Analysis and Resolution process area for more*
15063 *information about structured decision making and evaluating and*
15064 *selecting among alternatives.* [PA169.IG102.SP101.SubP102.R101]

- 15065 3. Define the process for using the decision-making rules.
15066 [PA169.IG102.SP101.SubP103]
- 15067 4. Define a process for conflict resolution when an issue cannot be
15068 decided at the level at which it arose. [PA169.IG102.SP101.SubP104]

15069 **SP 2.2 Establish Incentives for Integration**

15070 ***Establish and maintain incentives for adopting and demonstrating***
15071 ***integrative and collaborative behaviors at all levels of the***
15072 ***organization.*** [PA169.IG102.SP102]

15073 The recognition and reward systems in an organization are one of the
15074 motivators for behavior and value changes. To support IPPD, the
15075 recognition and reward systems (both positive rewards and negative
15076 consequences) need to recognize a shift in values from single point of
15077 success or failure (e.g., providing a management incentive package to
15078 the product or program manager alone) to integrated team success or
15079 failure (e.g., providing layered incentives to integrated team members
15080 based on degree of involvement and contribution). [PA169.IG102.SP102.N101]

15081 Individual excellence still needs to be recognized, but criteria should
15082 discern whether such excellence was achieved at the expense of the
15083 integrative behaviors expected or in support of it. For example,
15084 individuals (such as leaders) removing integration barriers or
15085 implementing collaboration capabilities may be just as important as an
15086 integrated team performing well. Care should be taken, however, not to
15087 single out individuals for recognition for a team's achievement.

15088 [PA169.IG102.SP102.N102]

15089 Incentives need to be consistent with the objectives of the organization
15090 and applied to achieve desired behavior at all levels of the organization.
15091 Criteria can establish guidelines for the reassignment of people unable
15092 to demonstrate desired behavior and the selection of people who can
15093 exhibit desired behavior for challenging or important jobs.

15094 [PA169.IG102.SP102.N103]

15095 Compensation is not the only motivator, although the giving of an object
15096 of some value is an appropriate recognition. Reinforcement of positive
15097 behavior via thanks or praise is usually appropriate, especially soon
15098 after the observed performance and such immediate recognition
15099 reinforces the collaborative nature of working in an IPPD environment. If
15100 staff have to wait for yearly performance appraisals, their motivation for
15101 working outside of their strict functional job description is lessened.

15102 [PA169.IG102.SP102.N104]

15103 The yearly performance appraisals also need to be addressed. Review
15104 mechanisms need to be structured so that both home organization
15105 supervisors and team leaders contribute to a person's performance
15106 review. [PA169.IG102.SP102.N105]

15107 **Typical Work Products**

15108 1. Compensation policies and procedures [PA169.IG102.SP102.W101]

15109 2. Integrated team and individual recognition and rewards

15110 [PA169.IG102.SP102.W102]

15111 **Subpractices**

15112 1. Structure the recognition and reward process to be consistent with
15113 the IPPD environment. [PA169.IG102.SP102.SubP101]

15114 The organization's recognition and reward process should recognize the value of
15115 individual and integrated team excellence and enable, promote, and reinforce
15116 integration. [PA169.IG102.SP102.SubP101.N101]

15117 2. Develop guidelines for team recognition as well as individual.

15118 [PA169.IG102.SP102.SubP102]

15119 3. Define procedures for integrated review processes that involve
15120 both the integrated team leader and the functional manager.

15121 [PA169.IG102.SP102.SubP103]

- 15122 4. Establish criteria for distinguishing behaviors that promote
15123 integrated team performance from those that establish barriers to
15124 team behaviors. [PA169.IG102.SP102.SubP104]

15125 **SP 2.3 Establish Mechanisms to Balance Team and Home Organization**
15126 **Responsibilities**

15127 ***Establish and maintain organizational guidelines to balance team***
15128 ***and home organization responsibilities.*** [PA169.IG102.SP103]

15129 Here "home organization" refers to that part of the organization to which
15130 personnel are assigned when they are not in an integrated team. This
15131 home organization may be called the "functional organization", "home
15132 base", "home office", or "direct organization." Regardless of what it is
15133 called, it is often responsible for the career growth of the personnel
15134 assigned to it, e.g., performance appraisals and training to maintain
15135 functional and discipline expertise. In an IPPD environment, reporting
15136 procedures and rating systems need to recognize that people's
15137 responsibility is focused on the integrated team, not to the traditional
15138 home organization. A balance must be struck, however, because the
15139 responsibility of integrated team members to their respective home
15140 organizations are still important, specifically for process implementation
15141 and improvement. Workloads should be balanced between projects
15142 and functions, while ensuring career growth and advancement.
15143 Mechanisms need to be created that support the home organization
15144 responsibility but align the work force to meet business objectives in a
15145 teaming environment. [PA169.IG102.SP103.N101]

15146 Striking this balance is difficult for an organization but exceedingly
15147 important for the personnel and the success of IPPD implementation.
15148 The balance must be reflected in the personal or career development
15149 plans for each individual. The knowledge and skills needed for an
15150 individual to succeed in both their functional and integrated team role
15151 should be honed, taking into account current and future assignments.
15152 [PA169.IG102.SP103.N102]

15153 Guidelines should also be in place for disbanding teams and
15154 maintaining home organizations. It has been observed that sometimes
15155 teams attempt to remain in place beyond their productive life in
15156 organizations that do not have a home organization for the team
15157 members to report back to after the team is dissolved. [PA169.IG102.SP103.N103]

15158 **Typical Work Products**

- 15159 1. Organizational guidelines for balancing team and home
15160 organization responsibilities [PA169.IG102.SP103.W101]
- 15161 2. Performance review process that considers both functional
15162 supervisor and team leader input [PA169.IG102.SP103.W102]

- 15163 **Subpractices**
- 15164 1. Establish guidelines for home organization responsibilities in
- 15165 promoting integrated team behavior. [PA169.IG102.SP103.SubP101]
- 15166 2. Establish guidelines for team management responsibilities to
- 15167 ensure integrated team members report appropriately to their home
- 15168 organization. [PA169.IG102.SP103.SubP102]
- 15169 3. Establish a performance review process that considers input from
- 15170 home organization and integrated team leaders. [PA169.IG102.SP103.SubP103]

15171 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

15172

The process is institutionalized as a defined process.

15173

Commitment to Perform

15174 **GP 2.1 (CO 1) Establish an Organizational Policy**

15175 ***Establish and maintain an organizational policy for planning and***

15176 ***performing the organizational environment for integration process.***

15177 *[GP103]*

15178 Elaboration:

15179 This policy establishes organizational expectations for providing an

15180 IPPD infrastructure and managing people for integration. [PA169.EL101]

15181

Ability to Perform

15182 **GP 3.1 (AB 1) Establish a Defined Process**

15183 ***Establish and maintain the description of a defined organizational***

15184 ***environment for integration process.*** [GP114]

15185 **GP 2.2 (AB 2) Plan the Process**

15186 ***Establish and maintain the requirements and objectives, and plans***

15187 ***for performing the organizational environment for integration***

15188 ***process.*** [GP104]

15189 Elaboration:

15190 These requirements, objectives, and plans are described in the
15191 organization's plan for the organizational environment for integration.

15192 [PA169.EL102]

15193 **GP 2.3 (AB 3) Provide Resources**

15194 ***Provide adequate resources for performing the organizational***
15195 ***environment for integration process, developing the work***
15196 ***products and providing the services of the process.*** [GP105]

15197 Elaboration:

15198 Examples of special equipment and facilities include: [PA169.EL103]

- 15199 • Manufacturing and production facilities
- 15200 • Prototyping or production equipment
- 15201 • Work space
- 15202 • Office equipment and supplies
- 15203 • Raw or stock input materials
- 15204 • Transportation resources
- 15205 • "Hot-lines" and "help-desks"
- 15206 • Information brokerage services
- 15207 • Support staff and/or services

15208
15209 Examples of tools used in performing the activities of the Organizational
15210 Environment for Integration process area include the following: [PA169.EL104]

- 15211 • Communications systems, tools, and resources
- 15212 • Computing resources and software productivity tools
- 15213 • Engineering or simulation tools
- 15214 • Proprietary engineering tools
- 15215 • Information technology capabilities

15216

15217 **GP 2.4 (AB 4) Assign Responsibility**

15218 ***Assign responsibility and authority for performing the process,***
15219 ***developing the work products, and providing the services of the***
15220 ***organizational environment for integration process.*** [GP106]

15221 **GP 2.5 (AB 5) Train People**

15222 ***Train the people performing or supporting the organizational***
15223 ***environment for integration process as needed.*** [GP107]

15224 Elaboration:

15225 Examples of training topics include the following: [PA169.EL105]

- 15226 • Work environment development
- 15227 • Ergonomics
- 15228 • Leadership policies for IPPD
- 15229 • Managing people for integration and collaboration
- 15230

15231 **Directing Implementation**

15232 **GP 2.6 (DI 1) Manage Configurations**

15233 ***Place designated work products of the organizational environment***
15234 ***for integration process under appropriate levels of configuration***
15235 ***management.*** [GP109]

15236 Elaboration:

15237 Examples of work products placed under configuration management
15238 include the following: [PA169.EL106]

- 15239 • Organizational guidelines that determine the degree of
15240 empowerment of individuals and integrated teams
- 15241 • Organizational process documentation for issue resolution
- 15242 • Organization's shared vision
- 15243

15244 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

15245 ***Identify and involve the relevant stakeholders of the organizational***
15246 ***environment for integration process as planned.*** [GP124]

15247 Elaboration:

15248 Examples of activities for stakeholder involvement include: [PA169.EL107]

- 15249
- 15250 • Establishing and maintaining the organization's shared vision
 - 15251 • Establishing and maintaining the integrated work environment
 - 15252 • Establishing IPPD skill needs
 - 15253 • Establishing and maintaining IPPD leadership mechanisms
 - 15254 • Establishing and maintaining organizational policies for the management of people in an IPPD environment
- 15255

15256 **GP 2.8 (DI 3) Monitor and Control the Process**

15257 ***Monitor and control the organizational environment for integration***
15258 ***process against the plan and take appropriate corrective action.***

15259 [GP110]

15260 Elaboration:

15261 Examples of measures used in monitoring and controlling the activities
15262 of the Organizational Environment for Integration process area include
15263 the following: [PA169.EL108]

- 15264
- 15265 • Parameters for key operating characteristics of the work environment
- 15266

15267 **GP 3.2 (DI 4) Collect Improvement Information**

15268 ***Collect work products, measures, measurement results, and***
15269 ***improvement information derived from planning and performing***
15270 ***the organizational environment for integration process to support***
15271 ***the future use and improvement of the organization's processes***
15272 ***and process assets.*** [GP117]

15273 Verifying Implementation

15274 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

15275 ***Objectively evaluate adherence of the organizational environment***
15276 ***for integration process and the work products and services of the***
15277 ***process to the applicable requirements, objectives, and standards,***
15278 ***and address noncompliance.*** [GP113]

15279

Elaboration:

15280

Examples of activities reviewed include the following: [PA169.EL109]

15281

- Establishing the shared vision for the organization

15282

- Developing guidelines for the degree of empowerment provided to people and teams

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15284

- Establishing and maintaining an issue resolution process for issues

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Examples of work products reviewed include the following: [PA169.EL110]

15287

- Organization's shared vision

15288

- Organizational guidelines that determine the degree of empowerment of individuals and integrated teams

15289

15290

- Organizational process documentation for issue resolution

15291

- Compensation policies and procedures

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

15294

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

15295

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15297 MATURITY LEVEL: 4 QUANTITATIVELY MANAGED

15298 The following section contains all of the process areas that belong to
15299 maturity level 4. The maturity level 4 process areas of CMMI are as
15300 follows: [FM111.T101]

- 15301 • Organizational Process Performance
- 15302 • Quantitative Project Management

15303 *Refer to the Model Components section of the Structure of the Model*
15304 *chapter of the Overview for more information about CMMI maturity*
15305 *levels.* [FM111.T101.R101]

15306 ORGANIZATIONAL PROCESS PERFORMANCE

15307 Maturity Level 4

15308 Purpose

15309 The purpose of Organizational Process Performance is to establish and
 15310 maintain a quantitative understanding of the performance of the
 15311 organization's set of standard processes, and to provide the process
 15312 performance data, baselines, and models to quantitatively manage the
 15313 organization's projects. [PA164]

15314 Introductory Notes

15315 Process performance is a measure of the actual results achieved by
 15316 following a process. Process performance is characterized by both
 15317 process measures (e.g., effort, cycle time, and defect removal
 15318 efficiency) and product measures (e.g., reliability, and defect density).
 15319 [PA164.N101]

15320 The common measures for the organization are composed of process
 15321 and product measures that summarize the actual performance of
 15322 processes in individual projects in the organization. The organizational
 15323 data for these measures is analyzed to establish a distribution and
 15324 range of results, which characterize the expected performance of the
 15325 process when used on any individual project in the organization.
 15326 [PA164.N102]

15327 In this process area, the phrase "quality and process performance
 15328 objectives" covers objectives and requirements for product quality,
 15329 service quality, and process performance. As indicated above, the term
 15330 process performance includes product quality; however, to emphasize
 15331 the importance of product quality, the phrase "quality and process
 15332 performance objectives" is used rather than just "process performance
 15333 objectives." [PA164.N106]

15334 The expected process performance can be used in establishing the
 15335 project's quality and process performance objectives and can be used
 15336 as a baseline against which actual project performance can be
 15337 compared. This information is used to quantitatively manage the
 15338 project. Each quantitatively managed project, in turn, provides actual
 15339 performance results that become a part of the baseline data for the
 15340 organization's process assets. [PA164.N103]

15341 The associated process capability models are used to represent past
15342 and current process performance and to predict future results of the
15343 process. [PA164.N104]

15344 For example, the latent defects in the delivered product can be
15345 predicted using measurements of defects identified during the product
15346 verification activities. [PA164.N107]

15347
15348 When the organization has measures, data, and analytic techniques for
15349 critical process and product characteristics, it is able to do the following:

[PA164.N105]

- 15351 • Determine whether processes are behaving consistently or have
15352 stable trends (i.e., are predictable).
- 15353 • Identify processes that perform within consistent natural bounds
15354 across process implementation teams.
- 15355 • Establish criteria for identifying whether a process or process
15356 element should be statistically managed, and determine pertinent
15357 measures and analytic techniques to be used in such
15358 management.
- 15359 • Identify processes that show unusual (e.g., sporadic or
15360 unpredictable) behavior.
- 15361 • Identify any aspects of the processes that can be improved in the
15362 organization's set of standard processes.
- 15363 • Identify implementations of processes which may be best
15364 practices.

15365 Related Process Areas

15366 *Refer to the Quantitative Project Management process area for more*
15367 *information about the use of process performance baselines and*
15368 *models* [PA164.R101]

15369 *Refer to the Measurement and Analysis process area for more*
15370 *information about specifying measures, collecting and analyzing data.*
15371 [PA164.R102]

15372 Specific and Generic Goals

15373 **SG 1 Establish Performance Baselines and Models** [PA164.IG101]

15374 ***Baselines and models that characterize the expected process performance of***
15375 ***the organization's set of standard processes are established and maintained.***

15376 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

15377 ***The process is institutionalized as a defined process.***

15378 Practice to Goal Relationship Table

15379 SG 1 Establish Performance Baselines and Models [PA164.IG101]

- 15380 SP 1.1 Select Processes
- 15381 SP 1.2 Establish Process Performance Measures
- 15382 SP 1.3 Establish Quality and Process Performance Objectives
- 15383 SP 1.4 Establish Process Performance Baselines
- 15384 SP 1.5 Establish Process Performance Models

15385 GG 3 Institutionalize a Defined Process

- 15386 GP 2.1 (CO 1) Establish an Organizational Policy
- 15387 GP 3.1 (AB 1) Establish a Defined Process
- 15388 GP 2.2 (AB 2) Plan the Process
- 15389 GP 2.3 (AB 3) Provide Resources
- 15390 GP 2.4 (AB 4) Assign Responsibility
- 15391 GP 2.5 (AB 5) Train People
- 15392 GP 2.6 (DI 1) Manage Configurations
- 15393 GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders
- 15394 GP 2.8 (DI 3) Monitor and Control the Process
- 15395 GP 3.2 (DI 4) Collect Improvement Information
- 15396 GP 2.9 (VE 1) Objectively Evaluate Adherence
- 15397 GP 2.10 (VE 2) Review Status with Higher-Level Management

15398 Specific Practices by Goal

15399 **SG 1 Establish Performance Baselines and Models** [PA164.IG101]

15400 ***Baselines and models that characterize the expected process performance of***
 15401 ***the organization's set of standard processes are established and maintained.***

15402 **SP 1.1 Select Processes**

15403 ***Select the processes or process elements in the organization's set***
 15404 ***of standard processes that are to be included in the organization's***
 15405 ***process performance analyses.*** [PA164.IG101.SP101]

15406 *Refer to the Organizational Process Definition process area for more*
 15407 *information about the structure of the organization's process assets.*

15408 [PA164.IG101.SP101.R101]

15409 The organization's set of standard processes consists of a set of
 15410 standard processes that, in turn, are comprised of process elements.

15411 [PA164.IG101.SP101.N101]

15412 Typically, it will not be possible, useful, or economically justifiable to
15413 apply quantitative process performance techniques to all processes or
15414 process elements of the organization's set of standard processes.
15415 Selection of the processes and/or process elements is based upon the
15416 needs and objectives of both the organization and projects.

[PA164.IG101.SP101.N102]

15418 **Typical Work Products**

- 15419 1. List of process or process elements identified for process
15420 performance analyses [PA164.IG101.SP101.W101]

15421 **SP 1.2 Establish Process Performance Measures**

15422 ***Establish and maintain definitions of the measures that are to be***
15423 ***included in the organization's process performance analyses.***

15424 [PA164.IG101.SP102]

15425 *Refer to the Measurement and Analysis process area for more*
15426 *information about selecting measures.* [PA164.IG101.SP102.R101]

15427 **Typical Work Products**

- 15428 1. Definitions for the selected measures of process performance
15429 [PA164.IG101.SP102.W101]

15430 **Subpractices**

- 15431 1. Determine which of the organization's business objectives for
15432 process performance need to be addressed by the measures.

15433 [PA164.IG101.SP102.SubP101]

- 15434 2. Select measures that provide appropriate insight into the
15435 organization's process performance. [PA164.IG101.SP102.SubP102]

15436 The Goal Question Metric paradigm is an approach that can be used to select
15437 measures that provide insight into the organization's business objectives.

15438 [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 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]

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Examples of business objectives include the following: [PA164.IG101.SP103.SubP101.N101]

- Achieve a development cycle of a specified time for a specified release of a product.
- Decrease the cost of maintenance of the products currently in development by a specified percent.

2. Define the organization's quantitative objectives for process performance. [PA164.IG101.SP103.SubP102]

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]

Examples of process performance objectives include the following:
[PA164.IG101.SP103.SubP102.N102]

- Achieve a specified productivity.
- Deliver work products with no more than a specified number of latent defects.

3. Define the priorities of the organization's objectives for process performance. [PA164.IG101.SP103.SubP103]

4. Review, negotiate, and obtain commitment for the organization's process performance objectives and their priorities from the relevant stakeholders. [PA164.IG101.SP103.SubP104]

5. Revise the organization's quantitative objectives for process performance as necessary. [PA164.IG101.SP103.SubP105]

Examples of when the organization's quantitative objectives for process performance may need to be revised include the following:
[PA164.IG101.SP103.SubP105.N101]

- When the organization's business objectives change
- When the organization's processes change
- When actual process performance differs significantly from the objectives

SP 1.4 Establish Process Performance Baselines

Establish and maintain the organization's process performance baselines. [PA164.IG101.SP104]

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:

[PA164.IG101.SP104.N101]

- 15508 • Individual process elements (e.g., test case inspection element)
- 15509 • Sequence of connected processes
- 15510 • Processes for the complete life cycle
- 15511 • Processes for developing individual work products

15512 There may be several process performance baselines to characterize
15513 performance for subgroups of the organization. [PA164.IG101.SP104.N102]

Examples of criteria used to categorize subgroups include the following:

[PA164.IG101.SP104.N104]

- 15514 • Product line
- 15515 • Application domain
- 15516 • Complexity
- 15517 • Team size
- 15518 • Work product size
- 15519 • Process elements from the organization's set of standard
- 15520 processes
- 15521
- 15522

15523
15524 Allowable tailoring of the organization's set of standard processes may
15525 significantly affect the comparability of the data for inclusion in process
15526 performance baselines. The effects of tailoring should be considered in
15527 establishing baselines. [PA164.IG101.SP104.N103]

15528 *Refer to the Quantitative Project Management process area for more*
15529 *information about the use of process baselines* [PA164.IG101.SP104.N103.R101]

15530 **Typical Work Products**

- 15531 1. Baseline data on the organization's process performance
- 15532 [PA164.IG101.SP104.W101]

15533 **Subpractices**

- 15534 1. Collect measurements from the organization's projects.
- 15535 [PA164.IG101.SP104.SubP101]

15536 *Refer to the Measurement and Analysis process area for information*
15537 *about collecting and analyzing data* [PA164.IG101.SP104.SubP101.R101]

- 15538 2. Establish and maintain the organization's process performance
15539 baselines from the collected measurements and analyses.

15540 [PA164.IG101.SP104.SubP102]

15541 *Refer to the Measurement and Analysis process area for information*
15542 *about measuring process performance to establish performance*
15543 *baselines.* [PA164.IG101.SP104.SubP102.R101]

15544 Process performance baselines are derived by analyzing the collected measures
15545 to establish a distribution and range of results that characterize the expected
15546 performance for selected processes when used on any individual project in the
15547 organization. [PA164.IG101.SP104.SubP102.N102]

15548 The measurements from stable processes from projects should be used; other
15549 data may not be reliable. [PA164.IG101.SP104.SubP102.N101]

15550 3. Review and get agreement with relevant stakeholders about the
15551 organization's process performance baselines. [PA164.IG101.SP104.SubP103]

15552 4. Make the organization's process performance information available
15553 across the organization in the organization's measurement
15554 repository. [PA164.IG101.SP104.SubP104]

15555 The organization's process performance baselines are used by the projects to
15556 estimate the natural bounds for process performance. [PA164.IG101.SP104.SubP104.N101]

15557 *Refer to the Organizational Process Definition process area for more*
15558 *information about establishing the measurement repository*

15559 [PA164.IG101.SP104.SubP104.N101.R101]

15560 5. Compare the organization's process performance baselines to the
15561 associated objectives. [PA164.IG101.SP104.SubP105]

15562 6. Revise the organization's process performance baselines as
15563 necessary. [PA164.IG101.SP104.SubP106]

15564 Examples of when the organization's process performance baselines may need to
15565 be revised include the following: [PA164.IG101.SP104.SubP106.N101]

- 15566 • When the processes change
- 15567 • When the organization's results change
- 15568 • When the organization's needs change

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15570 SP 1.5 Establish Process Performance Models

15571 ***Establish and maintain the process performance models for the***
15572 ***organization's set of standard processes.*** [PA164.IG101.SP105]

15573 Process performance models are used to estimate or predict the value
15574 of a process performance measure from the values of other process
15575 and product measurements. These process performance models
15576 typically use process and product measurements collected throughout
15577 the life cycle to estimate progress toward achieving objectives which
15578 cannot be measured until later in the life cycle. [PA164.IG101.SP105.N101]

15579 The process performance models are used as follows:

15580 [PA164.IG101.SP105.N102]

- 15581 • The organization uses them for estimating, analyzing, and
- 15582 predicting the process performance associated with the processes
- 15583 in the organization's set of standard processes.
- 15584 • The organization uses them to assess the (potential) return on
- 15585 investment for process improvement activities.
- 15586 • Projects use them for estimating, analyzing, and predicting the
- 15587 process performance for their defined processes.
- 15588 • Projects use them for selecting processes for use.

15589 These measures and models are defined to provide insight into and to
15590 provide the ability to predict critical process and product characteristics
15591 that are relevant to business value. [PA164.IG101.SP105.N103]

15592 Examples of areas to use models include the following:

15593 [PA164.IG101.SP105.N104]

- 15594 • Schedule and cost
- 15595 • Reliability
- 15596 • Defect identification and removal rates
- 15597 • Defect removal efficiency
- 15598 • Latent defect estimation
- 15599 • Development progress
- 15600 • A combination of these areas

15602 Examples of process performance models include the following:

15603 [PA164.IG101.SP105.N105]

- 15604 • System dynamics models
- 15605 • Reliability growth models
- 15606 • Complexity models

15608 *Refer to the Quantitative Project Management process area for more*
15609 *information about the use of process models* [PA164.IG101.SP105.N105.R101]

15610 **Typical Work Products**

- 15611 1. Process performance models [PA164.IG101.SP105.W101]

15612 **Subpractices**

- 15613 1. Establish the process performance models based on the
15614 organization's set of standard processes and the organization's
15615 process performance baselines. [PA164.IG101.SP105.SubP101]

- 15616 2. Calibrate the process performance models based on the
15617 organization's past results and current needs. [PA164.IG101.SP105.SubP102]
- 15618 3. Review the process performance models and get agreement with
15619 relevant stakeholders. [PA164.IG101.SP105.SubP103]
- 15620 4. Support the projects' use of the process performance models.
15621 [PA164.IG101.SP105.SubP104]
- 15622 5. Revise the process performance models as necessary.
15623 [PA164.IG101.SP105.SubP105]

15624 Examples of when the process performance models may need to be revised
15625 include the following: [PA164.IG101.SP105.SubP105.N101]

- 15626 • When the processes change
 - 15627 • When the organization's results change
 - 15628 • When the organization's needs change
- 15629

15630 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

15631 ***The process is institutionalized as a defined process.***

15632 Commitment to Perform

15633 **GP 2.1 (CO 1) Establish an Organizational Policy**

15634 ***Establish and maintain an organizational policy for planning and***
15635 ***performing the organizational process performance process.*** [GP103]

15636 Elaboration:

15637 This policy establishes organizational expectations for establishing and
15638 maintaining process performance baselines for the organization's set of
15639 standard processes. [PA164.EL101]

15640 Ability to Perform

15641 **GP 3.1 (AB 1) Establish a Defined Process**

15642 ***Establish and maintain the description of a defined organizational***
15643 ***process performance process.*** [GP114]

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GP 2.2 (AB 2) Plan the Process

Establish and maintain the requirements and objectives, and plans for performing the organizational process performance process.

[GP104]

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GP 2.3 (AB 3) Provide Resources

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

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Elaboration:

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Special expertise in statistics and statistical process control may be needed to establish the performance baseline of the organization's set of standard processes. [PA164.EL111]

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Examples of tools used in performing the activities of the Organizational Process Performance process area include the following: [PA164.EL102]

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- Database management systems
- System dynamic models
- Process modeling tools
- Statistical analysis packages
- Problem tracking packages

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GP 2.4 (AB 4) Assign Responsibility

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

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GP 2.5 (AB 5) Train People

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

15671 Elaboration:

15672 Examples of training topics include the following: [PA164.EL103]
15673

- Process and process improvement modeling
- Quantitative and statistical methods (e.g., estimating models, Pareto analysis, and control charts)

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15677 Directing Implementation

15678 **GP 2.6 (DI 1) Manage Configurations**

15679 *Place designated work products of the organizational process*
15680 *performance process under appropriate levels of configuration*
15681 *management.* [GP109]

15682 Elaboration:

15683 Examples of work products placed under configuration management
15684 include the following: [PA164.EL104]
15685

- Organizational process performance objectives
- Definition for the selected measures of process performance
- Baseline data on the organization's process performance

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15689 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

15690 *Identify and involve the relevant stakeholders of the organizational*
15691 *process performance process as planned.* [GP124]

15692 Elaboration:

15693 Examples of activities for stakeholder involvement include: [PA164.EL112]
15694

- Establishing the organization's process performance objectives and their priorities
- Reviewing and resolving issues on the organization's process performance baselines
- Reviewing and resolving issues on the organization's process performance models

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GP 2.8 (DI 3) Monitor and Control the Process

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

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[GP110]

15705

Elaboration:

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Examples of measures used in monitoring and controlling the activities of the Organizational Process Performance process area include the following: [PA164.EL105]

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- Trends in the organization's process performance with respect to changes in work products and task attributes (e.g., size growth, effort, schedule, and quality)

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GP 3.2 (DI 4) Collect Improvement Information

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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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15719 Verifying Implementation

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GP 2.9 (VE 1) Objectively Evaluate Adherence

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Objectively evaluate adherence of the organizational process performance 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: [PA164.EL106]

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- Establishing performance baselines and models

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Examples of work products reviewed include the following: [PA164.EL110]

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- Process performance plans
- Organizational process performance objectives
- Definition for the selected measures of process performance

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GP 2.10 (VE 2) 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]

15738 QUANTITATIVE PROJECT MANAGEMENT

15739 Maturity Level 4

15740 Purpose

15741 The purpose of the Quantitative Project Management process area is to
15742 quantitatively manage the project's defined process to achieve the
15743 project's established quality and process performance objectives. [PA165]

15744 Introductory Notes

15745 Quantitative Project Management involves the following: [PA165.N101]

- 15746 • Establishing and maintaining the project's quality and process
15747 performance objectives
- 15748 • Identifying suitable subprocesses that compose the project's
15749 defined process based on historical stability and capability data
15750 found in process performance baselines and/or models
- 15751 • Selecting the subprocesses of the project's defined process to be
15752 statistically managed
- 15753 • Selecting the measures and analytic techniques to be used in
15754 statistically managing the selected subprocesses
- 15755 • Establishing and maintaining statistical control of the selected
15756 subprocesses using the selected measures and analytic
15757 techniques
- 15758 • Determining whether the selected subprocesses are capable of
15759 satisfying their quality and process performance objectives, and
15760 taking corrective action as necessary
- 15761 • Determining whether the project's defined process is able to satisfy
15762 the project's objectives, and take corrective action when
15763 appropriate
- 15764 • Recording statistical and quality management data in the
15765 organization's measurement repository

15766 The process performance objectives, measures, and baselines
15767 identified above are developed through the Organizational Process
15768 Performance process area. Subsequently, the results of performing the
15769 Quantitative Project Management process area (measurement
15770 definitions, measurement data etc.) are part of the organizational assets
15771 referred to in the Organizational Process Performance process area.

[PA165.N102]

15773 Prior to implementing this process area, the organization should have
15774 already established a set of standard processes and related process
15775 assets such as the organization's measurement repository and the
15776 process asset library for use by each project in establishing its defined
15777 process. The project's defined process is a set of subprocesses that
15778 form an integrated and coherent life cycle for the project. It is
15779 established in part through selecting and tailoring from the
15780 organization's set of standard processes. [PA165.N103]

15781 The organization's measurement repository and process asset library
15782 provide information that assist in composing a defined process that will
15783 achieve the objectives that have been established by the project.
15784 [PA165.N104]

15785 In this process area, the phrase "quality and process performance
15786 objectives" covers objectives and requirements for product quality,
15787 service quality, and process performance. As commonly used, the term
15788 process performance includes product quality. However, to emphasize
15789 the importance of product quality, the phrase "quality and process
15790 performance objectives" is used rather than just "process performance
15791 objectives." [PA165.N105]

15792 Process performance is a measure of the actual process results
15793 achieved. Process performance is characterized by both process
15794 measures (e.g., effort, cycle time, and defect removal efficiency) and
15795 product measures (e.g., reliability, defect density, and response time).
15796 [PA165.N106]

15797 Subprocesses are defined components of a larger defined process. For
15798 example, a typical organization's development process may be defined
15799 in terms of subprocesses such as requirements development, design,
15800 build, test, and peer review. The subprocesses themselves may be
15801 further decomposed as necessary into finer-grained process
15802 descriptions. [PA165.N107]

15803 One essential element of quantitative management is having
15804 confidence in estimates, i.e. being able to predict the extent to which
15805 the project can fulfill its quality and process performance objectives.
15806 The subprocesses that will be statistically managed are chosen based
15807 on identified needs for predictable performance. [PA165.N108]

15808 Another essential element of quantitative management is understanding
15809 the nature and extent of the variation experienced in process
15810 performance, and recognizing when the project's actual performance
15811 may not be adequate to achieving the project's quality and process
15812 performance objectives. This recognition is a basis for taking corrective
15813 action. [PA165.N109]

15814 Statistical management involves statistical thinking and the correct use
15815 of a variety of statistical techniques, such as run charts, control charts,
15816 confidence intervals, prediction intervals, and tests of hypotheses.
15817 Quantitative management uses data from statistical management to
15818 help the project predict whether it will be able to achieve its quality and
15819 process performance objectives and take corrective action when
15820 appropriate. [PA165.N110]

15821 This process area applies to managing a project, but the concepts
15822 found here also apply to managing other groups and functions. Applying
15823 these concepts to managing other groups and functions may not
15824 necessarily contribute to achieving the organization's business
15825 objectives, but may help these groups and functions control their own
15826 processes. [PA165.N111]

15827 Examples of other groups and functions include the following:

15828 [PA165.N113]

- 15829 • Quality assurance
- 15830 • Process definition and improvement
- 15831 • Effort reporting
- 15832 • Customer complaint handling
- 15833 • Problem tracking and reporting

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15835 In this process area, the term "product" refers to products or services or
15836 both, as appropriate. [PA165.N112]

15837 Related Process Areas

15838 *Refer to the Project Monitoring and Control process area for more*
15839 *information about monitoring and controlling project progress and*
15840 *performance. [PA165.R101]*

15841 *Refer to Measurement and Analysis process area for more information*
15842 *about establishing measurable objectives, specifying the measures and*
15843 *analyses to be performed, obtaining and analyzing measures, and*
15844 *providing objective results. [PA165.R102]*

15845 *Refer to the Organizational Process Performance process area for*
15846 *more information about the organization's quality and process*
15847 *performance objectives, process performance analyses, process*
15848 *performance baselines, and process performance models. [PA165.R103]*

15849 *Refer to the Organizational Process Definition process area for more*
15850 *information about the organizational process assets including the*
15851 *organization's measurement repository. [PA165.R104]*

- 15852 *Refer to the Integrated Project Management (IPPD) process area for*
15853 *more information about establishing and maintaining the project's*
15854 *defined process. [PA165.R105]*
- 15855 *Refer to the Causal Analysis and Resolution process area for more*
15856 *information about how to identify the causes of defects and other*
15857 *problems and taking action to prevent them from occurring in the future.*
15858 *[PA165.R106]*
- 15859 *Refer to the Organizational Innovation and Deployment process area*
15860 *for more information about selecting and deploying improvements that*
15861 *support the organization's quality and process performance objectives.*
15862 *[PA165.R107]*

15863 Specific and Generic Goals

15864 **SG 1 Quantitatively Manage the Project** [PA165.IG101]

15865 *The project is quantitatively managed using quality and process performance*
15866 *objectives.*

15867 **SG 2 Statistically Manage Subprocess Performance** [PA165.IG102]

15868 *The performance of selected subprocesses within the project's defined*
15869 *process is statistically managed.*

15870 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

15871 *The process is institutionalized as a defined process.*

15872 Practice to Goal Relationship Table

15873 SG 1 Quantitatively Manage the Project [PA165.IG101]

- 15874 SP 1.1 Establish the Project's Objectives
- 15875 SP 1.2 Compose the Defined Process
- 15876 SP 1.3 Select the Subprocesses to be Managed
- 15877 SP 1.4 Manage Project Performance

15878 SG 2 Statistically Manage Subprocess Performance [PA165.IG102]

- 15879 SP 2.1 Select Measures and Analytic Techniques
- 15880 SP 2.2 Apply Statistical Methods to Understand Variation
- 15881 SP 2.3 Monitor Performance of the Selected Subprocesses
- 15882 SP 2.4 Record Statistical Management Data

15883 GG 3 Institutionalize a Defined Process

- 15884 GP 2.1 (CO 1) Establish an Organizational Policy
- 15885 GP 3.1 (AB 1) Establish a Defined Process
- 15886 GP 2.2 (AB 2) Plan the Process
- 15887 GP 2.3 (AB 3) Provide Resources
- 15888 GP 2.4 (AB 4) Assign Responsibility
- 15889 GP 2.5 (AB 5) Train People
- 15890 GP 2.6 (DI 1) Manage Configurations
- 15891 GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders
- 15892 GP 2.8 (DI 3) Monitor and Control the Process
- 15893 GP 3.2 (DI 4) Collect Improvement Information
- 15894 GP 2.9 (VE 1) Objectively Evaluate Adherence
- 15895 GP 2.10 (VE 2) Review Status with Higher-Level Management

15896 Specific Practices by Goal

15897 **SG 1 Quantitatively Manage the Project** [PA165.IG101]

15898 ***The project is quantitatively managed using quality and process performance***
 15899 ***objectives.***

15900 **SP 1.1 Establish the Project's Objectives**

15901 ***Establish and maintain the project's quality and process***
 15902 ***performance objectives.*** [PA165.IG101.SP101]

15903 This specific practice is typically performed early during project
 15904 planning. [PA165.IG101.SP101.N101]

15905 Note that the first three specific practices for Goal 1 of this process area
15906 may be addressed concurrently. When establishing the project's quality
15907 and process performance objectives, it is often useful to think ahead
15908 about which elements of the organization standard set of processes will
15909 be included in the projects defined process. Also, it is important to
15910 identify what subprocesses need to be statistically managed in order for
15911 the project to achieve those objectives The balance between project
15912 quality and performance objectives and the estimated performance of
15913 the projects defined process is typically developed through multiple
15914 iterations. Initially, project performance objectives are set. Then, the
15915 expected performance of the projects defined process is identified. If
15916 there is a difference between project quality and performance objectives
15917 and the defined project process performance estimate, negotiations
15918 between relevant stakeholders are required to eliminate the difference.
15919 [PA165.IG101.SP101.N102]

15920 **Typical Work Products**

- 15921 1. The project's documented quality and process performance
15922 objectives. [PA165.IG101.SP101.W101]

15923 **Subpractices**

- 15924 1. Review the organization's objectives for quality and process
15925 performance. [PA165.IG101.SP101.SubP101]

15926 The intent of this review is to ensure the project understands the broader business
15927 context in which the project will need to operate. The project's objectives for
15928 quality and process performance will be developed in the context of these
15929 overarching organizational objectives. [PA165.IG101.SP101.SubP101.N101]

15930 *Refer to the Organizational Process Performance process area for*
15931 *more information about the organization's quality and process*
15932 *performance objectives.* [PA165.IG101.SP101.SubP101.N101.R101]

- 15933 2. Identify the quality and process performance needs and priorities of
15934 the customer, end users, and other relevant stakeholders.
15935 [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]

8. Define and negotiate quality and process performance objectives for suppliers. [PA165.IG101.SP101.SubP108]

Refer to the Supplier Agreement Management process area for more information about establishing and maintaining agreements with suppliers. [PA165.IG101.SP101.SubP108.R101]

9. Revise the project's quality and process performance objectives as necessary. [PA165.IG101.SP101.SubP109]

SP 1.2 Compose the Defined Process

Select the processes and process elements that comprise the project's defined process based on historical stability and capability data. [PA165.IG101.SP102]

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]

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]

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]

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]

Typical Work Products

1. Criteria used in identifying which subprocesses are valid candidates for inclusion in the project's defined process
[PA165.IG101.SP102.W101]
2. Candidate subprocesses for inclusion in the project's defined process
[PA165.IG101.SP102.W102]
3. Subprocesses to be included in the project's defined process
[PA165.IG101.SP102.W103]
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]
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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]

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SP 1.3

Select the Subprocesses to be Managed

Select the subprocesses of the project's defined process that will be statistically managed [PA165.IG101.SP103]

Typical Work Products

1. Quality and process performance objectives that will be addressed by statistical management [PA165.IG101.SP103.W101]
2. Criteria used in selecting which subprocesses will be statistically managed [PA165.IG101.SP103.W102]
3. Subprocesses that will be statistically managed [PA165.IG101.SP103.W103]
4. Identified process and product attributes of the selected subprocesses that should be measured and controlled [PA165.IG101.SP103.W104]

Subpractices

1. Identify which of the quality and process performance objectives of the project will be statistically managed. [PA165.IG101.SP103.SubP101]
2. Select the subprocesses that are the main contributors to achieving the identified quality and process performance objectives and for which predictable performance is important. [PA165.IG101.SP103.SubP102]

It may not be possible to statistically manage some subprocesses (e.g., where new subprocesses and technologies are being pilot tested). In other cases it may not be economically justifiable to apply statistical techniques to certain subprocesses. [PA165.IG101.SP103.SubP102.N101]

Examples of criteria used in selecting subprocesses include the following:

[PA165.IG101.SP103.SubP102.N102]

- Customer requirements related to quality and process performance
- Quality and process performance objectives established by the customer
- Quality and process performance objectives established by the organization
- Stable performance of the subprocess on other projects
- Laws and regulations

3. Identify the product and process attributes of the selected subprocesses that will be measured and controlled.

[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 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

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

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]

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4. Use process performance models calibrated with obtained measures of critical attributes to estimate progress towards achieving the project's quality and process performance objectives. Process performance models are used to estimate progress toward achieving objectives that cannot be measured until a future phase in the life cycle. An example is the use of process performance models to predict the latent defects in the delivered product using interim measures of defects identified during peer reviews.

[PA165.IG101.SP104.SubP104]

Refer to the Organizational Process Performance process area for more information about process performance models.

[PA165.IG101.SP104.SubP104.R101]

The calibration is based on the results obtained from performing the previous subpractices. [PA165.IG101.SP104.SubP104.N101]

5. Identify and manage the risks associated with achieving the project's quality and process performance objectives.

[PA165.IG101.SP104.SubP105]

Refer to the Risk Management process area for more information about identifying and managing risks. [PA165.IG101.SP104.SubP105.R101]

Example sources for the risks include the following: [PA165.IG101.SP104.SubP105.N101]

- Inadequate stability and capability data in the organization's measurement repository
- Subprocesses having inadequate performance or capability
- Suppliers not achieving their quality and process performance objectives
- Lack of visibility into supplier capability
- Accuracy of the organization's process performance models for predicting future performance
- Predicted process performance (estimated progress) are deficient
- Other identified risks associated with identified deficiencies

6. Determine and document actions needed to address the deficiencies in achieving the project's quality and process performance objectives. [PA165.IG101.SP104.SubP106]

The intent of these actions are to plan and deploy the right set of activities, resources, and schedule to place the project back on track as much as possible to 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]

16202 **SG 2 Statistically Manage Subprocess Performance** [PA165.IG102]

16203 ***The performance of selected subprocesses within the project's defined***
16204 ***process is statistically managed.***

16205 This goal summarizes a means for achieving the goal of "Able
16206 processes," by selecting and statistically managing those subprocesses
16207 of the project's defined process that are important to achieving the
16208 project's objectives. When the selected subprocesses are brought
16209 under statistical control, their capability to achieve their objectives can
16210 be determined, and by this means, it will be possible to predict whether
16211 the project will be able to achieve its objectives, and if not, take
16212 appropriate corrective action. [PA165.IG102.N101]

16213 **SP 2.1 Select Measures and Analytic Techniques**

16214 ***Select the measures and analytic techniques to be used in***
16215 ***statistically managing the selected subprocesses.*** [PA165.IG102.SP101]

16216 *Refer to the Measurement and Analysis process area for more*
16217 *information about establishing measurable objectives; on defining,*
16218 *collecting, and analyzing measures; and on revising measures and*
16219 *statistical analysis techniques.* [PA165.IG102.SP101.R101]

16220 **Typical Work Products**

- 16221 1. Definitions of the measures and analytic techniques to be used in
16222 (or proposed for) statistically managing the subprocesses
16223 [PA165.IG102.SP101.W101]
- 16224 2. Operational definitions of the measures, their collection points in
16225 the subprocesses, and how the measures will be validated
16226 [PA165.IG102.SP101.W102]

16227 3. Traceability of measures back to the project's quality and process
16228 performance objectives [PA165.IG102.SP101.W103]

16229 4. Instrumented organizational support environment to support
16230 automatic data collection [PA165.IG102.SP101.W104]

16231 **Subpractices**

16232 1. Identify common measures from the organization's process assets
16233 that support the objectives of statistical management.

16234 [PA165.IG102.SP101.SubP101]

16235 *Refer to the Organization Process Definition process area for more*
16236 *information about common measures.* [PA165.IG102.SP101.SubP101.R101]

16237 Product lines or other stratification criteria may categorize common measures.

16238 [PA165.IG102.SP101.SubP101.N101]

16239 2. Identify additional measures that may be needed for this instance
16240 to cover critical product and process attributes of the selected
16241 subprocesses. [PA165.IG102.SP101.SubP102]

16242 Examples of additional measures include the following: [PA165.IG102.SP101.SubP102.N101]

- 16243 • A certain work product and task attribute required by the customer (e.g.,
16244 complexity) when the organization's standard work product and task attribute
16245 measure is size
- 16246 • Defect categories specified by a regulatory agency
- 16247 • Measures to address unique issues and concerns of the project

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16249 In some cases, measures may be research-oriented. Such measures should be
16250 explicitly identified. [PA165.IG102.SP101.SubP102.N102]

16251 3. Identify the measures that are appropriate for statistical
16252 management. [PA165.IG102.SP101.SubP103]

16253 Critical criteria for selecting statistical management measures include the
16254 following: [PA165.IG102.SP101.SubP103.N101]

- 16255 • Controllable (e.g., can a measure's values be changed by changing how the
16256 subprocess is implemented?)
- 16257 • Performance indicator (e.g., is the measure a good indicator of how well the
16258 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]

Refer to the Organizational Process Definition process area for more information about establishing and maintaining the organizational support environment. [PA165.IG102.SP101.SubP106.R101]

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.

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]

16297 Examples of statistical analysis techniques are given in the next specific practice.
16298 [PA165.IG102.SP101.SubP107.N102]

16299 8. Revise the measures and statistical analysis techniques as
16300 necessary. [PA165.IG102.SP101.SubP108]

16301 **SP 2.2 Apply Statistical Methods to Understand Variation**

16302 ***Establish and maintain an understanding of the variance of the***
16303 ***selected subprocesses using the selected measures and analytic***
16304 ***techniques.*** [PA165.IG102.SP102]

16305 *Refer to the Measurement and Analysis process area for more*
16306 *information about collecting, analyzing, and using measure results; and*
16307 *on verifying that collected measures are valid.* [PA165.IG102.SP102.R101]

16308 Understanding variation is achieved by collecting and analyzing process
16309 and product measures so that special causes of variation can be
16310 identified and addressed to achieve predictable performance.
16311 [PA165.IG102.SP102.N101]

16312 A special cause of variation is an unusual circumstance that causes an
16313 unexpected change in process performance. A transient circumstance
16314 can be a specific local condition, a single individual, or a small group of
16315 people performing in an unexpected way. Special causes are also
16316 known as "assignable causes" because they can be identified,
16317 analyzed, and addressed to prevent future problems. [PA165.IG102.SP102.N102]

16318 **Typical Work Products**

- 16319 1. Collected and verified measures including special causes of
16320 variation [PA165.IG102.SP102.W101]
- 16321 2. Natural bounds of process performance for each measured
16322 attribute of each selected subprocess [PA165.IG102.SP102.W102]
- 16323 3. Process performance compared to the natural bounds of process
16324 performance for each measured attribute of each selected
16325 subprocess [PA165.IG102.SP102.W103]

16326 **Subpractices**

- 16327 1. Establish trial natural bounds for subprocesses having suitable
16328 historical performance data. [PA165.IG102.SP102.SubP101]

16329 *Refer to the Organizational Process Performance process area for*
16330 *more information about organizational process performance baselines.*
16331 [PA165.IG102.SP102.SubP101.R101]

16332 Natural bounds of an attribute are the range within which variation normally
 16333 occurs. All processes will show some variation in process and product measures
 16334 each time they are executed. The issue is whether this variation is due to common
 16335 causes of variation in the normal performance of the process or to some special
 16336 cause that can and should be identified and removed. [PA165.IG102.SP102.SubP101.N101]

16337 When a subprocess is initially executed, suitable data for establishing trial natural
 16338 bounds are sometimes available from prior instances of the subprocess or
 16339 comparable subprocesses. These data are typically contained in the
 16340 organization's measurement repository. As the subprocess is executed, data
 16341 specific to that instance are collected and used to update and replace the trial
 16342 natural bounds. However, if the subprocess in question has been materially
 16343 tailored, or if the conditions are materially different than in previous instantiations,
 16344 the data in the repository may not be relevant and should not be used.
 16345 [PA165.IG102.SP102.SubP101.N102]

16346 In some cases there may be no historical comparable data (for example, when
 16347 introducing a new subprocess, when entering a new application domain, or when
 16348 significant changes have been made to the subprocess). In such cases, trial
 16349 natural bounds will have to be made from early process data of this subprocess.
 16350 These trial natural bounds must then be refined and updated as subprocess
 16351 execution continues. [PA165.IG102.SP102.SubP101.N103]

16352 Examples of criteria for determining whether data are comparable include the
 16353 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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 16359 2. Collect data on the selected measures as the subprocesses
 16360 execute. [PA165.IG102.SP102.SubP102]

16361 3. Calculate the natural bounds of process performance for each
 16362 measured attribute. [PA165.IG102.SP102.SubP103]

16363 Examples where the natural bounds are calculated include the following:
 16364 [PA165.IG102.SP102.SubP103.N101]

- Control charts
- Confidence intervals (for parameters of distributions)
- Prediction intervals (for future outcomes)

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 16369 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 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

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]

16438 Process capability is analyzed for those subprocesses and those
16439 measured attributes for which (derived) objectives have been
16440 established. Not all subprocesses or measured attributes that are
16441 statistically managed are analyzed regarding process capability.

16442 [PA165.IG102.SP103.N105]

16443 The historical data may be inadequate for initially determining whether
16444 the subprocess is capable. It also is possible that the estimated natural
16445 bounds for subprocess performance may shift away from the quality
16446 and process performance objectives. In either case, statistical control
16447 implies monitoring capability as well as stability. [PA165.IG102.SP103.N106]

16448 **Typical Work Products**

16449 1. Natural bounds of process performance for each selected
16450 subprocess compared to its established (derived) objectives

16451 [PA165.IG102.SP103.W101]

16452 2. For each subprocess, its process capability [PA165.IG102.SP103.W102]

16453 3. For each subprocess, the actions needed to address deficiencies
16454 in its process capability [PA165.IG102.SP103.W103]

16455 **Subpractices**

16456 1. Compare the quality and process performance objectives to the
16457 natural bounds of that measured attribute. [PA165.IG102.SP103.SubP101]

16458 This comparison provides an assessment of the process capability for each
16459 measured attribute of a subprocess. These comparisons can be displayed
16460 graphically, in ways that relate the estimated natural bounds to the objectives or
16461 as process capability indices, which summarize the relationship of the objectives
16462 to the natural bounds. [PA165.IG102.SP103.SubP101.N101]

16463 2. Monitor changes in quality and process performance objectives
16464 and a subprocess' process capability over time.

16465 [PA165.IG102.SP103.SubP102]

16466 3. Identify and document subprocess capability deficiencies.

16467 [PA165.IG102.SP103.SubP103]

16468 4. Determine and document actions needed to address subprocess
16469 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 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]

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GG 3 Institutionalize a Defined Process [CL104.GL101]

The process is institutionalized as a defined process.

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Commitment to Perform

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GP 2.1 (CO 1) Establish an Organizational Policy

Establish and maintain an organizational policy for planning and performing the quantitative project management process. [GP103]

16501 Elaboration:

16502 This policy establishes organizational expectations for quantitatively
16503 managing the project using quality and process performance objectives,
16504 and statistically managing selected subprocesses within the project's
16505 defined process [PA165.EL101]

16506 Ability to Perform

16507 **GP 3.1 (AB 1) Establish a Defined Process**

16508 *Establish and maintain the description of a defined quantitative*
16509 *project management process.* [GP114]

16510 **GP 2.2 (AB 2) Plan the Process**

16511 *Establish and maintain the requirements and objectives, and plans*
16512 *for performing the quantitative project management process.* [GP104]

16513 **GP 2.3 (AB 3) Provide Resources**

16514 *Provide adequate resources for performing the quantitative project*
16515 *management process, developing the work products and*
16516 *providing the services of the process.* [GP105]

16517 Elaboration:

16518 Special expertise in statistics and statistical process control may be
16519 needed to define the techniques for statistical management of selected
16520 subprocesses, but staff will use the tools and techniques to perform the
16521 statistical management. Special expertise in statistics may also be
16522 needed for analyzing and interpreting the measures resulting from
16523 statistical management. [PA165.EL102]

16524 Examples of tools used in performing the activities of the quantitative
16525 project management process include the following: [PA165.EL103]

- 16526 • System dynamics models
- 16527 • Automated test coverage analyzers
- 16528 • Statistical process and quality control packages
- 16529 • Statistical analysis packages

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16531 **GP 2.4 (AB 4) Assign Responsibility**

16532 *Assign responsibility and authority for performing the process,*
16533 *developing the work products, and providing the services of the*
16534 *quantitative project management process. [GP106]*

16535 **GP 2.5 (AB 5) Train People**

16536 *Train the people performing or supporting the quantitative project*
16537 *management process as needed. [GP107]*

16538 Elaboration:

16539 Examples of training topics include the following: [PA165.EL104]

- 16540
- Process modeling and analysis
 - Process measurement data selection, definition, collection, and validation
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16544 **Directing Implementation**

16545 **GP 2.6 (DI 1) Manage Configurations**

16546 *Place designated work products of the quantitative project*
16547 *management process under appropriate levels of configuration*
16548 *management. [GP109]*

16549 Elaboration:

16550 Examples of work products placed under configuration management
16551 include the following: [PA165.EL110]

- 16552
- Subprocesses to be included in the project's defined process
 - Operational definitions of the measures, their collection points in the subprocesses, and how the measures will be validated
 - Collected and verified measures, including special causes of variation
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16558 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

16559 *Identify and involve the relevant stakeholders of the quantitative*
16560 *project management process as planned. [GP124]*

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Elaboration:

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Examples of activities for stakeholder involvement include: [PA165.EL109]

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- Establishing project objectives

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- Resolving issues among the project's quality and process performance objectives

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- Assessing performance of the selected subprocesses

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- Identifying and managing the risks in achieving the project's quality and process performance objectives

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- Taking corrective action

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GP 2.8 (DI 3) Monitor and Control the Process

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Monitor and control the quantitative project 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 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)

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- Number of special causes of variation identified

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GP 3.2 (DI 4) Collect Improvement Information

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Collect work products, measures, measurement results, and improvement information derived from planning and performing the quantitative project management process to support the future use and improvement of the organization's processes and process assets. [GP117]

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16590 Verifying Implementation

16591 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

16592 ***Objectively evaluate adherence of the quantitative project***
16593 ***management process and the work products and services of the***
16594 ***process to the applicable requirements, objectives, and standards,***
16595 ***and address noncompliance.*** [GP113]

16596 Elaboration:

16597 Examples of activities reviewed include the following: [PA165.EL106]

- 16598 • Quantitatively managing the project using quality and process
- 16599 performance objectives
- 16600 • Statistically managing selected subprocesses within the project's
- 16601 defined process

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16603 Examples of work products reviewed include the following: [PA165.EL108]

- 16604 • Subprocesses to be included in the project's defined process
- 16605 • Operational definitions of the measures
- 16606 • Collected and verified measures including special causes of
- 16607 variation

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16609 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

16610 ***Review the activities, status, and results of the quantitative project***
16611 ***management process with higher-level management and resolve***
16612 ***issues.*** [GP112]

16613 MATURITY LEVEL: 5 OPTIMIZING

16614 The following section contains all of the process areas that belong to
16615 maturity level 5. The maturity level 5 process areas of CMMI are as
16616 follows: [FM112.T101]

- 16617 • Organizational Innovation and Deployment
- 16618 • Causal Analysis and Resolution

16619 *Refer to the Model Components section of the Structure of the Model*
16620 *chapter of the Overview for more information about CMMI maturity*
16621 *levels.* [FM112.T101.R101]

16622 ORGANIZATIONAL INNOVATION AND DEPLOYMENT

16623 Maturity Level 5

16624 Purpose

16625 The purpose of Organizational Innovation and Deployment is to select
 16626 and deploy incremental and innovative improvements that measurably
 16627 improve the organization's processes and technologies. The
 16628 improvements support the organization's quality and process
 16629 performance objectives as derived from the organization's business
 16630 objectives. [PA161]

16631 Introductory Notes

16632 The Organizational Innovation and Deployment process area selects
 16633 and deploys improvements that can improve the organization's ability to
 16634 meet its quality and process performance objectives. Quality and
 16635 process performance objectives that this process area might address
 16636 include the following: [PA161.N101]

- 16637 • Improved product quality (e.g., functionality, performance)
- 16638 • Increased productivity
- 16639 • Decreased development cycle time
- 16640 • Greater customer and end-user satisfaction
- 16641 • Shorter development and production time to change functionality,
 16642 add features, or adapt to new technologies

16643 Achievement of these objectives depends on the successful
 16644 establishment of an infrastructure that enables and encourages all
 16645 people in the organization to propose potential improvements to the
 16646 organization's processes and technologies. All members of the
 16647 organization can participate in the organization's process and
 16648 technology improvement activities. Their proposals are systematically
 16649 gathered and addressed. [PA161.N102]

16650 Pilots are conducted to evaluate significant changes involving untried,
 16651 high risk, or innovative improvements before they are incorporated into
 16652 normal practice. [PA161.N103]

16653 Process and technology improvements that will be deployed across the
 16654 organization are selected from process and technology improvement
 16655 proposals based on the following criteria: [PA161.N104]

- 16656 • A quantitative understanding of the organization's current quality
- 16657 and process performance
- 16658 • The organization's quality and process performance objectives
- 16659 • Estimates of the improvement in quality and process performance
- 16660 resulting from deploying the process and technology improvements
- 16661 • Estimated costs of deploying process and technology
- 16662 improvements, and the resources and funding available for such
- 16663 deployment

16664 The expected benefits added by the process and technology
16665 improvements are weighed against the cost and impact to the
16666 organization. Change and stability must be balanced carefully. Change
16667 that is too great or too rapid can overwhelm the organization, destroying
16668 its investment in organizational learning represented by the
16669 organization's process assets. Rigid stability can result in stagnation,
16670 allowing the changing business environment to erode the organization's
16671 business position. [PA161.N105]

16672 Improvements are deployed, as appropriate, to the following: [PA161.N106]

- 16673 • New projects
- 16674 • Ongoing development projects
- 16675 • Ongoing maintenance projects

16676 In this process area, the term 'process and technology improvements'
16677 refers to incremental and innovative improvements to processes and
16678 also to process or product technologies. [PA161.N107]

16679 The practices in this process area complement and extend those found
16680 in the Organizational Process Focus process area. The focus of this
16681 process area is process improvement that is based on a quantitative
16682 knowledge of the organization's set of standard processes and
16683 technologies and their expected quality and performance in predictable
16684 situations. In the Organizational Process Focus process area, no
16685 assumptions are made about the quantitative basis of improvement.

16686 [PA161.N108]

16687 Related Process Areas

16688 *Refer to the Organizational Process Definition process area for more*
16689 *information about incorporating the measures associated with the*
16690 *quantitative process improvement objectives into the organization's*
16691 *common set of measures and incorporating the deployed process*
16692 *improvements into the organization's process assets. [PA161.R101]*

16693 *Refer to the Organizational Process Focus process area for more*
 16694 *information about soliciting, collecting, and handling of process*
 16695 *improvement proposals and coordinating the deployment of the process*
 16696 *improvement into the project's defined processes. [PA161.R102]*

16697 *Refer to the Organizational Training process area for more information*
 16698 *about providing updated training to support deployment of process and*
 16699 *technology improvements. [PA161.R103]*

16700 *Refer to the Organizational Process Performance process area for*
 16701 *more information about quality and process performance objectives and*
 16702 *process performance models. Quality and process performance*
 16703 *objectives are used to analyze and select process and technology*
 16704 *improvement proposals for deployment. Process performance models*
 16705 *are used to quantify the impact and benefits of innovations. [PA161.R104]*

16706 *Refer to the Measurement and Analysis process area for more*
 16707 *information about defining the process and technology improvement*
 16708 *measures related to the organization's business objectives, establishing*
 16709 *measures and objectives to determine the value of selected process*
 16710 *and technology improvements with respect to business objectives, and*
 16711 *revising process and technology improvement measures. [PA161.R105]*

16712 *Refer to the Integrated Project Management (IPPD) process area for*
 16713 *more information about coordinating the deployment of process and*
 16714 *technology improvements into the project's defined process. [PA161.R106]*

16715 **Specific and Generic Goals**

16716 **SG 1 Select Improvements** [PA161.IG101]

16717 ***Process and technology improvements that contribute to meeting quality and***
 16718 ***process performance objectives are selected.***

16719 **SG 2 Deploy Improvements** [PA161.IG102]

16720 ***Measurable improvements to the organization's processes and technologies***
 16721 ***are continually and systematically deployed.***

16722 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

16723 ***The process is institutionalized as a defined process.***

16724 Practice to Goal Relationship Table

16725 SG 1 Select Improvements [PA161.IG101]

- 16726 SP 1.1 Collect and Analyze Improvement Proposals
- 16727 SP 1.2 Identify Innovations
- 16728 SP 1.3 Pilot Improvements
- 16729 SP 1.4 Select Improvements for Deployment

16730 SG 2 Deploy Improvements [PA161.IG102]

- 16731 SP 2.1 Plan the Deployment
- 16732 SP 2.2 Manage the Deployment
- 16733 SP 2.3 Measure Improvement Effects

16734 GG 3 Institutionalize a Defined Process

- 16735 GP 2.1 (CO 1) Establish an Organizational Policy
- 16736 GP 3.1 (AB 1) Establish a Defined Process
- 16737 GP 2.2 (AB 2) Plan the Process
- 16738 GP 2.3 (AB 3) Provide Resources
- 16739 GP 2.4 (AB 4) Assign Responsibility
- 16740 GP 2.5 (AB 5) Train People
- 16741 GP 2.6 (DI 1) Manage Configurations
- 16742 GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders
- 16743 GP 2.8 (DI 3) Monitor and Control the Process
- 16744 GP 3.2 (DI 4) Collect Improvement Information
- 16745 GP 2.9 (VE 1) Objectively Evaluate Adherence
- 16746 GP 2.10 (VE 2) Review Status with Higher-Level Management

16747 Specific Practices by Goal

16748 SG 1 Select Improvements [PA161.IG101]

16749 ***Process and technology improvements that contribute to meeting quality and***
 16750 ***process performance objectives are selected.***

16751 SP 1.1 Collect and Analyze Improvement Proposals

16752 ***Collect and analyze process and technology improvement***
 16753 ***proposals.*** [PA161.IG101.SP101]

16754 Each process and technology improvement proposal must be analyzed.

16755 [PA161.IG101.SP101.N101]

16756 Simple process and technology improvements, with well-understood
 16757 benefits and effects, will not usually undergo detailed evaluations.

16758 [PA161.IG101.SP101.N102]

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Examples of simple process and technology improvements include the following: [PA161.IG101.SP101.N104]

- Add an item to a peer review checklist.
- Combine the technical review and management review for suppliers into a single technical/management review.

Typical Work Products

1. Analyzed process and technology improvement proposals
[PA161.IG101.SP101.W101]

Subpractices

1. Collect process and technology improvement proposals.
[PA161.IG101.SP101.SubP101]

A process and technology improvement proposal documents proposed incremental and innovative improvements to specific processes and technologies. Managers and staff in the organization, as well as customers, end users, and suppliers can submit process and technology improvement proposals. Process and technology improvements may be implemented at the local level before being proposed for the organization. [PA161.IG101.SP101.SubP101.N101]

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]

16797	2. Analyze the costs and benefits of process and technology improvement proposals as appropriate. [PA161.IG101.SP101.SubP102]
16798	
16799	Process and technology improvement proposals that have a large cost to benefit ratio are rejected. [PA161.IG101.SP101.SubP102.N101]
16800	
16801	Criteria for evaluating costs and benefits include the following: [PA161.IG101.SP101.SubP102.N102]
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16803	<ul style="list-style-type: none">• 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
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16812	Process and technology improvement proposals that would not improve the organization's processes are rejected. [PA161.IG101.SP101.SubP102.N103]
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16814	Process performance models provide insight into the effect of process changes on process capability and performance. [PA161.IG101.SP101.SubP102.N104]
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16816	<i>Refer to the Organizational Process Performance process area for practices that cover process performance models.</i> [PA161.IG101.SP101.SubP102.N104.R101]
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16819	3. Identify the process and technology improvement proposals that are innovative. [PA161.IG101.SP101.SubP103]
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16821	Innovative improvements are also identified and analyzed in the "Identify Innovations" specific practice. [PA161.IG101.SP101.SubP103.N101]
16822	
16823	Whereas this specific practice analyzes proposals that have been passively collected, the purpose of the "Identify Innovations" specific practice is to actively search for and locate innovative improvements. The search primarily involves looking outside the organization. [PA161.IG101.SP101.SubP103.N102]
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16827	Innovative improvements are typically identified from reviewing process and technology improvement proposals or by actively investigating and monitoring innovations that are in use in other organizations or documented in research literature. Innovation may be inspired by internal improvement objectives or by the external business environment. [PA161.IG101.SP101.SubP103.N103]
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Innovative improvements are typically major changes to the process that represent a break from the old way of doing things (e.g., changing the life-cycle methodology). Innovative improvements may also include changes in the products that support, enhance, or automate the process (for example, using off-the-shelf products to support the process). [PA161.IG101.SP101.SubP103.N104]

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Examples of innovative improvements include the following:

[PA161.IG101.SP101.SubP103.N105]

- Advances in computer and related hardware products
- New support tools
- New techniques, methodologies, processes, or life cycles
- New interface standards
- New reusable components
- New management techniques
- New quality improvement techniques
- New process development and deployment support tools

4. Identify potential barriers and risks to deploying each process and 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

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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 Identify Innovations

Identify innovative improvements that would increase the organization's quality and process performance. [PA161.IG101.SP102]

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The specific practice "Collect and analyze improvement proposals" analyzed proposals that were passively collected. The purpose of this specific practice is to actively search for and locate innovative improvements. This search primarily involves looking outside the organization. [PA161.IG101.SP102.N101]

Typical Work Products

1. Candidate innovation improvements [PA161.IG101.SP102.W101]

Subpractices

1. Analyze the organization's set of standard processes to determine areas where innovative improvements would be most helpful. [PA161.IG101.SP102.SubP101]

16896 These analyses are performed to determine which subprocesses are critical to
16897 achieving the organization's quality and process performance objectives and
16898 which ones are good candidates to be improved. [PA161.IG101.SP102.SubP101.N101]

16899 2. Investigate innovative improvements that may improve the
16900 organization's set of standard processes. [PA161.IG101.SP102.SubP102]

16901 Investigating innovative improvements involves the following:

16902 [PA161.IG101.SP102.SubP102.N101]

- 16903 • Systematically maintaining awareness of leading relevant technical work and
16904 technology trends
- 16905 • Periodically searching for commercially available innovative improvements
- 16906 • Collecting proposals for innovative improvements from the projects and the
16907 organization
- 16908 • Systematically reviewing processes and technologies used externally and
16909 comparing them to those used within the organization
- 16910 • Identifying areas where innovative improvements have been used successfully,
16911 and reviewing data and documentation of experience using these improvements

16912 3. Analyze potential innovative improvements to understand their
16913 effects on process elements and predict their influence on the
16914 process. [PA161.IG101.SP102.SubP103]

16915 Process performance models can provide a basis for analyzing possible effects of
16916 changes to process elements. [PA161.IG101.SP102.SubP103.N101]

16917 *Refer to the Organizational Process Performance process area for*
16918 *more information about process performance models.*

16919 [PA161.IG101.SP102.SubP103.N101.R101]

16920 Examples of such process performance models include: [PA161.IG101.SP102.SubP103.N102]

- 16921 • System dynamics models
- 16922 • Reliability growth models
- 16923 • Complexity models

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16925 4. Analyze the costs and benefits of potential innovative
16926 improvements. [PA161.IG101.SP102.SubP104]

16927 Innovative improvements that have a very large cost to benefit ratio are rejected.

16928 [PA161.IG101.SP102.SubP104.N101]

16929 5. Create process and technology improvement proposals for those
16930 innovative improvements that would result in improving the
16931 organization's processes or technologies. [PA161.IG101.SP102.SubP105]

16932 6. Select the innovative improvements to be piloted before broad-
16933 scale deployment. [PA161.IG101.SP102.SubP106]

16934 Since innovations, by definition, usually represent a major change, most
16935 innovative improvements will be piloted. [PA161.IG101.SP102.SubP106.N101]

16936 7. Document the results of the evaluations of innovative
16937 improvements. [PA161.IG101.SP102.SubP107]

SP 1.3 Pilot Improvements

Pilot process and technology improvements to select which ones to implement. [PA161.IG101.SP103]

16941 Pilots are performed to assess new and unproven major changes
16942 before they are incorporated into normal practice, as appropriate.
16943 [PA161.IG101.SP103.N101]

Typical Work Products

- 16944 1. Pilot evaluation reports [PA161.IG101.SP103.W101]
- 16945 2. Documented lessons learned from pilots [PA161.IG101.SP103.W102]

Subpractices

- 16947 1. Plan the pilots. [PA161.IG101.SP103.SubP101]
- 16948 2. Review and get stakeholder agreement on the plans for the pilots.
16949 [PA161.IG101.SP103.SubP102]
- 16950 3. Consult with and assist the people performing the pilots.
16951 [PA161.IG101.SP103.SubP103]
- 16952 4. Perform each pilot in an environment that is characteristic of the
16953 environment present in a broad-scale deployment.
16954 [PA161.IG101.SP103.SubP104]
- 16955 5. Track the pilots against their plans. [PA161.IG101.SP103.SubP105]
- 16956 6. Review and document the results of pilots. [PA161.IG101.SP103.SubP106]

16958 Reviewing and documenting the results of pilots usually involves the following:
16959 [PA161.IG101.SP103.SubP106.N101]

- 16960 • Deciding whether to terminate the pilot, re-plan and continue the pilot, or proceed
16961 with deploying the process and technology improvement
- 16962 • Updating the disposition of process and technology improvement proposals
16963 associated with the pilot
- 16964 • Identifying and documenting new process and technology improvement proposals
16965 as appropriate
- 16966 • Identifying and documenting lessons learned and problems encountered during
16967 the pilot.

16968 **SP 1.4 Select Improvements for Deployment**

16969 **Select process and technology improvement proposals for**
16970 **deployment across the organization.** [PA161.IG101.SP104]

16971 **Typical Work Products**

- 16972 1. Process and technology improvement proposals selected for
16973 deployment [PA161.IG101.SP104.W101]

16974 **Subpractices**

- 16975 1. Prioritize the candidate process and technology improvements for
16976 deployment. [PA161.IG101.SP104.SubP101]

16977 Priority is based on an evaluation of the estimated cost-to-benefit ratio with regard
16978 to the quality and process performance objectives. [PA161.IG101.SP104.SubP101.N101]

16979 *Refer to the Organizational Process Performance process area for*
16980 *more information about quality and process performance objectives.*

16981 [PA161.IG101.SP104.SubP101.N101.R101]

- 16982 2. Select the process and technology improvements to be deployed.

16983 [PA161.IG101.SP104.SubP102]

16984 The selection of the process improvements is based on their priorities and the
16985 available resources. [PA161.IG101.SP104.SubP102.N101]

- 16986 3. Determine how each process and technology improvement will be
16987 deployed. [PA161.IG101.SP104.SubP103]

16988 Examples of how the process and technology improvements may be deployed
16989 include the following: [PA161.IG101.SP104.SubP103.N101]

- 16990 • Organization's process assets
- 16991 • All or a subset of the organization's product families
- 16992 • All or a subset of the organization's projects
- 16993 • All or a subset of the organizational groups

- 16994
16995 4. Document the results of the selection process. [PA161.IG101.SP104.SubP104]

16996 The results of the selection process usually include the following:

16997 [PA161.IG101.SP104.SubP104.N101]

- 16998 • The selection criteria
- 16999 • The disposition of each proposal
- 17000 • The rationale for the disposition of each proposal
- 17001 • The assets to be changed for each selected proposal

17002 **SG 2 Deploy Improvements** [PA161.IG102]

17003 ***Measurable improvements to the organization's processes and technologies***
17004 ***are continually and systematically deployed.***

17005 **SP 2.1 Plan the Deployment**

17006 ***Establish and maintain the plans for deploying the selected***
17007 ***process and technology improvements.*** [PA161.IG102.SP101]

17008 The plans for deploying each process and technology improvement
17009 may be included in the organization's process improvement deployment
17010 plan or they may be documented separately. [PA161.IG102.SP101.N101]

17011 This specific practice plans the deployment of individual process and
17012 technology improvements. The "Plan the Process" generic practice
17013 plans the deployment of the Organizational Innovation and Deployment
17014 process itself. [PA161.IG102.SP101.N102]

17015 **Typical Work Products**

- 17016 1. Deployment plan for selected process and technology
17017 improvements [PA161.IG102.SP101.W101]

17018 **Subpractices**

- 17019 1. Determine how each process and technology improvement must
17020 be adjusted for organization-wide deployment. [PA161.IG102.SP101.SubP101]

17021 Process and technology improvements proposed within a limited context (e.g., for
17022 a single project) might have to be modified to work across the organization.

17023 [PA161.IG102.SP101.SubP101.N101]

- 17024 2. Determine the changes necessary to deploy each process and
17025 technology improvement. [PA161.IG102.SP101.SubP102]

17026 Examples of changes needed to deploy a process and technology improvement
17027 includes the following: [PA161.IG102.SP101.SubP102.N101]

- 17028 • Process descriptions, standards, and procedures
- 17029 • Development environments
- 17030 • Education and training
- 17031 • Skills
- 17032 • Existing commitments
- 17033 • Existing activities
- 17034 • Continuing support to end users
- 17035 • Organizational culture and characteristics

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- 17037 3. Identify strategies to address potential barriers to deploying each
17038 process and technology improvement. [PA161.IG102.SP101.SubP103]
- 17039 4. Establish measures and objectives for determining the value of
17040 each process and technology improvement with respect to the
17041 organization's business objectives. [PA161.IG102.SP101.SubP104]

17042 Examples of measures for determining the value of a process and technology
17043 improvement include the following: [PA161.IG102.SP101.SubP104.N101]

- Return on investment
- Time to recover the cost of the process or technology improvement
- Measured improvement in the projects' or organization's process performance
- Number and type of project and organizational risks mitigated by the process or technology improvement
- Ability to respond quickly to changes in project requirements, market situations, and the business environment

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17052 *Refer to the Measurement and Analysis process area for more*
17053 *information about measurement selection.* [PA161.IG102.SP101.SubP104.N101.R101]

- 17054 5. Document the plan for deploying each process and technology
17055 improvement. [PA161.IG102.SP101.SubP105]
- 17056 6. Review and get agreement with stakeholders on the plan for
17057 deploying each process and technology improvement.
17058 [PA161.IG102.SP101.SubP106]
- 17059 7. Revise the plan for deploying each process and technology
17060 improvement as necessary. [PA161.IG102.SP101.SubP107]

17061 SP 2.2 Manage the Deployment

17062 ***Manage the deployment of the selected process and technology***
17063 ***improvements.*** [PA161.IG102.SP102]

17064 Typical Work Products

- 17065 1. Updated training materials (to reflect deployed process and
17066 technology improvements) [PA161.IG102.SP102.W101]
- 17067 2. Documented results of process and technology improvement
17068 deployment activities [PA161.IG102.SP102.W102]
- 17069 3. Revised process and technology improvement measures,
17070 objectives, priorities, and deployment plans [PA161.IG102.SP102.W103]

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Subpractices

1. Monitor the deployment of the process and technology improvements using the deployment plan. [PA161.IG102.SP102.SubP101]

2. Coordinate the deployment of process and technology improvements across the organization. [PA161.IG102.SP102.SubP102]

Coordinating deployment includes the following activities: [PA161.IG102.SP102.SubP102.N101]

- Coordinating the activities of projects, support groups, and organizational groups for each process and technology improvement.
- Coordinating the activities for deploying related process and technology improvements.

3. Quickly deploy process and technology improvements in a controlled and disciplined manner, as appropriate.

[PA161.IG102.SP102.SubP103]

Examples of methods for deploying process and technology improvements quickly include the following: [PA161.IG102.SP102.SubP103.N101]

- Using red-lines, process change notices, or other controlled process documentation as interim process descriptions
- Deploying process and technology improvements incrementally, rather than as a single deployment
- Providing comprehensive consulting to early adopters of the process and technology improvement in lieu of revised formal training

4. Incorporate the process and technology improvements into the organization's process assets, as appropriate. [PA161.IG102.SP102.SubP104]

Refer to the Organizational Process Definition process area for more information about the organization's process assets.

[PA161.IG102.SP102.SubP104.R101]

5. Coordinate the deployment of the process and technology improvements into the projects' defined processes as appropriate.

[PA161.IG102.SP102.SubP105]

Refer to the Organizational Process Focus process area for more information about deploying the organization's process assets.

[PA161.IG102.SP102.SubP105.R101]

6. Provide consulting, as appropriate, to support deployment of the process and technology improvements. [PA161.IG102.SP102.SubP106]

7. Provide updated training materials to reflect the improvements to the organization's process and technology assets.

[PA161.IG102.SP102.SubP107]

17109 *Refer to the Organizational Training process area for more information*
17110 *about training materials.* [PA161.IG102.SP102.SubP107.R101]

17111 8. Verify that the deployment of all process and technology
17112 improvements is completed. [PA161.IG102.SP102.SubP108]

17113 9. Determine whether the ability of the defined process to meet
17114 quality and process performance objectives is adversely affected
17115 by the process and technology improvement and take corrective
17116 action as necessary. [PA161.IG102.SP102.SubP109]

17117 *Refer to the Quantitative Project Management process area for more*
17118 *information about quantitatively managing the project's defined process*
17119 *to achieve the project's established quality and process performance*
17120 *objectives* [PA161.IG102.SP102.SubP109.R101]

17121 10. Document and review the results of process and technology
17122 improvement deployment. [PA161.IG102.SP102.SubP110]

17123 Documenting and reviewing the results includes the following:

17124 [PA161.IG102.SP102.SubP110.N101]

- 17125
- Identifying and documenting lessons learned
 - Identifying and documenting new process and technology improvement proposals
 - Revising process and technology improvement measures, objectives, priorities,
17127 and deployment plans
- 17128

17129 *Refer to the Measurement and Analysis process area for more*
17130 *information about measurement selection.* [PA161.IG102.SP102.SubP110.N101.R101]

17131 **SP 2.3 Measure Improvement Effects**

17132 ***Measure the effects of the deployed process and technology***
17133 ***improvements.*** [PA161.IG102.SP103]

17134 *Refer to the Measurement and Analysis process area for more*
17135 *information about measurement collection and analysis.*

17136 [PA161.IG102.SP103.R101]

17137 **Typical Work Products**

- 17138 1. Documented measures of the effects resulting from the deployed
17139 process and technology improvements [PA161.IG102.SP103.W101]

17140 **Subpractices**

- 17141 1. Measure the actual cost, effort, and schedule for deploying each
17142 process and technology improvement. [PA161.IG102.SP103.SubP101]

- 17143 2. Measure the value of each process and technology improvement.

17144 [PA161.IG102.SP103.SubP102]

17145 3. Measure the progress toward achieving the organization's
17146 quantitative objectives for process and technology improvement.
17147 [PA161.IG102.SP103.SubP103]

17148 4. Analyze the progress toward achieving the organization's
17149 quantitative objectives for process and technology improvement
17150 and take corrective action as needed. [PA161.IG102.SP103.SubP104]

17151 *Refer to the Organizational Process Performance process area for*
17152 *more information about process performance analyses.*

17153 [PA161.IG102.SP103.SubP104.R101]

17154 5. Store the measures in the organizational measurement repository.
17155 [PA161.IG102.SP103.SubP105]

17156 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

17157 ***The process is institutionalized as a defined process.***

17158 **Commitment to Perform**

17159 **GP 2.1 (CO 1) Establish an Organizational Policy**

17160 ***Establish and maintain an organizational policy for planning and***
17161 ***performing the organizational innovation and deployment***
17162 ***process.*** [GP103]

17163 Elaboration:

17164 This policy establishes organizational expectations for identifying and
17165 deploying process and technology improvements that contribute to
17166 meeting quality and process performance objectives. [PA161.EL101]

17167 **Ability to Perform**

17168 **GP 3.1 (AB 1) Establish a Defined Process**

17169 ***Establish and maintain the description of a defined organizational***
17170 ***innovation and deployment process.*** [GP114]

17171 **GP 2.2 (AB 2) Plan the Process**

17172 ***Establish and maintain the requirements and objectives, and plans***
17173 ***for performing the organizational innovation and deployment***
17174 ***process.*** [GP104]

17175 Elaboration:

17176 These requirements, objectives, and plans are described in the
17177 organization's plan for organizational innovation deployment. This plan
17178 differs from the deployment plan for selected process and technology
17179 improvements described in the specific practice in this process area.
17180 The plan for organizational innovation deployment addresses strategic,
17181 high-level planning for all the organizational innovation deployment
17182 activities. The deployment plan addresses the implementation of
17183 selected process and technology improvement proposals. [PA161.EL110]

17184 **GP 2.3 (AB 3) Provide Resources**

17185 ***Provide adequate resources for performing the organizational***
17186 ***innovation and deployment process, developing the work***
17187 ***products and providing the services of the process.*** [GP105]

17188 Elaboration:

17189 Examples of tools used in performing the activities of the Organizational
17190 Innovation and Deployment process area include the following:
17191 [PA161.EL102]

- 17192 • Simulation packages
- 17193 • Prototyping tools
- 17194 • Statistical packages
- 17195 • Dynamic systems modeling
- 17196 • Subscriptions to online technology databases
- 17197 • Process modeling tools

17198

17199 **GP 2.4 (AB 4) Assign Responsibility**

17200 ***Assign responsibility and authority for performing the process,***
17201 ***developing the work products, and providing the services of the***
17202 ***organizational innovation and deployment process.*** [GP106]

17203 **GP 2.5 (AB 5) Train People**

17204 ***Train the people performing or supporting the organizational***
17205 ***innovation and deployment process as needed.*** [GP107]

17206 Elaboration:

17207 Examples of training topics include the following: [PA161.EL103]

- 17208 • Planning, designing, and conducting pilots
- 17209 • Cost/benefit analysis
- 17210 • Technology transition
- 17211 • Change management

17212

17213 **Directing Implementation**

17214 **GP 2.6 (DI 1) Manage Configurations**

17215 ***Place designated work products of the organizational innovation***
17216 ***and deployment process under appropriate levels of configuration***
17217 ***management.*** [GP109]

17218 Elaboration:

17219 Examples of work products placed under configuration management
17220 include the following: [PA161.EL111]

- 17221 • Documented lessons learned from pilots
- 17222 • Revised process and technology improvement measures,
17223 objectives, priorities, and deployment plans
- 17224 • Updated training material

17225

17226 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

17227 ***Identify and involve the relevant stakeholders of the organizational***
17228 ***innovation and deployment process as planned.*** [GP124]

17229 Elaboration:

17230 Examples of activities for stakeholder involvement include: [PA161.EL114]

- 17231 • Reviewing process and technology improvement proposals that
17232 may have major impacts on process performance or on customer
17233 and end-user satisfaction
- 17234 • Providing feedback to the organization on the status and results of
17235 the process and technology improvement deployment activities

17236
17237 The feedback typically involves: [PA161.EL115]

- 17238 • Informing the people who submit process and technology
17239 improvement proposals about the disposition of their proposals.
- 17240 • Regularly informing stakeholders about the plans and status for
17241 selecting and deploying process and technology improvements.
- 17242 • Preparing and distributing a summary of process and technology
17243 improvement selection and deployment activities.

17244 **GP 2.8 (DI 3) Monitor and Control the Process**

17245 ***Monitor and control the organizational innovation and deployment***
17246 ***process against the plan and take appropriate corrective action.***

17247 [GP110]

17248 Elaboration:

17249 Examples of measures used in monitoring and controlling the activities
17250 of the Organizational Innovation Deployment process area include the
17251 following: [PA161.EL106]

- 17252 • Change in quality or process performance

17253

17254 **GP 3.2 (DI 4) Collect Improvement Information**

17255 ***Collect work products, measures, measurement results, and***
17256 ***improvement information derived from planning and performing***
17257 ***the organizational innovation and deployment process to support***
17258 ***the future use and improvement of the organization's processes***
17259 ***and process assets.*** [GP117]

17260 Verifying Implementation

17261 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

17262 *Objectively evaluate adherence of the organizational innovation*
17263 *and deployment process and the work products and services of*
17264 *the process to the applicable requirements, objectives, and*
17265 *standards, and address noncompliance.* [GP113]

17266 Elaboration:

17267 Examples of activities reviewed include the following: [PA161.EL109]

- 17268 • Selecting improvements
- 17269 • Deploying improvements

17270

17271 Examples of work products reviewed include the following: [PA161.EL113]

- 17272 • Deployment plans
- 17273 • Revised process and technology improvement measures,
17274 objectives, priorities, and deployment plans
- 17275 • Updated training material

17276

17277 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

17278 *Review the activities, status, and results of the organizational*
17279 *innovation and deployment process with higher-level*
17280 *management and resolve issues.* [GP112]

17281 CAUSAL ANALYSIS AND RESOLUTION

17282 Maturity Level 5

17283 Purpose

17284 The purpose of Causal Analysis and Resolution is to identify causes of
17285 defects and other problems and take action to prevent them from
17286 occurring in the future. [PA155]

17287 Introductory Notes

17288 Causal Analysis and Resolution involves the following: [PA155.N101]

- 17289 • Identifying and analyzing causes of defects and other problems
- 17290 • Taking specific actions to remove the causes and prevent the
- 17291 occurrence of those types of defects and problems in the future

17292 Causal analysis and resolution is the process of improving quality and
17293 productivity by preventing the introduction of defects into a product.
17294 Many development processes rely on defect detection and correction.
17295 However, reliance on detecting defects after they have been introduced
17296 is not cost effective. A more effective approach involves preventing
17297 defects from being introduced during development by integrating defect
17298 prevention activities into the development process. Causal analysis is
17299 applied during each stage of the development cycle. [PA155.N102]

17300 Since defects and problems may have been previously encountered on
17301 other projects or in earlier stages or tasks of the current project, causal
17302 analysis and resolution activities are a mechanism for communicating
17303 lessons learned among projects. [PA155.N103]

17304 The types of defects and other problems are analyzed to identify any
17305 trends. Based on an understanding of the defined process and how it is
17306 implemented, the root causes of the defects and the future implications
17307 of the defects are determined. [PA155.N104]

17308 Causal analysis may also be performed on problems unrelated to
17309 defects. For example, causal analysis may be used to improve quality
17310 attributes such as cycle time. Such analysis may be initiated by
17311 improvement proposals, simulations, dynamic systems models,
17312 engineering analyses, new business directives, or other means.

17313 [PA155.N105]

- 17314 Sometimes it may be impractical to perform causal analysis on all
17315 defects. In these cases, tradeoffs are made between estimated
17316 investments and estimated returns in quality, productivity, and cycle
17317 time are performed, and defect targets are selected for causal analysis.
17318 [PA155.N106]
- 17319 A measurement process should already be in place. The defined
17320 measures can be used or in some instances new measures may be
17321 needed to analyze the effects of the process change. [PA155.N107]
- 17322 *Refer to the Measurement and Analysis process area for more*
17323 *information about establishing a measurement process.* [PA155.N107.R101]
- 17324 Causal Analysis and Resolution activities provide a mechanism for
17325 projects to evaluate their processes at the local level and look for
17326 improvements that can be implemented. [PA155.N108]
- 17327 When improvements are judged to be effective, the information is
17328 extended to the organizational level. [PA155.N109]
- 17329 *Refer to the Organizational Innovation and Deployment process area*
17330 *for more information about improving organizational level processes*
17331 *through proposed improvements and action proposals.* [PA155.N109.R101]
- 17332 The informative material in this process area is written with the
17333 assumption that maturity level 4 process areas have been implemented,
17334 using terms like 'common cause' and 'stable process.' However,
17335 activities may be applicable with reduced value if this assumption is not
17336 met. [PA155.N110]

17337 Related Process Areas

- 17338 *Refer to the Quantitative Project Management process area for more*
17339 *information about practices regarding the analysis of process*
17340 *performance and the creation of process capability measures for*
17341 *selected project processes.* [PA155.R101]
- 17342 *Refer to the Organizational Innovation and Deployment process area*
17343 *for more information about practices regarding the selection and*
17344 *deployment of improvements to organizational processes and*
17345 *technologies.* [PA155.R102]
- 17346 *Refer to the Measurement and Analysis process area for more*
17347 *information about practices regarding the measurement of performance*
17348 *and performance change as a result of causal analysis and resolution*
17349 *actions.* [PA155.R103]

17350 Specific and Generic Goals

17351 **SG 1 Determine Causes of Defects** [PA155.IG101]

17352 ***Root causes of defects and other problems are systematically determined.***

17353 **SG 2 Address Causes of Defects** [PA155.IG102]

17354 ***Root causes of defects and other problems are systematically addressed to prevent their future occurrence.***
17355

17356 **GG 3 Institutionalize a Defined Process** [CL104.GL101]

17357 ***The process is institutionalized as a defined process.***

17358 Practice to Goal Relationship Table

17359 SG 1 Determine Causes of Defects [PA155.IG101]

17360 SP 1.1 Select Defect Data for Analysis

17361 SP 1.2 Analyze Causes

17362 SG 2 Address Causes of Defects [PA155.IG102]

17363 SP 2.1 Implement the Action Proposals

17364 SP 2.2 Evaluate the Effect of Changes

17365 SP 2.3 Record Data

17366 GG 3 Institutionalize a Defined Process

17367 GP 2.1 (CO 1) Establish an Organizational Policy

17368 GP 3.1 (AB 1) Establish a Defined Process

17369 GP 2.2 (AB 2) Plan the Process

17370 GP 2.3 (AB 3) Provide Resources

17371 GP 2.4 (AB 4) Assign Responsibility

17372 GP 2.5 (AB 5) Train People

17373 GP 2.6 (DI 1) Manage Configurations

17374 GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders

17375 GP 2.8 (DI 3) Monitor and Control the Process

17376 GP 3.2 (DI 4) Collect Improvement Information

17377 GP 2.9 (VE 1) Objectively Evaluate Adherence

17378 GP 2.10 (VE 2) Review Status with Higher-Level Management

17379 Specific Practices by Goal

17380 **SG 1 Determine Causes of Defects** [PA155.IG101]

17381 ***Root causes of defects and other problems are systematically determined.***

17382 A root cause is an antecedent source of a defect such that if it is

17383 removed, the defect is decreased or removed itself. [PA155.IG101.N101]

17384

SP 1.1 Select Defect Data for Analysis

17385

Select the defects and other problems for analysis. [PA155.IG101.SP101]

17386

Typical Work Products

17387

1. Defect and problem data selected for further analysis

17388

[PA155.IG101.SP101.W101]

17389

Subpractices

17390

1. Gather relevant defect data. [PA155.IG101.SP101.SubP101]

17391

Examples of relevant data may include the following: [PA155.IG101.SP101.SubP101.N101]

17392

- Project management problem reports requiring corrective action

17393

- Defects found in peer reviews

17394

- Defects found in testing

17395

- Process capability problems found from statistical analysis in managing the defined process

17396

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Refer to the Verification process area for more information about work product verification. [PA155.IG101.SP101.SubP101.N101.R101]

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17400

Refer to the Quantitative Project Management process area for more information about statistical management. [PA155.IG101.SP101.SubP101.N101.R102]

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17402

2. Determine which defects and other problems will be analyzed

17403

further. [PA155.IG101.SP101.SubP102]

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When determining which defects to analyze further, consider the impact of the defects, the frequency of occurrence, the similarity between defects, the cost of analysis, the time and resources needed, safety considerations, etc.

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[PA155.IG101.SP101.SubP102.N101]

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Examples of methods for selecting defects and other problems include the following: [PA155.IG101.SP101.SubP102.N102]

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- Pareto analysis

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- Histograms

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- Process capability analysis

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SP 1.2 Analyze Causes

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Perform causal analysis of selected defects and other problems and propose actions to address them. [PA155.IG101.SP102]

17416

17417 The purpose of this analysis is to develop solutions to the identified
17418 problems by analyzing the relevant data and producing action proposals
17419 for implementation. [PA155.IG101.SP102.N101]

17420 **Typical Work Products**

17421 1. Action proposal [PA155.IG101.SP102.W101]

17422 **Subpractices**

17423 1. Conduct causal analysis with the people who are responsible for
17424 performing the task. [PA155.IG101.SP102.SubP101]

17425 Examples of when to perform causal analysis include the following:

17426 [PA155.IG101.SP102.SubP101.N101]

- 17427 • When a stable process does not meet its specified product quality, service quality,
17428 or process performance objectives.
- 17429 • During the task, if and when the number of defects or the magnitude of identified
17430 problems warrants additional meetings
- 17431 • During the task, when the performance of a stable process needs to be improved
17432 to meet process performance objectives.
- 17433 • Periodically, during in-process tasks of long duration (e.g., a level-of-effort
17434 customer-support task)
- 17435 • Periodically, after products are released to the customer(s) (internal and external)
- 17436 • Shortly after the task is completed

17437
17438 *Refer to the Quantitative Project Management process area for more*
17439 *information about achieving the project's quality and process*
17440 *performance objectives.* [PA155.IG101.SP102.SubP101.N101.R101]

17441 2. Group the selected defects and other problems based on their
17442 causes. [PA155.IG101.SP102.SubP102]

17443 Examples of cause groups, or categories, include the following:

17444 [PA155.IG101.SP102.SubP102.N101]

- 17445 • Inadequate training
- 17446 • Breakdown of communications
- 17447 • Not accounting for all details of the problem
- 17448 • Making mistakes in manual procedures (e.g., typing)
- 17449 • Process deficiency

17450
17451 3. Analyze selected defects and other problems by group to
17452 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

17487 **SG 2 Address Causes of Defects** [PA155.IG102]

17488 ***Root causes of defects and other problems are systematically addressed to***
17489 ***prevent their future occurrence.***

17490 Projects operating according to a well-defined process will
17491 systematically analyze the operation where problems still occur and
17492 implement process changes to eliminate common causes of selected
17493 problems. [PA155.IG102.N101]

17494 **SP 2.1 Implement the Action Proposals**

17495 ***Implement the selected action proposals that were developed in***
17496 ***causal analysis.*** [PA155.IG102.SP101]

17497 *Refer to the Measurement and Analysis process area for more*
17498 *information about how to evaluate and select action proposals.*
17499 [PA155.IG102.SP101.R101]

17500 Action proposals describe the tasks necessary to remove the root
17501 causes of the analyzed defects or problems and avoid their
17502 reoccurrence. [PA155.IG102.SP101.N101]

17503 Only changes that prove to be of value should be considered for broad
17504 implementation. [PA155.IG102.SP101.N102]

17505 **Typical Work Products**

- 17506 1. Action plans for implementing selected proposals
17507 [PA155.IG102.SP101.W101]

17508 **Subpractices**

- 17509 1. Analyze the action proposals and determine their priorities.
17510 [PA155.IG102.SP101.SubP101]

17511 Criteria for prioritizing action proposals include the following:
17512 [PA155.IG102.SP101.SubP101.N101]

- 17513 • Implications of not addressing the defects
17514 • Cost to implement process improvements to prevent the defects
17515 • Expected impact on quality

- 17516 2. Select the action proposals that will be implemented.
17517 [PA155.IG102.SP101.SubP102]

- 17518 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]

SP 2.2 Evaluate the Effect of Changes

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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]

Refer to the Measurement and Analysis process area for more information about how to measure a change in performance.

[PA155.IG102.SP102.SubP101.R101]

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]

2. Measure the capability of the project's defined process as appropriate. [PA155.IG102.SP102.SubP102]

Refer to the Measurement and Analysis process area for more information about how to measure process capability.

[PA155.IG102.SP102.SubP102.R101]

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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SP 2.3 Record Data

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]

17601

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

17609

Typical Work Products

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1. Causal analysis and resolution records [PA155.IG102.SP103.W101]

17611

GG 3 Institutionalize a Defined Process [CL104.GL101]

17612

The process is institutionalized as a defined process.

17613

Commitment to Perform

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GP 2.1 (CO 1) Establish an Organizational Policy

17615

Establish and maintain an organizational policy for planning and performing the causal analysis and resolution process. [GP103]

17616

17617 Elaboration:

17618 This policy establishes organizational expectations for identifying and
17619 systematically addressing common causes of defects and other
17620 problems. [PA155.EL101]

17621 Ability to Perform

17622 **GP 3.1 (AB 1) Establish a Defined Process**

17623 ***Establish and maintain the description of a defined causal analysis***
17624 ***and resolution process.*** [GP114]

17625 **GP 2.2 (AB 2) Plan the Process**

17626 ***Establish and maintain the requirements and objectives, and plans***
17627 ***for performing the causal analysis and resolution process.*** [GP104]

17628 Elaboration:

17629 These requirements, objectives, and plans are described in the
17630 organization's plan for causal analysis and resolution. This plan differs
17631 from the action proposals and associated action plans described in the
17632 specific practice in this process area. The process action proposals
17633 and plans address the activities needed to remove the root cause under
17634 study; whereas the plan for causal analysis and resolution addresses
17635 the organization's overall process. [PA155.EL107]

17636 **GP 2.3 (AB 3) Provide Resources**

17637 ***Provide adequate resources for performing the causal analysis***
17638 ***and resolution process, developing the work products and***
17639 ***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 Causal Analysis and Resolution process area include the following: [PA155.EL102]

- Database systems
- Process modeling tools
- Statistical analysis packages
- Tools, methods, and analysis techniques (e.g., Ishakawa or fishbone diagram, Pareto analysis, histograms, process capability studies, control charts)

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GP 2.4 (AB 4) Assign Responsibility

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17653

Assign responsibility and authority for performing the process, developing the work products, and providing the services of the causal analysis and resolution process. [GP106]

17654

GP 2.5 (AB 5) Train People

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Train the people performing or supporting the causal analysis and resolution process as needed. [GP107]

17657

Elaboration:

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Examples of training topics include the following: [PA155.EL103]

- Quality management methods (e.g., root cause analysis)

17661

Directing Implementation

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GP 2.6 (DI 1) Manage Configurations

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Place designated work products of the causal analysis and resolution process under appropriate levels of configuration management. [GP109]

17666 Elaboration:

17667 Examples of work products placed under configuration management
17668 include the following: [PA155.EL104]
17669

- Action proposals
- Action plans for implementing selected proposals
- Causal analysis and resolution records

17672

17673 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

17674 ***Identify and involve the relevant stakeholders of the causal***
17675 ***analysis and resolution process as planned.*** [GP124]

17676 Elaboration:

17677 Examples of activities for stakeholder involvement include: [PA155.EL110]
17678

- Conducting causal analysis
- Assessing the action proposals

17680

17681 **GP 2.8 (DI 3) Monitor and Control the Process**

17682 ***Monitor and control the causal analysis and resolution process***
17683 ***against the plan and take appropriate corrective action.*** [GP110]

17684 Elaboration:

17685 Examples of measures used in monitoring and controlling the activities
17686 of the Causal Analysis and Resolution process area include the
17687 following: [PA155.EL105]
17688

- Number of root causes removed
- Change in quality or process performance per instance of the
17689 Causal Analysis and Resolution process

17691

17692 **GP 3.2 (DI 4) Collect Improvement Information**

17693 ***Collect work products, measures, measurement results, and***
17694 ***improvement information derived from planning and performing***
17695 ***the causal analysis and resolution process to support the future***
17696 ***use and improvement of the organization's processes and process***
17697 ***assets.*** [GP117]

17698 Verifying Implementation

17699 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

17700 ***Objectively evaluate adherence of the causal analysis and***
17701 ***resolution process and the work products and services of the***
17702 ***process to the applicable requirements, objectives, and standards,***
17703 ***and address noncompliance.*** [GP113]

17704 Elaboration:

17705 Examples of activities reviewed include the following: [PA155.EL106]

- 17706
- Determining causes of defects
 - Addressing causes of defects
- 17707

17708

17709 Examples of work products reviewed include the following: [PA155.EL109]

- 17710
- Action plans for implementing selected proposals
 - Causal analysis and resolution records
- 17711

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17713 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

17714 ***Review the activities, status, and results of the causal analysis and***
17715 ***resolution process with higher-level management and resolve***
17716 ***issues.*** [GP112]

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Appendixes

17718

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17720
17721

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Systems Engineering Capability Model, Interim Standard 731, Electronic Industries Alliance. Available WWW <URL: <http://www.eiafoundation.org/eng/published.htm>> [SR120]

Software Engineering Institute. *The Common CMM Framework (CCF) Draft E*. [SR103]

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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)
OUS/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

- 17761 • Terms that are differentiated when they really are synonyms
- 17762 according to the standard English dictionary
- 17763 • Overly restrictive definitions that would hinder use of the terms
- 17764 generally understood by the public in more commonplace
- 17765 situations
- 17766 • Definitions that provide explanatory information that more rightly
- 17767 belong elsewhere in the model

- 17768 You may notice that the term “process” is not defined in the glossary.
- 17769 The reason for its conspicuous absence is that it meets only one of the
- 17770 criteria for inclusion in the glossary. “Process” certainly appears in the
- 17771 model in multiple places (that is, it passes criteria 1). However, this term
- 17772 is defined adequately in the Webster’s dictionary and is not uniquely
- 17773 used in the CMMI models (that is, it fails criteria 2 and 3). [FM113.T107]

- 17774 The Webster’s entry of “process” comprises multiple definitions,
- 17775 including those for the term as a noun, verb, or adjective. All of these
- 17776 definitions are valid; however, among them there is the following
- 17777 definition: “a series of actions or operations conducing to an end;
- 17778 especially a continuous operation or treatment especially in
- 17779 manufacture.” This definition most likely applies to most uses of the
- 17780 word “process” in CMMI products, but this word may also be used
- 17781 according to the other definitions provided in Webster’s. [FM113.T108]

- 17782 When selecting definitions for terms in the CMMI glossary, we tried to
- 17783 use definitions from recognized sources where possible. Definitions
- 17784 were first selected from existing sources that have a widespread
- 17785 readership in the software and systems development domain. If we
- 17786 selected a definition from one of these sources, we included a note at
- 17787 the end of the definition in brackets (for example, [ISO 9000]). Our
- 17788 order of precedence when selecting definitions was as follows: [FM113.T109]

- 17789 1. Webster’s Dictionary
- 17790 2. ISO/IEC 9000
- 17791 3. ISO/IEC 12207
- 17792 4. ISO/IEC 15504
- 17793 5. ISO/IEC 15288
- 17794 6. CMMI Source Models [FM113.T115]
 - 17795 • IPD-CMM v0.98
 - 17796 • EIA/IS 731 (SECM)
 - 17797 • SW-CMM v 2, draft C
- 17798 7. CMMI A-Spec
- 17799 8. IEEE
- 17800 9. SW-CMM v1.1
- 17801 10. EIA 632
- 17802 11. SA-CMM
- 17803 12. FAA-CMM
- 17804 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).

17811

D. Required and Expected Model Elements

17812

MATURITY LEVEL: 2

17813 REQUIREMENTS MANAGEMENT

17814 Maturity Level 2

17815 The purpose of Requirements Management is to manage the
17816 requirements of the project's products and product components and to
17817 identify inconsistencies between those requirements and the project's
17818 plans and work products. [PA146]

17819 Specific and Generic Goals

17820 **SG 1 Manage Requirements**

17821 *Requirements are managed and inconsistencies with project plans and work*
17822 *products are identified.* [PA146.IG101]

17823 **GG 2 Institutionalize a Managed Process**

17824 *The process is institutionalized as a managed process.* [CL103.GL101]

17825 Practices by Goal:

17826 **SG 1 Manage Requirements**

17827 *Requirements are managed and inconsistencies with project plans and work*
17828 *products are identified.* [PA146.IG101]

17829 **SP 1.1 Obtain an Understanding of Requirements**

17830 *Develop an understanding with the requirements providers on the*
17831 *meaning of the requirements.* [PA146.IG101.SP101]

17832 **SP 1.2 Obtain Commitment to Requirements**

17833 *Obtain commitment to the requirements from the project*
17834 *participants.* [PA146.IG101.SP102]

17835 **SP 1.3 Manage Requirements Changes**

17836 *Manage changes to the requirements as they evolve during the*
17837 *project.* [PA146.IG101.SP103]

17838	SP 1.4	Maintain Bi-directional Traceability of Requirements	
17839		<i>Maintain bi-directional traceability among the requirements and the project plans and work products.</i> [PA146.IG101.SP104]	
17840			
17841	SP 1.5	Identify Inconsistencies between Project Work and Requirements	
17842		<i>Identify inconsistencies between the project plans and work products and the requirements.</i> [PA146.IG101.SP105]	
17843			
17844	GG 2	Institutionalize a Managed Process	
17845		<i>The process is institutionalized as a managed process.</i> [CL103.GL101]	
17846		Commitment to Perform	
17847	GP 2.1	(CO 1) Establish an Organizational Policy	
17848		<i>Establish and maintain an organizational policy for planning and performing the requirements management process.</i> [GP103]	
17849			
17850		Ability to Perform	
17851	GP 2.2	(AB 1) Plan the Process	
17852		<i>Establish and maintain the requirements and objectives, and plans for performing the requirements management process.</i> [GP104]	
17853			
17854	GP 2.3	(AB 2) Provide Resources	
17855		<i>Provide adequate resources for performing the requirements management process, developing the work products and providing the services of the process.</i> [GP105]	
17856			
17857			
17858	GP 2.4	(AB 3) Assign Responsibility	
17859		<i>Assign responsibility and authority for performing the process, developing the work products, and providing the services of the requirements management process.</i> [GP106]	
17860			
17861			

17862 **GP 2.5 (AB 4) Train People**

17863 *Train the people performing or supporting the requirements*
17864 *management process as needed. [GP107]*

17865 Directing Implementation

17866 **GP 2.6 (DI 1) Manage Configurations**

17867 *Place designated work products of the requirements management*
17868 *process under appropriate levels of configuration management.*
17869 *[GP109]*

17870 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

17871 *Identify and involve the relevant stakeholders of the requirements*
17872 *management process as planned. [GP124]*

17873 **GP 2.8 (DI 3) Monitor and Control the Process**

17874 *Monitor and control the requirements management process*
17875 *against the plan and take appropriate corrective action. [GP110]*

17876 Verifying Implementation

17877 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

17878 *Objectively evaluate adherence of the requirements management*
17879 *process and the work products and services of the process to the*
17880 *applicable requirements, objectives, and standards, and address*
17881 *noncompliance. [GP113]*

17882 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

17883 *Review the activities, status, and results of the requirements*
17884 *management process with higher-level management and resolve*
17885 *issues. [GP112]*

17886 PROJECT PLANNING

17887 Maturity Level 2

17888 The purpose of Project Planning is to establish and maintain plans that
17889 define project activities. [PA163]

17890 Specific and Generic Goals

17891 **SG 1 Establish Estimates**

17892 *Estimates of project planning parameters are established and maintained.*
17893 [PA163.IG101]

17894 **SG 2 Develop a Project Plan**

17895 *A project plan is established and maintained as the basis for managing the*
17896 *project.* [PA163.IG102]

17897 **SG 3 Obtain Commitment to the Plan**

17898 *Commitments to the project plan are established and maintained.* [PA163.IG103]

17899 **GG 2 Institutionalize a Managed Process**

17900 *The process is institutionalized as a managed process.* [CL103.GL101]

17901 Practices by Goal:

17902 **SG 1 Establish Estimates**

17903 *Estimates of project planning parameters are established and maintained.*
17904 [PA163.IG101]

17905 **SP 1.1 Estimate the Scope of the Project**

17906 *Establish and maintain a top-level work breakdown structure*
17907 *(WBS) to estimate of the scope of the project.* [PA163.IG101.SP101]

17908 **SP 1.2 Establish Estimates of Project Attributes**

17909 *Establish and document estimates of the attributes of the work*
17910 *products and tasks.* [PA163.IG101.SP102]

17911	SP 1.3	Define Project Life Cycle
17912		<i>Define the project life-cycle phases upon which to scope the</i>
17913		<i>planning effort.</i> [PA163.IG101.SP103]
17914	SP 1.4	Determine Estimates of Effort and Cost
17915		<i>Estimate the project effort and cost for the attributes of the work</i>
17916		<i>products and tasks based on estimation rationale.</i> [PA163.IG101.SP104]
17917	SG 2	Develop a Project Plan
17918		<i>A project plan is established and maintained as the basis for managing the</i>
17919		<i>project.</i> [PA163.IG102]
17920	SP 2.1	Establish the Budget and Schedule
17921		<i>Establish and maintain the project's budget and schedule.</i>
17922		[PA163.IG102.SP101]
17923	SP 2.2	Identify Project Risks
17924		<i>Identify and analyze project risks.</i> [PA163.IG102.SP103]
17925	SP 2.3	Plan for Data Management
17926		<i>Plan for the management of project data.</i> [PA163.IG102.SP102]
17927	SP 2.4	Plan for Project Resources
17928		<i>Plan for necessary resources to perform the project.</i> [PA163.IG102.SP104]
17929	SP 2.5	Plan for Needed Knowledge and Skills
17930		<i>Plan for knowledge and skills needed to perform the project.</i>
17931		[PA163.IG102.SP105]
17932	SP 2.6	Plan Stakeholder Involvement
17933		<i>Plan the involvement with identified stakeholders.</i> [PA163.IG102.SP106]

17934 **SP 2.7 Establish the Project Plan**

17935
17936

Establish and maintain the overall project plan content.

[PA163.IG102.SP107]

17937 **SG 3 Obtain Commitment to the Plan**

17938

Commitments to the project plan are established and maintained. [PA163.IG103]

17939 **SP 3.1 Review Subordinate Plans**

17940
17941

Review subordinate plans to understand project commitments.

[PA163.IG103.SP103]

17942 **SP 3.2 Reconcile Work and Resource Levels**

17943
17944

Reconcile the project plan to reflect available and projected resources. [PA163.IG103.SP101]

17945 **SP 3.3 Obtain Plan Commitment**

17946
17947

Obtain commitment from relevant stakeholders responsible for performing and supporting plan execution. [PA163.IG103.SP102]

17948 **GG 2 Institutionalize a Managed Process**

17949

The process is institutionalized as a managed process. [CL103.GL101]

17950 **Commitment to Perform**

17951 **GP 2.1 (CO 1) Establish an Organizational Policy**

17952
17953

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

17954 **Ability to Perform**

17955 **GP 2.2 (AB 1) Plan the Process**

17956
17957

Establish and maintain the requirements and objectives, and plans for performing the project planning process. [GP104]

17958 **GP 2.3 (AB 2) Provide Resources**
17959 *Provide adequate resources for performing the project planning*
17960 *process, developing the work products and providing the services*
17961 *of the process. [GP105]*

17962 **GP 2.4 (AB 3) Assign Responsibility**
17963 *Assign responsibility and authority for performing the process,*
17964 *developing the work products, and providing the services of the*
17965 *project planning process. [GP106]*

17966 **GP 2.5 (AB 4) Train People**
17967 *Train the people performing or supporting the project planning*
17968 *process as needed. [GP107]*

17969 Directing Implementation

17970 **GP 2.6 (DI 1) Manage Configurations**
17971 *Place designated work products of the project planning process*
17972 *under appropriate levels of configuration management. [GP109]*

17973 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**
17974 *Identify and involve the relevant stakeholders of the project*
17975 *planning process as planned. [GP124]*

17976 **GP 2.8 (DI 3) Monitor and Control the Process**
17977 *Monitor and control the project planning process against the plan*
17978 *and take appropriate corrective action. [GP110]*

17979 Verifying Implementation

17980 **GP 2.9 (VE 1) Objectively Evaluate Adherence**
17981 *Objectively evaluate adherence of the project planning process*
17982 *and the work products and services of the process to the*
17983 *applicable requirements, objectives, and standards, and address*
17984 *noncompliance. [GP113]*

17985

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

17986

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

17987

17988 PROJECT MONITORING AND CONTROL

17989 Maturity Level 2

17990 The purpose of Project Monitoring and Control is to provide
17991 understanding into the project's progress so that appropriate corrective
17992 actions can be taken when the project's performance deviates
17993 significantly from the plan. [PA162]

17994 Specific and Generic Goals

17995 **SG 1 Monitor Project Against Plan**

17996 *Actual performance and progress of the project is monitored against the*
17997 *project plan.* [PA162.IG101]

17998 **SG 2 Manage Corrective Action to Closure**

17999 *Corrective actions are managed to closure when the project's performance or*
18000 *results deviate significantly from the plan.* [PA162.IG102]

18001 **GG 2 Institutionalize a Managed Process**

18002 *The process is institutionalized as a managed process.* [CL103.GL101]

18003 Practices by Goal:

18004 **SG 1 Monitor Project Against Plan**

18005 *Actual performance and progress of the project is monitored against the*
18006 *project plan.* [PA162.IG101]

18007 **SP 1.1 Monitor Project Planning Parameters**

18008 *Monitor the actual values of the project planning parameters*
18009 *against the project plan.* [PA162.IG101.SP101]

18010 **SP 1.2 Monitor Commitments**

18011 *Monitor commitments against those identified in the project plan.*
18012 [PA162.IG101.SP102]

18013	SP 1.3	Monitor Project Risks
18014		<i>Monitor risks against those identified in the project plan.</i>
18015		<i>[PA162.IG101.SP103]</i>
18016	SP 1.4	Monitor Data Management
18017		<i>Monitor the management of project data.</i> <i>[PA162.IG101.SP106]</i>
18018	SP 1.5	Monitor Stakeholder Involvement
18019		<i>Monitor stakeholder involvement against the project plan.</i>
18020		<i>[PA162.IG101.SP107]</i>
18021	SP 1.6	Conduct Progress Reviews
18022		<i>Periodically review the project's progress, performance, and</i>
18023		<i>issues.</i> <i>[PA162.IG101.SP104]</i>
18024	SP 1.7	Conduct Milestone Reviews
18025		<i>Review the accomplishments and results of the project at selected</i>
18026		<i>project milestones.</i> <i>[PA162.IG101.SP105]</i>
18027	SG 2	Manage Corrective Action to Closure
18028		<i>Corrective actions are managed to closure when the project's performance or</i>
18029		<i>results deviate significantly from the plan.</i> <i>[PA162.IG102]</i>
18030	SP 2.1	Analyze Issues
18031		<i>Collect and analyze the issues and determine the corrective</i>
18032		<i>actions necessary to address the issues.</i> <i>[PA162.IG102.SP101]</i>
18033	SP 2.2	Take Correction Action
18034		<i>Take corrective action on identified issues.</i> <i>[PA162.IG102.SP102]</i>
18035	SP 2.3	Manage Corrective Action
18036		<i>Manage corrective actions to closure.</i> <i>[PA162.IG102.SP103]</i>

18037 **GG 2 Institutionalize a Managed Process**

18038 ***The process is institutionalized as a managed process.*** [CL103.GL101]

18039 Commitment to Perform

18040 **GP 2.1 (CO 1) Establish an Organizational Policy**

18041 ***Establish and maintain an organizational policy for planning and***
18042 ***performing the project monitoring and control process.*** [GP103]

18043 Ability to Perform

18044 **GP 2.2 (AB 1) Plan the Process**

18045 ***Establish and maintain the requirements and objectives, and plans***
18046 ***for performing the project monitoring and control process.*** [GP104]

18047 **GP 2.3 (AB 2) Provide Resources**

18048 ***Provide adequate resources for performing the project monitoring***
18049 ***and control process, developing the work products and providing***
18050 ***the services of the process.*** [GP105]

18051 **GP 2.4 (AB 3) Assign Responsibility**

18052 ***Assign responsibility and authority for performing the process,***
18053 ***developing the work products, and providing the services of the***
18054 ***project monitoring and control process.*** [GP106]

18055 **GP 2.5 (AB 4) Train People**

18056 ***Train the people performing or supporting the project monitoring***
18057 ***and control process as needed.*** [GP107]

18058 Directing Implementation

18059 **GP 2.6 (DI 1) Manage Configurations**

18060 *Place designated work products of the project monitoring and*
18061 *control process under appropriate levels of configuration*
18062 *management.* [GP109]

18063 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

18064 *Identify and involve the relevant stakeholders of the project*
18065 *monitoring and control process as planned.* [GP124]

18066 **GP 2.8 (DI 3) Monitor and Control the Process**

18067 *Monitor and control the project monitoring and control process*
18068 *against the plan and take appropriate corrective action.* [GP110]

18069 Verifying Implementation

18070 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

18071 *Objectively evaluate adherence of the project monitoring and*
18072 *control process and the work products and services of the*
18073 *process to the applicable requirements, objectives, and standards,*
18074 *and address noncompliance.* [GP113]

18075 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

18076 *Review the activities, status, and results of the project monitoring*
18077 *and control process with higher-level management and resolve*
18078 *issues.* [GP112]

18079 SUPPLIER AGREEMENT MANAGEMENT

18080 Maturity Level 2

18081 The purpose of Supplier Agreement Management is to manage the
18082 acquisition of products and services from suppliers external to the
18083 project for which there exists a formal agreement. [PA166]

18084 Specific and Generic Goals

18085 **SG 1 Establish Supplier Agreements**

18086 ***Agreements with the suppliers are established and maintained.*** [PA166.IG101]

18087 **SG 2 Satisfy Supplier Agreements**

18088 ***Agreements with the suppliers are satisfied by both the project and the***
18089 ***supplier.*** [PA166.IG102]

18090 **GG 2 Institutionalize a Managed Process**

18091 ***The process is institutionalized as a managed process.*** [CL103.GL101]

18092 Practices by Goal:

18093 **SG 1 Establish Supplier Agreements**

18094 ***Agreements with the suppliers are established and maintained.*** [PA166.IG101]

18095 **SP 1.1 Analyze Needs and Requirements Determined by the Project**

18096 ***Analyze the project's needs and requirements that will be fulfilled***
18097 ***by sources outside the project to determine how the needs and***
18098 ***requirements will be satisfied.*** [PA166.IG101.SP101]

18099 **SP 1.2 Select Suppliers**

18100 ***Select suppliers based on an evaluation of their ability to meet the***
18101 ***specified requirements and established criteria.*** [PA166.IG101.SP102]

18102 **SP 1.3 Establish Supplier Agreements**
18103 *Establish and maintain formal agreements with the supplier.*
18104 [PA166.IG101.SP103]

18105 **SG 2 Satisfy Supplier Agreements**
18106 *Agreements with the suppliers are satisfied by both the project and the*
18107 *supplier.* [PA166.IG102]

18108 **SP 2.1 Acquire COTS Products**
18109 *Acquire COTS products to satisfy the specified requirements that*
18110 *are covered under a supplier agreement.* [PA166.IG102.SP101]

18111 **SP 2.2 Execute the Supplier Agreement**
18112 *Perform activities with the supplier as specified in the supplier*
18113 *agreement.* [PA166.IG102.SP102]

18114 **SP 2.3 Conduct Acceptance Testing**
18115 *Ensure that the supplier agreement is satisfied before accepting*
18116 *the acquired product.* [PA166.IG102.SP103]

18117 **SP 2.4 Transition Products**
18118 *Transition the acquired products from the supplier to the project.*
18119 [PA166.IG102.SP104]

18120 **GG 2 Institutionalize a Managed Process**
18121 *The process is institutionalized as a managed process.* [CL103.GL101]

18122 Commitment to Perform

18123 **GP 2.1 (CO 1) Establish an Organizational Policy**
18124 *Establish and maintain an organizational policy for planning and*
18125 *performing the supplier agreement management process.* [GP103]

18126 Ability to Perform

18127 **GP 2.2 (AB 1) Plan the Process**

18128 *Establish and maintain the requirements and objectives, and plans*
18129 *for performing the supplier agreement management process. [GP104]*

18130 **GP 2.3 (AB 2) Provide Resources**

18131 *Provide adequate resources for performing the supplier agreement*
18132 *management process, developing the work products and*
18133 *providing the services of the process. [GP105]*

18134 **GP 2.4 (AB 3) Assign Responsibility**

18135 *Assign responsibility and authority for performing the process,*
18136 *developing the work products, and providing the services of the*
18137 *supplier agreement management process. [GP106]*

18138 **GP 2.5 (AB 4) Train People**

18139 *Train the people performing or supporting the supplier agreement*
18140 *management process as needed. [GP107]*

18141 Directing Implementation

18142 **GP 2.6 (DI 1) Manage Configurations**

18143 *Place designated work products of the supplier agreement*
18144 *management process under appropriate levels of configuration*
18145 *management. [GP109]*

18146 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

18147 *Identify and involve the relevant stakeholders of the supplier*
18148 *agreement management process as planned. [GP124]*

18149 **GP 2.8 (DI 3) Monitor and Control the Process**

18150 *Monitor and control the supplier agreement management process*
18151 *against the plan and take appropriate corrective action. [GP110]*

18152 Verifying Implementation

18153 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

18154 *Objectively evaluate adherence of the supplier agreement*
18155 *management process and the work products and services of the*
18156 *process to the applicable requirements, objectives, and standards,*
18157 *and address noncompliance.* [GP113]

18158 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

18159 *Review the activities, status, and results of the supplier agreement*
18160 *management process with higher-level management and resolve*
18161 *issues.* [GP112]

18162 MEASUREMENT AND ANALYSIS

18163 Maturity Level 2

18164 The purpose of Measurement and Analysis is to develop and sustain a
18165 measurement capability that is used to support management
18166 information needs. [PA154]

18167 Specific and Generic Goals

18168 **SG 1 Align Measurement and Analysis Activities**

18169 *Measurement objectives and practices are aligned with identified information*
18170 *needs and objectives.* [PA154.IG101]

18171 **SG 2 Provide Measurement Results**

18172 *Measurement results that address identified information needs and objectives*
18173 *are provided.* [PA154.IG102]

18174 **GG 2 Institutionalize a Managed Process**

18175 *The process is institutionalized as a managed process.* [CL103.GL101]

18176 Practices by Goal:

18177 **SG 1 Align Measurement and Analysis Activities**

18178 *Measurement objectives and practices are aligned with identified information*
18179 *needs and objectives.* [PA154.IG101]

18180 **SP 1.1 Establish Measurement Objectives**

18181 *Establish and maintain measurement objectives that are derived*
18182 *from identified information needs and objectives.* [PA154.IG101.SP101]

18183 **SP 1.2 Specify Measures**

18184 *Specify measures to address the measurement objectives.*
18185 [PA154.IG101.SP102]

18186	SP 1.3	Specify Data Collection and Storage Procedures
18187		<i>Specify how measurement data will be obtained and stored.</i>
18188		[PA154.IG101.SP103]
18189	SP 1.4	Specify Analysis Procedures
18190		<i>Specify how measurement data will be analyzed and reported.</i>
18191		[PA154.IG101.SP104]
18192	SG 2	Provide Measurement Results
18193		<i>Measurement results that address identified information needs and objectives are provided.</i>
18194		[PA154.IG102]
18195	SP 2.1	Collect Measurement Data
18196		<i>Obtain specified measurement data.</i> [PA154.IG102.SP101]
18197	SP 2.2	Analyze Measurement Data
18198		<i>Analyze and interpret measurement data.</i> [PA154.IG102.SP102]
18199	SP 2.3	Store Data and Results
18200		<i>Manage and store measurement data, measurement specifications, and analysis results.</i> [PA154.IG102.SP103]
18201		
18202	SP 2.4	Communicate Results
18203		<i>Report results of measurement and analysis activities to all affected stakeholders.</i> [PA154.IG102.SP104]
18204		
18205	GG 2	Institutionalize a Managed Process
18206		<i>The process is institutionalized as a managed process.</i> [CL103.GL101]

18207 Commitment to Perform

18208 **GP 2.1 (CO 1) Establish an Organizational Policy**

18209 *Establish and maintain an organizational policy for planning and*
18210 *performing the measurement and analysis process. [GP103]*

18211 Ability to Perform

18212 **GP 2.2 (AB 1) Plan the Process**

18213 *Establish and maintain the requirements and objectives, and plans*
18214 *for performing the measurement and analysis process. [GP104]*

18215 **GP 2.3 (AB 2) Provide Resources**

18216 *Provide adequate resources for performing the measurement and*
18217 *analysis process, developing the work products and providing the*
18218 *services of the process. [GP105]*

18219 **GP 2.4 (AB 3) Assign Responsibility**

18220 *Assign responsibility and authority for performing the process,*
18221 *developing the work products, and providing the services of the*
18222 *measurement and analysis process. [GP106]*

18223 **GP 2.5 (AB 4) Train People**

18224 *Train the people performing or supporting the measurement and*
18225 *analysis process as needed. [GP107]*

18226 Directing Implementation

18227 **GP 2.6 (DI 1) Manage Configurations**

18228 *Place designated work products of the measurement and analysis*
18229 *process under appropriate levels of configuration management.*
18230 *[GP109]*

18231 **GP 2.7** **(DI 2)** **Identify and Involve Relevant Stakeholders**
18232 *Identify and involve the relevant stakeholders of the measurement*
18233 *and analysis process as planned.* [GP124]

18234 **GP 2.8** **(DI 3)** **Monitor and Control the Process**
18235 *Monitor and control the measurement and analysis process*
18236 *against the plan and take appropriate corrective action.* [GP110]

18237 Verifying Implementation

18238 **GP 2.9** **(VE 1)** **Objectively Evaluate Adherence**
18239 *Objectively evaluate adherence of the measurement and analysis*
18240 *process and the work products and services of the process to the*
18241 *applicable requirements, objectives, and standards, and address*
18242 *noncompliance.* [GP113]

18243 **GP 2.10** **(VE 2)** **Review Status with Higher-Level Management**
18244 *Review the activities, status, and results of the measurement and*
18245 *analysis process with higher-level management and resolve*
18246 *issues.* [GP112]

18247 PROCESS AND PRODUCT QUALITY ASSURANCE

18248 Maturity Level 2

18249 The purpose of Process and Product Quality Assurance is to provide
18250 staff and management with objective insight into the processes and
18251 associated work products. [PA145]

18252 Specific and Generic Goals

18253 **SG 1 Objectively Evaluate Processes and Work Products**

18254 *Adherence of the performed process and associated work products and*
18255 *services to applicable process descriptions, standards and procedures is*
18256 *objectively evaluated.* [PA145.IG101]

18257 **SG 2 Provide Objective Insight**

18258 *Noncompliance issues are objectively tracked and communicated, and*
18259 *resolution is ensured.* [PA145.IG102]

18260 **GG 2 Institutionalize a Managed Process**

18261 *The process is institutionalized as a managed process.* [CL103.GL101]

18262 Practices by Goal:

18263 **SG 1 Objectively Evaluate Processes and Work Products**

18264 *Adherence of the performed process and associated work products and*
18265 *services to applicable process descriptions, standards and procedures is*
18266 *objectively evaluated.* [PA145.IG101]

18267 **SP 1.1 Objectively Evaluate Processes**

18268 *Objectively evaluate the designated performed processes against*
18269 *the applicable process descriptions, standards and procedures.*
18270 [PA145.IG101.SP101]

18271 **SP 1.2 Objectively Evaluate Work Products and Services**

18272 *Objectively evaluate the designated work products and services*
18273 *against the applicable process descriptions, standards, and*
18274 *procedures.* [PA145.IG101.SP102]

18275 **SG 2 Provide Objective Insight**

18276 ***Noncompliance issues are objectively tracked and communicated, and***
18277 ***resolution is ensured.*** [PA145.IG102]

18278 **SP 2.1 Communicate and Ensure Resolution of Noncompliance Issues**

18279 ***Communicate quality issues and ensure resolution of***
18280 ***noncompliance issues with the staff and managers.*** [PA145.IG102.SP101]

18281 **SP 2.2 Establish Records**

18282 ***Establish and maintain records of the quality assurance activities.***
18283 [PA145.IG102.SP102]

18284 **GG 2 Institutionalize a Managed Process**

18285 ***The process is institutionalized as a managed process.*** [CL103.GL101]

18286 **Commitment to Perform**

18287 **GP 2.1 (CO 1) Establish an Organizational Policy**

18288 ***Establish and maintain an organizational policy for planning and***
18289 ***performing the process and product quality assurance process.***
18290 [GP103]

18291 **Ability to Perform**

18292 **GP 2.2 (AB 1) Plan the Process**

18293 ***Establish and maintain the requirements and objectives, and plans***
18294 ***for performing the process and product quality assurance***
18295 ***process.*** [GP104]

18296 **GP 2.3 (AB 2) Provide Resources**

18297 ***Provide adequate resources for performing the process and***
18298 ***product quality assurance process, developing the work products***
18299 ***and providing the services of the process.*** [GP105]

18300 **GP 2.4 (AB 3) Assign Responsibility**
18301 *Assign responsibility and authority for performing the process,*
18302 *developing the work products, and providing the services of the*
18303 *process and product quality assurance process. [GP106]*

18304 **GP 2.5 (AB 4) Train People**
18305 *Train the people performing or supporting the process and*
18306 *product quality assurance process as needed. [GP107]*

18307 Directing Implementation

18308 **GP 2.6 (DI 1) Manage Configurations**
18309 *Place designated work products of the process and product*
18310 *quality assurance process under appropriate levels of*
18311 *configuration management. [GP109]*

18312 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**
18313 *Identify and involve the relevant stakeholders of the process and*
18314 *product quality assurance process as planned. [GP124]*

18315 **GP 2.8 (DI 3) Monitor and Control the Process**
18316 *Monitor and control the process and product quality assurance*
18317 *process against the plan and take appropriate corrective action.*
18318 *[GP110]*

18319 Verifying Implementation

18320 **GP 2.9 (VE 1) Objectively Evaluate Adherence**
18321 *Objectively evaluate adherence of the process and product quality*
18322 *assurance process and the work products and services of the*
18323 *process to the applicable requirements, objectives, and standards,*
18324 *and address noncompliance. [GP113]*

18325

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

18326

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

18327

18328

18329 CONFIGURATION MANAGEMENT

18330 Maturity Level 2

18331 The purpose of Configuration Management is to establish and maintain
18332 the integrity of work products using configuration identification,
18333 configuration control, configuration status accounting, and configuration
18334 audits. [PA159]

18335 Specific and Generic Goals

18336 **SG 1 Establish Baselines**

18337 ***Baselines of identified work products are established and maintained.*** [PA159.IG101]

18338 **SG 2 Track and Control Changes**

18339 ***Changes to the work products under configuration management are tracked***
18340 ***and controlled.*** [PA159.IG102]

18341 **SG 3 Establish Integrity**

18342 ***Integrity of baselines is established and maintained.*** [PA159.IG103]

18343 **GG 2 Institutionalize a Managed Process**

18344 ***The process is institutionalized as a managed process.*** [CL103.GL101]

18345 Practices by Goal:

18346 **SG 1 Establish Baselines**

18347 ***Baselines of identified work products are established and maintained.*** [PA159.IG101]

18348 **SP 1.1 Identify Configuration Items**

18349 ***Identify the configuration items, components, and related work***
18350 ***products that will be placed under configuration management.***

18351 [PA159.IG101.SP101]

18352 **SP 1.2 Establish a Configuration Management System**

18353 ***Establish and maintain a configuration management and change***
18354 ***management system for controlling work products.*** [PA159.IG101.SP102]

18355 **SP 1.3 Create or Release Baselines**

18356 ***Create or release baselines for internal use and for delivery to the***
18357 ***customer.*** [PA159.IG101.SP103]

18358 **SG 2 Track and Control Changes**

18359 ***Changes to the work products under configuration management are tracked***
18360 ***and controlled.*** [PA159.IG102]

18361 **SP 2.1 Track Changes**

18362 ***Track change requests for the configuration items.*** [PA159.IG102.SP101]

18363 **SP 2.2 Control Changes**

18364 ***Control changes to the content of configuration items.*** [PA159.IG102.SP102]

18365 **SG 3 Establish Integrity**

18366 ***Integrity of baselines is established and maintained.*** [PA159.IG103]

18367 **SP 3.1 Establish Configuration Management Records**

18368 ***Establish and maintain records describing configuration items.***
18369 [PA159.IG103.SP101]

18370 **SP 3.2 Perform Configuration Audits**

18371 ***Perform configuration audits to maintain integrity of the***
18372 ***configuration baselines.*** [PA159.IG103.SP102]

18373 **GG 2 Institutionalize a Managed Process**

18374 ***The process is institutionalized as a managed process.*** [CL103.GL101]

18375 **Commitment to Perform**

18376 **GP 2.1 (CO 1) Establish an Organizational Policy**

18377 ***Establish and maintain an organizational policy for planning and***
18378 ***performing the configuration management process.*** [GP103]

18379 Ability to Perform

18380 **GP 2.2 (AB 1) Plan the Process**

18381 *Establish and maintain the requirements and objectives, and plans*
18382 *for performing the configuration management process. [GP104]*

18383 **GP 2.3 (AB 2) Provide Resources**

18384 *Provide adequate resources for performing the configuration*
18385 *management process, developing the work products and*
18386 *providing the services of the process. [GP105]*

18387 **GP 2.4 (AB 3) Assign Responsibility**

18388 *Assign responsibility and authority for performing the process,*
18389 *developing the work products, and providing the services of the*
18390 *configuration management process. [GP106]*

18391 **GP 2.5 (AB 4) Train People**

18392 *Train the people performing or supporting the configuration*
18393 *management process as needed. [GP107]*

18394 Directing Implementation

18395 **GP 2.6 (DI 1) Manage Configurations**

18396 *Place designated work products of the configuration management*
18397 *process under appropriate levels of configuration management.*
18398 *[GP109]*

18399 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

18400 *Identify and involve the relevant stakeholders of the configuration*
18401 *management process as planned. [GP124]*

18402 **GP 2.8 (DI 3) Monitor and Control the Process**

18403 *Monitor and control the configuration management process*
18404 *against the plan and take appropriate corrective action. [GP110]*

18405 Verifying Implementation

18406 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

18407 *Objectively evaluate adherence of the configuration management*
18408 *process and the work products and services of the process to the*
18409 *applicable requirements, objectives, and standards, and address*
18410 *noncompliance.* [GP113]

18411 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

18412 *Review the activities, status, and results of the configuration*
18413 *management process with higher-level management and resolve*
18414 *issues.* [GP112]

18415

MATURITY LEVEL: 3

18416 REQUIREMENTS DEVELOPMENT

18417 Maturity Level 3

18418 The purpose of Requirements Development is to produce and analyze
18419 customer, product, and product component requirements. [PA157]

18420 Specific and Generic Goals

18421 **SG 1 Develop Customer Requirements**

18422 *Stakeholder needs, expectations, constraints, and interfaces are collected and*
18423 *translated into customer requirements.* [PA157.IG101]

18424 **SG 2 Develop Product Requirements**

18425 *Customer requirements are refined and elaborated to develop product and*
18426 *product component requirements for the product life cycle.* [PA157.IG103]

18427 **SG 3 Analyze and Validate Requirements**

18428 *The requirements are analyzed and validated, and a definition of required*
18429 *functionality is developed.* [PA157.IG102]

18430 **GG 3 Institutionalize a Defined Process**

18431 *The process is institutionalized as a defined process.* [CL104.GL101]

18432 Practices by Goal:

18433 **SG 1 Develop Customer Requirements**

18434 *Stakeholder needs, expectations, constraints, and interfaces are collected and*
18435 *translated into customer requirements.* [PA157.IG101]

18436 **SP 1.1 Elicit Needs**

18437 *Elicit stakeholder needs, expectations, constraints, and interfaces*
18438 *for all phases of the product's life cycle.* [PA157.IG101.SP102]

18439 The following specific practice appears in the continuous representation as
18440 SP 1.1-1, but is subsumed in the staged representation by SP 1.1 Elicit Needs. The
18441 specific practice is presented here only as informative material.

18442 **SP 1.1-1 Collect Stakeholder Needs**

18443 *Identify and collect stakeholder needs, expectations, constraints,*
18444 *and interfaces for all phases of the product's life cycle.*

18445 [PA157.IG101.SP101]

18446 **SP 1.2 Transform Stakeholder Needs, Expectations, Constraints, and In-**
18447 **terfaces into Customer Requirements**

18448 *Transform stakeholder needs, expectations, constraints, and*
18449 *interfaces into customer requirements.* [PA157.IG101.SP103]

18450 **SG 2 Develop Product Requirements**

18451 *Customer requirements are refined and elaborated to develop product and*
18452 *product component requirements for the product life cycle.* [PA157.IG103]

18453 **SP 2.1 Establish Product and Product Component Requirements**

18454 *Establish and maintain, from the customer requirements, product*
18455 *and product component requirements essential to product and*
18456 *product component effectiveness and affordability.* [PA157.IG103.SP101]

18457 **SP 2.2 Allocate Product Component Requirements**

18458 *Allocate the requirements for each product component.*

18459 [PA157.IG103.SP102]

18460 **SP 2.3 Identify Interface Requirements**

18461 *Identify interface requirements.* [PA157.IG103.SP103]

18462 **SG 3 Analyze and Validate Requirements**

18463 *The requirements are analyzed and validated, and a definition of required*
18464 *functionality is developed.* [PA157.IG102]

18465	SP 3.1	Establish Operational Concepts and Scenarios
18466		<i>Establish and maintain operational concepts and scenarios.</i>
18467		[PA157.IG102.SP101]
18468	SP 3.2	Establish a Definition of Required Functionality
18469		<i>Establish and maintain a definition of required functionality.</i>
18470		[PA157.IG102.SP102]
18471	SP 3.3	Analyze Requirements
18472		<i>Analyze derived requirements to ensure that they are necessary and sufficient.</i> [PA157.IG102.SP103]
18473		
18474	SP 3.4	Evaluate Product Cost, Schedule and Risk
18475		<i>Analyze requirements with the purpose of reducing the life-cycle cost, schedule and risk of product development.</i> [PA157.IG102.SP104]
18476		
18477	SP 3.5	Validate Requirements with Comprehensive Methods
18478		<i>Validate requirements to ensure the resulting product will perform as intended in the user's environment using multiple techniques as appropriate.</i> [PA157.IG102.SP106]
18479		
18480		
18481		The following specific practice appears in the continuous representation as
18482		SP 3.5-1, but is subsumed in the staged representation by SP 3.5 Validate Re-
18483		quirements with Comprehensive Methods. The specific practice is presented here
18484		only as informative material.
18485	SP 3.5-1	Validate Requirements
18486		<i>Validate requirements to ensure the resulting product will perform appropriately in its intended use environment.</i> [PA157.IG102.SP105]
18487		
18488	GG 3	Institutionalize a Defined Process
18489		<i>The process is institutionalized as a defined process.</i> [CL104.GL101]

18490 Commitment to Perform

18491 **GP 2.1 (CO 1) Establish an Organizational Policy**

18492 *Establish and maintain an organizational policy for planning and*
18493 *performing the requirements development process. [GP103]*

18494 Ability to Perform

18495 **GP 3.1 (AB 1) Establish a Defined Process**

18496 *Establish and maintain the description of a defined requirements*
18497 *development process. [GP114]*

18498 **GP 2.2 (AB 2) Plan the Process**

18499 *Establish and maintain the requirements and objectives, and plans*
18500 *for performing the requirements development process. [GP104]*

18501 **GP 2.3 (AB 3) Provide Resources**

18502 *Provide adequate resources for performing the requirements*
18503 *development process, developing the work products and*
18504 *providing the services of the process. [GP105]*

18505 **GP 2.4 (AB 4) Assign Responsibility**

18506 *Assign responsibility and authority for performing the process,*
18507 *developing the work products, and providing the services of the*
18508 *requirements development process. [GP106]*

18509 **GP 2.5 (AB 5) Train People**

18510 *Train the people performing or supporting the requirements*
18511 *development process as needed. [GP107]*

18512 Directing Implementation

18513 **GP 2.6 (DI 1) Manage Configurations**

18514 *Place designated work products of the requirements development*
18515 *process under appropriate levels of configuration management.*
18516 [GP109]

18517 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

18518 *Identify and involve the relevant stakeholders of the requirements*
18519 *development process as planned.* [GP124]

18520 **GP 2.8 (DI 3) Monitor and Control the Process**

18521 *Monitor and control the requirements development process*
18522 *against the plan and take appropriate corrective action.* [GP110]

18523 **GP 3.2 (DI 4) Collect Improvement Information**

18524 *Collect work products, measures, measurement results, and*
18525 *improvement information derived from planning and performing*
18526 *the requirements development process to support the future use*
18527 *and improvement of the organization's processes and process*
18528 *assets.* [GP117]

18529 Verifying Implementation

18530 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

18531 *Objectively evaluate adherence of the requirements development*
18532 *process and the work products and services of the process to the*
18533 *applicable requirements, objectives, and standards, and address*
18534 *noncompliance.* [GP113]

18535 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

18536 *Review the activities, status, and results of the requirements*
18537 *development process with higher-level management and resolve*
18538 *issues.* [GP112]

18539 TECHNICAL SOLUTION

18540 Maturity Level 3

18541 The purpose of Technical Solution is to develop, design, and implement
18542 solutions to requirements. Solutions, designs and implementations
18543 encompass products, product components, and product related
18544 processes either singly or in combinations as appropriate. [PA160]

18545 Specific and Generic Goals

18546 **SG 1 Select Product Component Solutions**

18547 *Product or product component solutions, including applicable product related*
18548 *processes, are selected from alternative solutions.* [PA160.IG101]

18549 **SG 2 Develop the Design**

18550 *Product or product component designs are developed.* [PA160.IG102]

18551 **SG 3 Implement the Product Design**

18552 *Product components, and associated support documentation, are*
18553 *implemented from their designs.* [PA160.IG103]

18554 **GG 3 Institutionalize a Defined Process**

18555 *The process is institutionalized as a defined process.* [CL104.GL101]

18556 Practices by Goal:

18557 **SG 1 Select Product Component Solutions**

18558 *Product or product component solutions, including applicable product related*
18559 *processes, are selected from alternative solutions.* [PA160.IG101]

18560 **SP 1.1 Develop Detailed Alternative Solutions and Selection Criteria**

18561 *Develop detailed alternative solutions and selection criteria.*

18562 [PA160.IG101.SP102]

18563 The following specific practice appears in the continuous representation as
18564 SP 1.1-1, but is subsumed in the staged representation by SP 1.1 Develop Detailed

18565 Alternative Solutions and Selection Criteria. The specific practice is presented here
18566 only as informative material.

18567 **SP 1.1-1 Develop Alternative Solutions and Selection Criteria**

18568 *Develop alternative solutions and establish selection criteria.*

18569 [PA160.IG101.SP101]

18570 **SP 1.2 Evolve Operational Concepts and Scenarios**

18571 *Evolve the operational concept, scenarios, and environments to*
18572 *describe the conditions, operating modes, and operating states*
18573 *specific to each product component.* [PA160.IG101.SP103]

18574 **SP 1.3 Select Product Component Solutions**

18575 *Select the product component solutions that best satisfy the*
18576 *criteria established.* [PA160.IG101.SP104]

18577 **SG 2 Develop the Design**

18578 *Product or product component designs are developed.* [PA160.IG102]

18579 **SP 2.1 Use Effective Design Methods**

18580 *Establish and use effective design methods.* [PA160.IG102.SP101]

18581 **SP 2.2 Establish a Complete Technical Data Package**

18582 *Establish and maintain a complete technical data package.*

18583 [PA160.IG102.SP103]

18584 The following specific practice appears in the continuous representation as
18585 SP 2.2-1, but is subsumed in the staged representation by SP 2.2 Establish a Com-
18586 plete Technical Data Package . The specific practice is presented here only as in-
18587 formative material.

18588 **SP 2.2-1 Develop a Technical Data Package**

18589 *Develop a product or product component technical data package.*

18590 [PA160.IG102.SP102]

18591 **SP 2.3 Design Comprehensive Interface**

18592 ***Design product component interfaces in terms of established and***
18593 ***maintained criteria.*** [PA160.IG102.SP105]

18594 The following specific practice appears in the continuous representation as
18595 SP 2.3-1, but is subsumed in the staged representation by SP 2.3 Design Compre-
18596 hensive Interface . The specific practice is presented here only as informative mate-
18597 rial.

18598 **SP 2.3-1 Establish Interface Descriptions**

18599 ***Establish and maintain the solution for product component***
18600 ***interfaces.*** [PA160.IG102.SP104]

18601 **SP 2.4 Perform Make, Buy, or Reuse Analyses**

18602 ***Evaluate whether the product components should be developed,***
18603 ***purchased, or reused based on established criteria.*** [PA160.IG102.SP106]

18604 **SG 3 Implement the Product Design**

18605 ***Product components, and associated support documentation, are***
18606 ***implemented from their designs.*** [PA160.IG103]

18607 **SP 3.1 Implement the Design**

18608 ***Implement the designs of the product components.*** [PA160.IG103.SP101]

18609 **SP 3.2 Establish Product Support Documentation**

18610 ***Establish and maintain the end-use documentation.*** [PA160.IG103.SP102]

18611 **GG 3 Institutionalize a Defined Process**

18612 ***The process is institutionalized as a defined process.*** [CL104.GL101]

18613 Commitment to Perform

18614 **GP 2.1 (CO 1) Establish an Organizational Policy**

18615 *Establish and maintain an organizational policy for planning and*
18616 *performing the technical solution process. [GP103]*

18617 Ability to Perform

18618 **GP 3.1 (AB 1) Establish a Defined Process**

18619 *Establish and maintain the description of a defined technical*
18620 *solution process. [GP114]*

18621 **GP 2.2 (AB 2) Plan the Process**

18622 *Establish and maintain the requirements and objectives, and plans*
18623 *for performing the technical solution process. [GP104]*

18624 **GP 2.3 (AB 3) Provide Resources**

18625 *Provide adequate resources for performing the technical solution*
18626 *process, developing the work products and providing the services*
18627 *of the process. [GP105]*

18628 **GP 2.4 (AB 4) Assign Responsibility**

18629 *Assign responsibility and authority for performing the process,*
18630 *developing the work products, and providing the services of the*
18631 *technical solution process. [GP106]*

18632 **GP 2.5 (AB 5) Train People**

18633 *Train the people performing or supporting the technical solution*
18634 *process as needed. [GP107]*

18635 Directing Implementation

18636 **GP 2.6 (DI 1) Manage Configurations**
18637 *Place designated work products of the technical solution process*
18638 *under appropriate levels of configuration management. [GP109]*

18639 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**
18640 *Identify and involve the relevant stakeholders of the technical*
18641 *solution process as planned. [GP124]*

18642 **GP 2.8 (DI 3) Monitor and Control the Process**
18643 *Monitor and control the technical solution process against the*
18644 *plan and take appropriate corrective action. [GP110]*

18645 **GP 3.2 (DI 4) Collect Improvement Information**
18646 *Collect work products, measures, measurement results, and*
18647 *improvement information derived from planning and performing*
18648 *the technical solution process to support the future use and*
18649 *improvement of the organization's processes and process assets.*
18650 *[GP117]*

18651 Verifying Implementation

18652 **GP 2.9 (VE 1) Objectively Evaluate Adherence**
18653 *Objectively evaluate adherence of the technical solution process*
18654 *and the work products and services of the process to the*
18655 *applicable requirements, objectives, and standards, and address*
18656 *noncompliance. [GP113]*

18657 **GP 2.10 (VE 2) Review Status with Higher-Level Management**
18658 *Review the activities, status, and results of the technical solution*
18659 *process with higher-level management and resolve issues. [GP112]*

18660 PRODUCT INTEGRATION

18661 Maturity Level 3

18662 The purpose of Product Integration is to assemble the product from the
18663 product components, ensure that the product, as integrated, functions
18664 properly, and deliver the product. [PA147]

18665 Specific and Generic Goals

18666 **SG 1 Prepare for Product Integration**

18667 *The strategy for conducting product integration is established and*
18668 *maintained.* [PA147.IG101]

18669 **SG 2 Ensure Interface Compatibility**

18670 *The product component interfaces, both internal and external, are compatible.*
18671 [PA147.IG102]

18672 **SG 3 Assemble Product Components and Deliver the Product**

18673 *Verified product components are assembled and the integrated, verified, and*
18674 *validated product is delivered.* [PA147.IG103]

18675 **GG 3 Institutionalize a Defined Process**

18676 *The process is institutionalized as a defined process.* [CL104.GL101]

18677 Practices by Goal:

18678 **SG 1 Prepare for Product Integration**

18679 *The strategy for conducting product integration is established and*
18680 *maintained.* [PA147.IG101]

18681 **SP 1.1 Establish a Product Integration Strategy**

18682 *Establish and maintain a strategy for integration of the product*
18683 *components.* [PA147.IG101.SP101]

18736 **GP 2.5 (AB 5) Train People**

18737 ***Train the people performing or supporting the product integration***
18738 ***process as needed.*** [GP107]

18739 Directing Implementation

18740 **GP 2.6 (DI 1) Manage Configurations**

18741 ***Place designated work products of the product integration***
18742 ***process under appropriate levels of configuration management.***
18743 [GP109]

18744 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

18745 ***Identify and involve the relevant stakeholders of the product***
18746 ***integration process as planned.*** [GP124]

18747 **GP 2.8 (DI 3) Monitor and Control the Process**

18748 ***Monitor and control the product integration process against the***
18749 ***plan and take appropriate corrective action.*** [GP110]

18750 **GP 3.2 (DI 4) Collect Improvement Information**

18751 ***Collect work products, measures, measurement results, and***
18752 ***improvement information derived from planning and performing***
18753 ***the product integration process to support the future use and***
18754 ***improvement of the organization's processes and process assets.***
18755 [GP117]

18756 Verifying Implementation

18757 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

18758 ***Objectively evaluate adherence of the product integration process***
18759 ***and the work products and services of the process to the***
18760 ***applicable requirements, objectives, and standards, and address***
18761 ***noncompliance.*** [GP113]

18762

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

18763

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

18764

18765 VERIFICATION

18766 Maturity Level 3

18767 The purpose of Verification is to assure that selected work products
18768 meet their specified requirements. [PA150]

18769 Specific and Generic Goals

18770 **SG 1 Prepare for Verification**

18771 *Preparation for verification is conducted.* [PA150.IG101]

18772 **SG 2 Perform Peer Reviews**

18773 *Peer reviews are performed on selected work products.* [PA150.IG102]

18774 **SG 3 Verify Selected Work Products**

18775 *Selected work products are verified against their specified requirements.*
18776 [PA150.IG103]

18777 **GG 3 Institutionalize a Defined Process**

18778 *The process is institutionalized as a defined process.* [CL104.GL101]

18779 Practices by Goal:

18780 **SG 1 Prepare for Verification**

18781 *Preparation for verification is conducted.* [PA150.IG101]

18782 **SP 1.1 Establish a Verification Strategy**

18783 *Establish and maintain a verification strategy for selected work*
18784 *products.* [PA150.IG101.SP101]

18785 **SP 1.2 Establish the Verification Environment**

18786 *Establish and maintain the environment needed to support*
18787 *verification.* [PA150.IG101.SP102]

18788	SP 1.3	Establish Detailed Verification Plans
18789		<i>Establish and maintain detailed verification plans for selected</i>
18790		<i>work products.</i> [PA150.IG101.SP103]
18791	SG 2	Perform Peer Reviews
18792		<i>Peer reviews are performed on selected work products.</i> [PA150.IG102]
18793	SP 2.1	Prepare for Peer Reviews
18794		<i>Prepare for peer reviews of selected work products.</i> [PA150.IG102.SP101]
18795	SP 2.2	Conduct Peer Reviews
18796		<i>Conduct peer reviews on selected work products and identify</i>
18797		<i>issues resulting from the peer review.</i> [PA150.IG102.SP102]
18798	SP 2.3	Analyze Peer Review Data
18799		<i>Analyze data about preparation, conduct, and results of the peer</i>
18800		<i>reviews.</i> [PA150.IG102.SP103]
18801	SG 3	Verify Selected Work Products
18802		<i>Selected work products are verified against their specified requirements.</i>
18803		[PA150.IG103]
18804	SP 3.1	Perform Verification
18805		<i>Perform verification according to the verification strategy.</i>
18806		[PA150.IG103.SP101]
18807	SP 3.2	Analyze Verification Results and Identify Corrective Action
18808		<i>Analyze the results of all verification activities and identify</i>
18809		<i>corrective action.</i> [PA150.IG103.SP102]
18810	SP 3.3	Perform Re-Verification
18811		<i>Perform re-verification of corrected work products and ensure that</i>
18812		<i>work products have not been negatively impacted.</i> [PA150.IG103.SP103]

18813 **GG 3 Institutionalize a Defined Process**

18814 ***The process is institutionalized as a defined process.*** [CL104.GL101]

18815 Commitment to Perform

18816 **GP 2.1 (CO 1) Establish an Organizational Policy**

18817 ***Establish and maintain an organizational policy for planning and***
18818 ***performing the verification process.*** [GP103]

18819 Ability to Perform

18820 **GP 3.1 (AB 1) Establish a Defined Process**

18821 ***Establish and maintain the description of a defined verification***
18822 ***process.*** [GP114]

18823 **GP 2.2 (AB 2) Plan the Process**

18824 ***Establish and maintain the requirements and objectives, and plans***
18825 ***for performing the verification process.*** [GP104]

18826 **GP 2.3 (AB 3) Provide Resources**

18827 ***Provide adequate resources for performing the verification***
18828 ***process, developing the work products and providing the services***
18829 ***of the process.*** [GP105]

18830 **GP 2.4 (AB 4) Assign Responsibility**

18831 ***Assign responsibility and authority for performing the process,***
18832 ***developing the work products, and providing the services of the***
18833 ***verification process.*** [GP106]

18834 **GP 2.5 (AB 5) Train People**

18835 ***Train the people performing or supporting the verification process***
18836 ***as needed.*** [GP107]

18862 VALIDATION

18863 Maturity Level 3

18864 The purpose of Validation is to demonstrate that a product or product
18865 component fulfills its intended use when placed in its intended
18866 environment. [PA149]

18867 Specific and Generic Goals

18868 **SG 1 Prepare for Validation**

18869 ***Preparation for validation is conducted.*** [PA149.IG101]

18870 **SG 2 Validate Product or Product Components**

18871 ***The product or product components are validated to ensure that they are***
18872 ***suitable for use in their intended operating environment.*** [PA149.IG102]

18873 **GG 3 Institutionalize a Defined Process**

18874 ***The process is institutionalized as a defined process.*** [CL104.GL101]

18875 Practices by Goal:

18876 **SG 1 Prepare for Validation**

18877 ***Preparation for validation is conducted.*** [PA149.IG101]

18878 **SP 1.1 Establish a Validation Strategy**

18879 ***Establish and maintain a validation strategy.*** [PA149.IG101.SP101]

18880 **SP 1.2 Establish the Validation Environment**

18881 ***Establish and maintain the environment needed to support***
18882 ***validation.*** [PA149.IG101.SP102]

18883 **SP 1.3 Define Detailed Validation Procedures**

18884 ***Define detailed procedures and criteria for validation.*** [PA149.IG101.SP103]

18885 **SG 2** **Validate Product or Product Components**

18886 *The product or product components are validated to ensure that they are*
18887 *suitable for use in their intended operating environment.* [PA149.IG102]

18888 **SP 2.1** **Perform Validation**

18889 *Perform validation according to the validation strategy.*
18890 [PA149.IG102.SP101]

18891 **SP 2.2** **Capture and Analyze Validation Results**

18892 *Capture and analyze the results of the validation activities and*
18893 *identify issues.* [PA149.IG102.SP102]

18894 **GG 3** **Institutionalize a Defined Process**

18895 *The process is institutionalized as a defined process.* [CL104.GL101]

18896 Commitment to Perform

18897 **GP 2.1** **(CO 1)** **Establish an Organizational Policy**

18898 *Establish and maintain an organizational policy for planning and*
18899 *performing the validation process.* [GP103]

18900 Ability to Perform

18901 **GP 3.1** **(AB 1)** **Establish a Defined Process**

18902 *Establish and maintain the description of a defined validation*
18903 *process.* [GP114]

18904 **GP 2.2** **(AB 2)** **Plan the Process**

18905 *Establish and maintain the requirements and objectives, and plans*
18906 *for performing the validation process.* [GP104]

18907 **GP 2.3 (AB 3) Provide Resources**
18908 *Provide adequate resources for performing the validation process,*
18909 *developing the work products and providing the services of the*
18910 *process.* [GP105]

18911 **GP 2.4 (AB 4) Assign Responsibility**
18912 *Assign responsibility and authority for performing the process,*
18913 *developing the work products, and providing the services of the*
18914 *validation process.* [GP106]

18915 **GP 2.5 (AB 5) Train People**
18916 *Train the people performing or supporting the validation process*
18917 *as needed.* [GP107]

18918 Directing Implementation

18919 **GP 2.6 (DI 1) Manage Configurations**
18920 *Place designated work products of the validation process under*
18921 *appropriate levels of configuration management.* [GP109]

18922 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**
18923 *Identify and involve the relevant stakeholders of the validation*
18924 *process as planned.* [GP124]

18925 **GP 2.8 (DI 3) Monitor and Control the Process**
18926 *Monitor and control the validation process against the plan and*
18927 *take appropriate corrective action.* [GP110]

18928 **GP 3.2 (DI 4) Collect Improvement Information**
18929 *Collect work products, measures, measurement results, and*
18930 *improvement information derived from planning and performing*
18931 *the validation process to support the future use and improvement*
18932 *of the organization's processes and process assets.* [GP117]

18933 Verifying Implementation

18934 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

18935 *Objectively evaluate adherence of the validation process and the*
18936 *work products and services of the process to the applicable*
18937 *requirements, objectives, and standards, and address*
18938 *noncompliance.* [GP113]

18939 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

18940 *Review the activities, status, and results of the validation process*
18941 *with higher-level management and resolve issues.* [GP112]

18942 ORGANIZATIONAL PROCESS FOCUS

18943 Maturity Level 3

18944 The purpose of Organizational Process Focus is to establish and
18945 maintain an understanding of the organization's processes and process
18946 assets, and to identify, plan, and implement the organization's process
18947 improvement activities. [PA152]

18948 Specific and Generic Goals

18949 **SG 1 Determine Process Improvement Opportunities**

18950 ***Strengths, weaknesses, and improvement opportunities for the organization's***
18951 ***processes are identified periodically and as needed.*** [PA152.IG101]

18952 **SG 2 Plan and Implement Process Improvement Activities**

18953 ***Improvements are planned and implemented, process assets are deployed,***
18954 ***and process-related experiences are incorporated into the organization's***
18955 ***process assets.*** [PA152.IG102]

18956 **GG 3 Institutionalize a Defined Process**

18957 ***The process is institutionalized as a defined process.*** [CL104.GL101]

18958 Practices by Goal:

18959 **SG 1 Determine Process Improvement Opportunities**

18960 ***Strengths, weaknesses, and improvement opportunities for the organization's***
18961 ***processes are identified periodically and as needed.*** [PA152.IG101]

18962 **SP 1.1 Establish Organizational Process Needs**

18963 ***Establish and maintain the description of the process needs and***
18964 ***objectives for the organization.*** [PA152.IG101.SP101]

18965 **SP 1.2 Assess the Organization's Processes**

18966 ***Assess the processes of the organization periodically and as***
18967 ***needed to maintain an understanding of their strengths and***
18968 ***weaknesses.*** [PA152.IG101.SP102]

18969	SP 1.3	Identify the Organization's Process Improvements
18970		<i>Identify improvements to the organization's processes and related process assets. [PA152.IG101.SP103]</i>
18971		
18972	SG 2	Plan and Implement Process Improvement Activities
18973		<i>Improvements are planned and implemented, process assets are deployed, and process-related experiences are incorporated into the organization's process assets. [PA152.IG102]</i>
18974		
18975		
18976	SP 2.1	Establish Process Action Plans
18977		<i>Establish and maintain process action plans to address improvements to the organization's processes and related process assets. [PA152.IG102.SP101]</i>
18978		
18979		
18980	SP 2.2	Implement Process Action Plans
18981		<i>Implement process action plans across the organization. [PA152.IG102.SP102]</i>
18982		
18983	SP 2.3	Deploy Process and Related Process Assets
18984		<i>Deploy the process and related process assets across the organization. [PA152.IG102.SP103]</i>
18985		
18986	SP 2.4	Incorporate Process-Related Experiences into the Organization's Process Assets
18987		<i>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]</i>
18988		
18989		
18990		
18991	GG 3	Institutionalize a Defined Process
18992		<i>The process is institutionalized as a defined process. [CL104.GL101]</i>

18993 Commitment to Perform

18994 **GP 2.1 (CO 1) Establish an Organizational Policy**

18995 *Establish and maintain an organizational policy for planning and*
18996 *performing the organizational process focus process. [GP103]*

18997 Ability to Perform

18998 **GP 3.1 (AB 1) Establish a Defined Process**

18999 *Establish and maintain the description of a defined organizational*
19000 *process focus process. [GP114]*

19001 **GP 2.2 (AB 2) Plan the Process**

19002 *Establish and maintain the requirements and objectives, and plans*
19003 *for performing the organizational process focus process. [GP104]*

19004 **GP 2.3 (AB 3) Provide Resources**

19005 *Provide adequate resources for performing the organizational*
19006 *process focus process, developing the work products and*
19007 *providing the services of the process. [GP105]*

19008 **GP 2.4 (AB 4) Assign Responsibility**

19009 *Assign responsibility and authority for performing the process,*
19010 *developing the work products, and providing the services of the*
19011 *organizational process focus process. [GP106]*

19012 **GP 2.5 (AB 5) Train People**

19013 *Train the people performing or supporting the organizational*
19014 *process focus process as needed. [GP107]*

19015 Directing Implementation

19016	GP 2.6	(DI 1)	Manage Configurations
19017			<i>Place designated work products of the organizational process focus process under appropriate levels of configuration management.</i> [GP109]
19018			
19019			
19020	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
19021			<i>Identify and involve the relevant stakeholders of the organizational process focus process as planned.</i> [GP124]
19022			
19023	GP 2.8	(DI 3)	Monitor and Control the Process
19024			<i>Monitor and control the organizational process focus process against the plan and take appropriate corrective action.</i> [GP110]
19025			
19026	GP 3.2	(DI 4)	Collect Improvement Information
19027			<i>Collect work products, measures, measurement results, and improvement information derived from planning and performing the organizational process focus process to support the future use and improvement of the organization's processes and process assets.</i> [GP117]
19028			
19029			
19030			
19031			

19032 Verifying Implementation

19033	GP 2.9	(VE 1)	Objectively Evaluate Adherence
19034			<i>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.</i> [GP113]
19035			
19036			
19037			
19038	GP 2.10	(VE 2)	Review Status with Higher-Level Management
19039			<i>Review the activities, status, and results of the organizational process focus process with higher-level management and resolve issues.</i> [GP112]
19040			
19041			

19042 ORGANIZATIONAL PROCESS DEFINITION

19043 Maturity Level 3

19044 The purpose of Organizational Process Definition is to establish and
19045 maintain a usable set of organizational process assets. [PA153]

19046 Specific and Generic Goals

19047 **SG 1 Create Organizational Process Assets**

19048 *A set of organizational process assets is available.* [PA153.IG101]

19049 **SG 2 Make Supporting Process Assets Available**

19050 *Process assets that support the use of the organization's set of standard*
19051 *processes are available.* [PA153.IG102]

19052 **GG 3 Institutionalize a Defined Process**

19053 *The process is institutionalized as a defined process.* [CL104.GL101]

19054 Practices by Goal:

19055 **SG 1 Create Organizational Process Assets**

19056 *A set of organizational process assets is available.* [PA153.IG101]

19057 **SP 1.1 Establish Standard Processes**

19058 *Establish and maintain the organization's set of standard*
19059 *processes.* [PA153.IG101.SP101]

19060 **SP 1.2 Establish Life-Cycle Model Descriptions**

19061 *Establish and maintain descriptions of the life-cycle process*
19062 *models approved for use in the organization.* [PA153.IG101.SP102]

19063 **SP 1.3 Establish Tailoring Criteria and Guidelines**

19064 *Establish and maintain the tailoring criteria and guidelines for the*
19065 *organization's set of standard processes.* [PA153.IG101.SP103]

19066 **SG 2 Make Supporting Process Assets Available**

19067 *Process assets that support the use of the organization's set of standard*
19068 *processes are available.* [PA153.IG102]

19069 **SP 2.1 Establish an Organizational Measurement Repository**

19070 *Establish and maintain an organizational measurement repository*
19071 [PA153.IG102.SP101]

19072 **SP 2.2 Establish an Organizational Process Asset Library**

19073 *Establish and maintain the organization's library of process-*
19074 *related assets.* [PA153.IG102.SP102]

19075 **GG 3 Institutionalize a Defined Process**

19076 *The process is institutionalized as a defined process.* [CL104.GL101]

19077 Commitment to Perform

19078 **GP 2.1 (CO 1) Establish an Organizational Policy**

19079 *Establish and maintain an organizational policy for planning and*
19080 *performing the organizational process definition process.* [GP103]

19081 Ability to Perform

19082 **GP 3.1 (AB 1) Establish a Defined Process**

19083 *Establish and maintain the description of a defined organizational*
19084 *process definition process.* [GP114]

19085 **GP 2.2 (AB 2) Plan the Process**

19086 *Establish and maintain the requirements and objectives, and plans*
19087 *for performing the organizational process definition process.* [GP104]

19088 **GP 2.3 (AB 3) Provide Resources**
19089 *Provide adequate resources for performing the organizational*
19090 *process definition process, developing the work products and*
19091 *providing the services of the process. [GP105]*

19092 **GP 2.4 (AB 4) Assign Responsibility**
19093 *Assign responsibility and authority for performing the process,*
19094 *developing the work products, and providing the services of the*
19095 *organizational process definition process. [GP106]*

19096 **GP 2.5 (AB 5) Train People**
19097 *Train the people performing or supporting the organizational*
19098 *process definition process as needed. [GP107]*

19099 **Directing Implementation**

19100 **GP 2.6 (DI 1) Manage Configurations**
19101 *Place designated work products of the organizational process*
19102 *definition process under appropriate levels of configuration*
19103 *management. [GP109]*

19104 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**
19105 *Identify and involve the relevant stakeholders of the organizational*
19106 *process definition process as planned. [GP124]*

19107 **GP 2.8 (DI 3) Monitor and Control the Process**
19108 *Monitor and control the organizational process definition process*
19109 *against the plan and take appropriate corrective action. [GP110]*

19110 **GP 3.2 (DI 4) Collect Improvement Information**
19111 *Collect work products, measures, measurement results, and*
19112 *improvement information derived from planning and performing*
19113 *the organizational process definition process to support the future*
19114 *use and improvement of the organization's processes and process*
19115 *assets. [GP117]*

19116 Verifying Implementation

19117 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

19118 *Objectively evaluate adherence of the organizational process*
19119 *definition process and the work products and services of the*
19120 *process to the applicable requirements, objectives, and standards,*
19121 *and address noncompliance. [GP113]*

19122 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

19123 *Review the activities, status, and results of the organizational*
19124 *process definition process with higher-level management and*
19125 *resolve issues. [GP112]*

19126 ORGANIZATIONAL TRAINING

19127 Maturity Level 3

19128 The purpose of Organizational Training is to develop the skills and
19129 knowledge of people so they can perform their roles effectively and
19130 efficiently. [PA158]

19131 Specific and Generic Goals

19132 **SG 1 Identify Training Needs and Make Training Available**

19133 *Training to support the organization's management and technical roles is*
19134 *identified and made available.* [PA158.IG101]

19135 **SG 2 Provide Necessary Training**

19136 *Training necessary for individuals to perform their roles effectively is*
19137 *provided.* [PA158.IG102]

19138 **GG 3 Institutionalize a Defined Process**

19139 *The process is institutionalized as a defined process.* [CL104.GL101]

19140 Practices by Goal:

19141 **SG 1 Identify Training Needs and Make Training Available**

19142 *Training to support the organization's management and technical roles is*
19143 *identified and made available.* [PA158.IG101]

19144 **SP 1.1 Establish the Strategic Training needs**

19145 *Establish and maintain the strategic training needs of the*
19146 *organization.* [PA158.IG101.SP101]

19147 **SP 1.2 Determine Which Training Needs Are the Responsibility of the Or-**
19148 **ganization**

19149 *Determine which training needs are the responsibility of the*
19150 *organization and which will be left to the individual project or*
19151 *support group.* [PA158.IG101.SP102]

19152 **SP 1.3 Establish Organizational Training Tactical Plan**
19153 *Establish and maintain an organizational training tactical plan.*
19154 [PA158.IG101.SP103]

19155 **SP 1.4 Establish Training Capability**
19156 *Establish and maintain training capability to address*
19157 *organizational training needs.* [PA158.IG101.SP104]

19158 **SG 2 Provide Necessary Training**

19159 *Training necessary for individuals to perform their roles effectively is*
19160 *provided.* [PA158.IG102]

19161 **SP 2.1 Deliver Training**
19162 *Deliver the training following an organizational training plan.*
19163 [PA158.IG102.SP101]

19164 **SP 2.2 Establish Training Records**
19165 *Establish and maintain records of the organizational training.*
19166 [PA158.IG102.SP102]

19167 **SP 2.3 Assess Training Effectiveness**
19168 *Assess the effectiveness of the organization's training program.*
19169 [PA158.IG102.SP103]

19170 **GG 3 Institutionalize a Defined Process**

19171 *The process is institutionalized as a defined process.* [CL104.GL101]

19172 Commitment to Perform

19173 **GP 2.1 (CO 1) Establish an Organizational Policy**
19174 *Establish and maintain an organizational policy for planning and*
19175 *performing the organizational training process.* [GP103]

19176 Ability to Perform

19177 **GP 3.1 (AB 1) Establish a Defined Process**

19178 *Establish and maintain the description of a defined organizational*
19179 *training process. [GP114]*

19180 **GP 2.2 (AB 2) Plan the Process**

19181 *Establish and maintain the requirements and objectives, and plans*
19182 *for performing the organizational training process. [GP104]*

19183 **GP 2.3 (AB 3) Provide Resources**

19184 *Provide adequate resources for performing the organizational*
19185 *training process, developing the work products and providing the*
19186 *services of the process. [GP105]*

19187 **GP 2.4 (AB 4) Assign Responsibility**

19188 *Assign responsibility and authority for performing the process,*
19189 *developing the work products, and providing the services of the*
19190 *organizational training process. [GP106]*

19191 **GP 2.5 (AB 5) Train People**

19192 *Train the people performing or supporting the organizational*
19193 *training process as needed. [GP107]*

19194 Directing Implementation

19195 **GP 2.6 (DI 1) Manage Configurations**

19196 *Place designated work products of the organizational training*
19197 *process under appropriate levels of configuration management.*
19198 *[GP109]*

19199 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**

19200 *Identify and involve the relevant stakeholders of the organizational*
19201 *training process as planned. [GP124]*

19202 **GP 2.8 (DI 3) Monitor and Control the Process**
19203 ***Monitor and control the organizational training process against the***
19204 ***plan and take appropriate corrective action. [GP110]***

19205 **GP 3.2 (DI 4) Collect Improvement Information**
19206 ***Collect work products, measures, measurement results, and***
19207 ***improvement information derived from planning and performing***
19208 ***the organizational training process to support the future use and***
19209 ***improvement of the organization's processes and process assets.***
19210 ***[GP117]***

19211 Verifying Implementation

19212 **GP 2.9 (VE 1) Objectively Evaluate Adherence**
19213 ***Objectively evaluate adherence of the organizational training***
19214 ***process and the work products and services of the process to the***
19215 ***applicable requirements, objectives, and standards, and address***
19216 ***noncompliance. [GP113]***

19217 **GP 2.10 (VE 2) Review Status with Higher-Level Management**
19218 ***Review the activities, status, and results of the organizational***
19219 ***training process with higher-level management and resolve***
19220 ***issues. [GP112]***

19221 INTEGRATED PROJECT MANAGEMENT (IPPD)

19222 Maturity Level 3

19223 The purpose of Integrated Project Management (IPPD) is to establish
19224 and manage the project and the involvement of the relevant
19225 stakeholders according to an integrated and defined process that is
19226 tailored from the organization's set of standard processes. It also covers
19227 the establishment of a shared vision for the project and a team structure
19228 for integrated teams that will carry out the objectives of the project .

19229 [PA167]

19230 Specific and Generic Goals

19231 **SG 1 Use the Project's Defined Process**

19232 *The project is conducted using a defined process that is tailored from the*
19233 *organization's set of standard processes.* [PA167.IG101]

19234 **SG 2 Coordinate and Collaborate with Relevant Stakeholders**

19235 *Coordination and collaboration of the project with relevant stakeholders is*
19236 *conducted.* [PA167.IG102]

19237 **SG 3 Use the Project's Shared Vision**

19238 *The project is conducted using the project's shared vision.* [PA167.IG103]

19239 **SG 4 Organize Integrated Teams**

19240 *The integrated teams needed to execute the project are identified, defined,*
19241 *structured, and tasked.* [PA167.IG104]

19242 **GG 3 Institutionalize a Defined Process**

19243 *The process is institutionalized as a defined process.* [CL104.GL101]

19244 Practices by Goal:

19245 **SG 1 Use the Project's Defined Process**

19246 *The project is conducted using a defined process that is tailored from the*
19247 *organization's set of standard processes.* [PA167.IG101]

19248	SP 1.1	Establish the Project's Defined Process
19249		<i>Establish and maintain the project's defined process.</i> [PA167.IG101.SP101]
19250	SP 1.2	Use Organizational Process Assets for Planning Project Activities
19251		<i>Use the organization's process assets and measurement repository for estimating and planning the project's activities.</i>
19252		
19253		[PA167.IG101.SP102]
19254	SP 1.3	Integrate Plans
19255		<i>Integrate the project plan and the subordinate plans to describe the project's defined process.</i> [PA167.IG101.SP103]
19256		
19257	SP 1.4	Manage the Project Using the Integrated Plans
19258		<i>Manage the project using the project plan, the subordinate plans, and the project's defined process.</i> [PA167.IG101.SP104]
19259		
19260	SP 1.5	Contribute to the Organization's Process Assets
19261		<i>Contribute work products, measures, and documented experiences to the organization's process assets.</i> [PA167.IG101.SP105]
19262		
19263	SG 2	Coordinate and Collaborate with Relevant Stakeholders
19264		<i>Coordination and collaboration of the project with relevant stakeholders is conducted.</i> [PA167.IG102]
19265		
19266	SP 2.1	Manage Stakeholder Involvement
19267		<i>Manage the involvement of the relevant stakeholders in the project.</i> [PA167.IG102.SP101]
19268		
19269	SP 2.2	Manage Dependencies
19270		<i>Participate with relevant stakeholders to identify, negotiate, and track critical dependencies.</i> [PA167.IG102.SP102]
19271		
19272	SP 2.3	Resolve Coordination Issues
19273		<i>Resolve issues with relevant stakeholders.</i> [PA167.IG102.SP103]

19274 **SG 3 Use the Project's Shared Vision**

19275 ***The project is conducted using the project's shared vision.*** [PA167.IG103]

19276 **SP 3.1 Define Project's Shared Vision Context**

19277 ***Identify expectations, constraints, interfaces, and operational***
19278 ***conditions applicable to the project's shared vision.*** [PA167.IG103.SP101]

19279 **SP 3.2 Establish the Project's Shared Vision**

19280 ***Establish and maintain a shared vision for the project.*** [PA167.IG103.SP102]

19281 **SG 4 Organize Integrated Teams**

19282 ***The integrated teams needed to execute the project are identified, defined,***
19283 ***structured, and tasked.*** [PA167.IG104]

19284 **SP 4.1 Determine Integrated Team Structure for the Project**

19285 ***Determine the integrated team structure that will best meet the***
19286 ***project objectives and constraints.*** [PA167.IG104.SP101]

19287 **SP 4.2 Develop a Preliminary Distribution of Requirements to Integrated**
19288 ***Teams***

19289 ***Develop a preliminary distribution of requirements,***
19290 ***responsibilities, authorities, tasks, and interfaces to teams in the***
19291 ***selected integrated team structure.*** [PA167.IG104.SP102]

19292 **SP 4.3 Establish Integrated Teams**

19293 ***Establish and maintain teams in the integrated team structure.***
19294 [PA167.IG104.SP103]

19295 **GG 3 Institutionalize a Defined Process**

19296 ***The process is institutionalized as a defined process.*** [CL104.GL101]

19297 Commitment to Perform

19298 **GP 2.1 (CO 1) Establish an Organizational Policy**

19299 *Establish and maintain an organizational policy for planning and*
19300 *performing the integrated project management (IPPD) process.*

19301 [GP103]

19302 Ability to Perform

19303 **GP 3.1 (AB 1) Establish a Defined Process**

19304 *Establish and maintain the description of a defined integrated*
19305 *project management (IPPD) process. [GP114]*

19306 **GP 2.2 (AB 2) Plan the Process**

19307 *Establish and maintain the requirements and objectives, and plans*
19308 *for performing the integrated project management (IPPD) process.*

19309 [GP104]

19310 **GP 2.3 (AB 3) Provide Resources**

19311 *Provide adequate resources for performing the integrated project*
19312 *management (IPPD) process, developing the work products and*
19313 *providing the services of the process. [GP105]*

19314 **GP 2.4 (AB 4) Assign Responsibility**

19315 *Assign responsibility and authority for performing the process,*
19316 *developing the work products, and providing the services of the*
19317 *integrated project management (IPPD) process. [GP106]*

19318 **GP 2.5 (AB 5) Train People**

19319 *Train the people performing or supporting the integrated project*
19320 *management (IPPD) process as needed. [GP107]*

19321 Directing Implementation

19322	GP 2.6	(DI 1)	Manage Configurations	<i>Place designated work products of the integrated project management (IPPD) process under appropriate levels of configuration management. [GP109]</i>
19323				
19324				
19325				
19326	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders	<i>Identify and involve the relevant stakeholders of the integrated project management (IPPD) process as planned. [GP124]</i>
19327				
19328				
19329	GP 2.8	(DI 3)	Monitor and Control the Process	<i>Monitor and control the integrated project management (IPPD) process against the plan and take appropriate corrective action. [GP110]</i>
19330				
19331				
19332				
19333	GP 3.2	(DI 4)	Collect Improvement Information	<i>Collect work products, measures, measurement results, and improvement information derived from planning and performing the integrated project management (IPPD) process to support the future use and improvement of the organization's processes and process assets. [GP117]</i>
19334				
19335				
19336				
19337				
19338				

19339 Verifying Implementation

19340	GP 2.9	(VE 1)	Objectively Evaluate Adherence	<i>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]</i>
19341				
19342				
19343				
19344	GP 2.10	(VE 2)	Review Status with Higher-Level Management	<i>Review the activities, status, and results of the integrated project management (IPPD) process with higher-level management and resolve issues. [GP112]</i>
19345				
19346				
19347				
19348				

19349 RISK MANAGEMENT

19350 Maturity Level 3

19351 The purpose of Risk Management is to identify potential problems
19352 before they occur, so that risk-handling activities may be planned and
19353 invoked as needed across the life cycle to mitigate adverse impacts on
19354 achieving objectives. [PA148]

19355 Specific and Generic Goals

19356 **SG 1 Prepare for Risk Management**

19357 *Preparation for risk management is conducted.* [PA148.IG101]

19358 **SG 2 Identify and Analyze Risks**

19359 *Risks are identified and analyzed to determine their relative importance.*
19360 [PA148.IG102]

19361 **SG 3 Mitigate Risks**

19362 *Risks are handled and mitigated, where appropriate, to reduce adverse*
19363 *impacts on achieving objectives.* [PA148.IG103]

19364 **GG 3 Institutionalize a Defined Process**

19365 *The process is institutionalized as a defined process.* [CL104.GL101]

19366 Practices by Goal:

19367 **SG 1 Prepare for Risk Management**

19368 *Preparation for risk management is conducted.* [PA148.IG101]

19369 **SP 1.1 Determine Risk Sources and Categories**

19370 *Determine risk sources and categories.* [PA148.IG101.SP101]

19371 **SP 1.2 Define Risk Parameters**

19372 *Define the parameters used to analyze and classify risks, and the*
19373 *parameters used to control the risk management effort.*

19374 [PA148.IG101.SP102]

19375 **SP 1.3 Establish a Risk Management Strategy**
19376 ***Establish and maintain the strategy and methods to be used for***
19377 ***risk management.*** [PA148.IG101.SP103]

19378 **SG 2 Identify and Analyze Risks**

19379 ***Risks are identified and analyzed to determine their relative importance.***
19380 [PA148.IG102]

19381 **SP 2.1 Identify Risks**
19382 ***Identify and document the risks.*** [PA148.IG102.SP101]

19383 **SP 2.2 Evaluate, Classify, and Prioritize Risks**
19384 ***Evaluate and classify each identified risk using the defined risk***
19385 ***categories and parameters, and determine its relative priority.***
19386 [PA148.IG102.SP102]

19387 **SG 3 Mitigate Risks**

19388 ***Risks are handled and mitigated, where appropriate, to reduce adverse***
19389 ***impacts on achieving objectives.*** [PA148.IG103]

19390 **SP 3.1 Develop Risk Mitigation Plans**
19391 ***Develop a risk mitigation plan for the most important risks to the***
19392 ***project, as defined by the risk management strategy.*** [PA148.IG103.SP101]

19393 **SP 3.2 Implement Risk Mitigation Plans**
19394 ***Monitor the status of each risk periodically and implement the risk***
19395 ***mitigation plan as appropriate.*** [PA148.IG103.SP102]

19396 **GG 3 Institutionalize a Defined Process**

19397 ***The process is institutionalized as a defined process.*** [CL104.GL101]

19420 Directing Implementation

19421 **GP 2.6 (DI 1) Manage Configurations**
 19422 *Place designated work products of the risk management process*
 19423 *under appropriate levels of configuration management. [GP109]*

19424 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**
 19425 *Identify and involve the relevant stakeholders of the risk*
 19426 *management process as planned. [GP124]*

19427 **GP 2.8 (DI 3) Monitor and Control the Process**
 19428 *Monitor and control the risk management process against the plan*
 19429 *and take appropriate corrective action. [GP110]*

19430 **GP 3.2 (DI 4) Collect Improvement Information**
 19431 *Collect work products, measures, measurement results, and*
 19432 *improvement information derived from planning and performing*
 19433 *the risk management process to support the future use and*
 19434 *improvement of the organization's processes and process assets.*
 19435 *[GP117]*

19436 Verifying Implementation

19437 **GP 2.9 (VE 1) Objectively Evaluate Adherence**
 19438 *Objectively evaluate adherence of the risk management process*
 19439 *and the work products and services of the process to the*
 19440 *applicable requirements, objectives, and standards, and address*
 19441 *noncompliance. [GP113]*

19442 **GP 2.10 (VE 2) Review Status with Higher-Level Management**
 19443 *Review the activities, status, and results of the risk management*
 19444 *process with higher-level management and resolve issues. [GP112]*

19445 INTEGRATED TEAMING

19446 Maturity Level 3

19447 The purpose of Integrated Teaming is to form and sustain an integrated
19448 team for the development of work products. [PA170]

19449 Specific and Generic Goals

19450 **SG 1 Establish Team Composition**

19451 *Team composition that provides the knowledge and skills required to deliver*
19452 *the team's product is established and maintained.* [PA170.IG101]

19453 **SG 2 Govern Team Operation**

19454 *Operation of the integrated team is governed according to established*
19455 *principles.* [PA170.IG102]

19456 **GG 3 Institutionalize a Defined Process**

19457 *The process is institutionalized as a defined process.* [CL104.GL101]

19458 Practices by Goal:

19459 **SG 1 Establish Team Composition**

19460 *Team composition that provides the knowledge and skills required to deliver*
19461 *the team's product is established and maintained.* [PA170.IG101]

19462 **SP 1.1 Identify Team Tasks**

19463 *Identify and define the team's specific internal tasks to generate*
19464 *the team's expected output.* [PA170.IG101.SP101]

19465 **SP 1.2 Identify Needed Knowledge and Skills**

19466 *Identify the knowledge, skills, and functional expertise needed to*
19467 *perform team tasks.* [PA170.IG101.SP102]

19468 **SP 1.3 Assign Appropriate Team Members**

19469 *Assign the appropriate personnel to be team members based on*
19470 *required knowledge and skills.* [PA170.IG101.SP103]

19471 **SG 2 Govern Team Operation**

19472 ***Operation of the integrated team is governed according to established***
19473 ***principles.*** [PA170.IG102]

19474 **SP 2.1 Establish a Shared Vision**

19475 ***Establish and maintain a shared vision for the integrated team that***
19476 ***is aligned with any overarching or higher-level vision.***
19477 [PA170.IG102.SP101]

19478 **SP 2.2 Establish a Team Charter**

19479 ***Establish and maintain a team charter based on the integrated***
19480 ***team's shared vision and overall team objectives.*** [PA170.IG102.SP102]

19481 **SP 2.3 Define Roles and Responsibilities**

19482 ***Clearly define and maintain each team member's roles and***
19483 ***responsibilities.*** [PA170.IG102.SP103]

19484 **SP 2.4 Establish Operating Procedures**

19485 ***Establish and maintain integrated team operating procedures.***
19486 [PA170.IG102.SP104]

19487 **SP 2.5 Collaborate among Interfacing Teams**

19488 ***Establish and maintain collaboration among interfacing teams.***
19489 [PA170.IG102.SP105]

19490 **GG 3 Institutionalize a Defined Process**

19491 ***The process is institutionalized as a defined process.*** [CL104.GL101]

19492 **Commitment to Perform**

19493 **GP 2.1 (CO 1) Establish an Organizational Policy**

19494 ***Establish and maintain an organizational policy for planning and***
19495 ***performing the integrated teaming process.*** [GP103]

19496 Ability to Perform

19497 **GP 3.1 (AB 1) Establish a Defined Process**
 19498 *Establish and maintain the description of a defined integrated*
 19499 *teaming process. [GP114]*

19500 **GP 2.2 (AB 2) Plan the Process**
 19501 *Establish and maintain the requirements and objectives, and plans*
 19502 *for performing the integrated teaming process. [GP104]*

19503 **GP 2.3 (AB 3) Provide Resources**
 19504 *Provide adequate resources for performing the integrated teaming*
 19505 *process, developing the work products and providing the services*
 19506 *of the process. [GP105]*

19507 **GP 2.4 (AB 4) Assign Responsibility**
 19508 *Assign responsibility and authority for performing the process,*
 19509 *developing the work products, and providing the services of the*
 19510 *integrated teaming process. [GP106]*

19511 **GP 2.5 (AB 5) Train People**
 19512 *Train the people performing or supporting the integrated teaming*
 19513 *process as needed. [GP107]*

19514 Directing Implementation

19515 **GP 2.6 (DI 1) Manage Configurations**
 19516 *Place designated work products of the integrated teaming process*
 19517 *under appropriate levels of configuration management. [GP109]*

19518 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**
 19519 *Identify and involve the relevant stakeholders of the integrated*
 19520 *teaming process as planned. [GP124]*

19521 **GP 2.8** **(DI 3)** **Monitor and Control the Process**
19522 *Monitor and control the integrated teaming process against the*
19523 *plan and take appropriate corrective action.* [GP110]

19524 **GP 3.2** **(DI 4)** **Collect Improvement Information**
19525 *Collect work products, measures, measurement results, and*
19526 *improvement information derived from planning and performing*
19527 *the integrated teaming process to support the future use and*
19528 *improvement of the organization's processes and process assets.*
19529 [GP117]

19530 Verifying Implementation

19531 **GP 2.9** **(VE 1)** **Objectively Evaluate Adherence**
19532 *Objectively evaluate adherence of the integrated teaming process*
19533 *and the work products and services of the process to the*
19534 *applicable requirements, objectives, and standards, and address*
19535 *noncompliance.* [GP113]

19536 **GP 2.10** **(VE 2)** **Review Status with Higher-Level Management**
19537 *Review the activities, status, and results of the integrated teaming*
19538 *process with higher-level management and resolve issues.* [GP112]

19539 DECISION ANALYSIS AND RESOLUTION

19540 Maturity Level 3

19541 The purpose of Decision Analysis and Resolution is to make decisions
19542 using a structured approach that evaluates identified alternatives
19543 against established criteria. [PA156]

19544 Specific and Generic Goals

19545 **SG 1 Evaluate Alternatives**

19546 ***Decisions are based on an evaluation of alternatives using established***
19547 ***criteria.*** [PA156.IG101]

19548 **GG 3 Institutionalize a Defined Process**

19549 ***The process is institutionalized as a defined process.*** [CL104.GL101]

19550 Practices by Goal:

19551 **SG 1 Evaluate Alternatives**

19552 ***Decisions are based on an evaluation of alternatives using established***
19553 ***criteria.*** [PA156.IG101]

19554 **SP 1.1 Establish and Use Guidelines for Decision Analysis**

19555 ***Establish and use guidelines to determine which issues are***
19556 ***subject to a structured decision analysis and resolution process.***

19557 [PA156.IG101.SP101]

19558 **SP 1.2 Select Decision-Making Techniques**

19559 ***Select the decision-making techniques.*** [PA156.IG101.SP102]

19560 **SP 1.3 Establish Evaluation Criteria**

19561 ***Establish the evaluation criteria and their relative ranking.***

19562 [PA156.IG101.SP103]

19563 **SP 1.4 Identify Alternative Solutions**
19564 ***Identify alternative solutions to issues.*** [PA156.IG101.SP104]

19565 **SP 1.5 Evaluate Alternatives**
19566 ***Evaluate alternative solutions using the documented criteria.***
19567 [PA156.IG101.SP105]

19568 **SP 1.6 Select Solutions**
19569 ***Select solutions from the alternatives based on the evaluation***
19570 ***criteria.*** [PA156.IG101.SP106]

19571 **GG 3 Institutionalize a Defined Process**
19572 ***The process is institutionalized as a defined process.*** [CL104.GL101]

19573 Commitment to Perform

19574 **GP 2.1 (CO 1) Establish an Organizational Policy**
19575 ***Establish and maintain an organizational policy for planning and***
19576 ***performing the decision analysis and resolution process.*** [GP103]

19577 Ability to Perform

19578 **GP 3.1 (AB 1) Establish a Defined Process**
19579 ***Establish and maintain the description of a defined decision***
19580 ***analysis and resolution process.*** [GP114]

19581 **GP 2.2 (AB 2) Plan the Process**
19582 ***Establish and maintain the requirements and objectives, and plans***
19583 ***for performing the decision analysis and resolution process.*** [GP104]

19584 **GP 2.3 (AB 3) Provide Resources**
19585 *Provide adequate resources for performing the decision analysis*
19586 *and resolution process, developing the work products and*
19587 *providing the services of the process. [GP105]*

19588 **GP 2.4 (AB 4) Assign Responsibility**
19589 *Assign responsibility and authority for performing the process,*
19590 *developing the work products, and providing the services of the*
19591 *decision analysis and resolution process. [GP106]*

19592 **GP 2.5 (AB 5) Train People**
19593 *Train the people performing or supporting the decision analysis*
19594 *and resolution process as needed. [GP107]*

19595 Directing Implementation

19596 **GP 2.6 (DI 1) Manage Configurations**
19597 *Place designated work products of the decision analysis and*
19598 *resolution process under appropriate levels of configuration*
19599 *management. [GP109]*

19600 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**
19601 *Identify and involve the relevant stakeholders of the decision*
19602 *analysis and resolution process as planned. [GP124]*

19603 **GP 2.8 (DI 3) Monitor and Control the Process**
19604 *Monitor and control the decision analysis and resolution process*
19605 *against the plan and take appropriate corrective action. [GP110]*

19606 **GP 3.2 (DI 4) Collect Improvement Information**
19607 *Collect work products, measures, measurement results, and*
19608 *improvement information derived from planning and performing*
19609 *the decision analysis and resolution process to support the future*
19610 *use and improvement of the organization's processes and process*
19611 *assets. [GP117]*

19612 Verifying Implementation

19613 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

19614 *Objectively evaluate adherence of the decision analysis and*
19615 *resolution process and the work products and services of the*
19616 *process to the applicable requirements, objectives, and standards,*
19617 *and address noncompliance.* [GP113]

19618 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

19619 *Review the activities, status, and results of the decision analysis*
19620 *and resolution process with higher-level management and resolve*
19621 *issues.* [GP112]

19622 ORGANIZATIONAL ENVIRONMENT FOR INTEGRATION

19623 Maturity Level 3

19624 The purpose of Organizational Environment for Integration is to provide
19625 an IPPD infrastructure and manage people for integration. [PA169]

19626 Specific and Generic Goals

19627 **SG 1 Provide IPPD Infrastructure**

19628 *An infrastructure that maximizes the productivity of people and effects the*
19629 *collaboration necessary for integration is provided.* [PA169.IG101]

19630 **SG 2 Manage People for Integration**

19631 *People are managed to nurture the integrative and collaborative behaviors of*
19632 *an IPPD environment.* [PA169.IG102]

19633 **GG 3 Institutionalize a Defined Process**

19634 *The process is institutionalized as a defined process.* [CL104.GL101]

19635 Practices by Goal:

19636 **SG 1 Provide IPPD Infrastructure**

19637 *An infrastructure that maximizes the productivity of people and effects the*
19638 *collaboration necessary for integration is provided.* [PA169.IG101]

19639 **SP 1.1 Establish the Organization's Shared Vision**

19640 *Establish and maintain a shared vision for the organization.*
19641 [PA169.IG101.SP101]

19642 **SP 1.2 Establish an Integrated Work Environment**

19643 *Establish and maintain an integrated work environment that*
19644 *supports IPPD by enabling collaboration and concurrent*
19645 *development.* [PA169.IG101.SP102]

19646 **SP 1.3 Identify IPPD-Unique Skill Requirements**

19647 *Identify the unique skills needed to support the IPPD environment.*
19648 [PA169.IG101.SP103]

19649 **SG 2 Manage People for Integration**

19650 *People are managed to nurture the integrative and collaborative behaviors of*
19651 *an IPPD environment.* [PA169.IG102]

19652 **SP 2.1 Establish Leadership Mechanisms**

19653 *Establish and maintain leadership mechanisms to enable timely*
19654 *collaboration.* [PA169.IG102.SP101]

19655 **SP 2.2 Establish Incentives for Integration**

19656 *Establish and maintain incentives for adopting and demonstrating*
19657 *integrative and collaborative behaviors at all levels of the*
19658 *organization.* [PA169.IG102.SP102]

19659 **SP 2.3 Establish Mechanisms to Balance Team and Home Organization**
19660 **Responsibilities**

19661 *Establish and maintain organizational guidelines to balance team*
19662 *and home organization responsibilities.* [PA169.IG102.SP103]

19663 **GG 3 Institutionalize a Defined Process**

19664 *The process is institutionalized as a defined process.* [CL104.GL101]

19665 **Commitment to Perform**

19666 **GP 2.1 (CO 1) Establish an Organizational Policy**

19667 *Establish and maintain an organizational policy for planning and*
19668 *performing the organizational environment for integration process.*
19669 [GP103]

19670 Ability to Perform

19671 **GP 3.1 (AB 1) Establish a Defined Process**
 19672 *Establish and maintain the description of a defined organizational*
 19673 *environment for integration process. [GP114]*

19674 **GP 2.2 (AB 2) Plan the Process**
 19675 *Establish and maintain the requirements and objectives, and plans*
 19676 *for performing the organizational environment for integration*
 19677 *process. [GP104]*

19678 **GP 2.3 (AB 3) Provide Resources**
 19679 *Provide adequate resources for performing the organizational*
 19680 *environment for integration process, developing the work*
 19681 *products and providing the services of the process. [GP105]*

19682 **GP 2.4 (AB 4) Assign Responsibility**
 19683 *Assign responsibility and authority for performing the process,*
 19684 *developing the work products, and providing the services of the*
 19685 *organizational environment for integration process. [GP106]*

19686 **GP 2.5 (AB 5) Train People**
 19687 *Train the people performing or supporting the organizational*
 19688 *environment for integration process as needed. [GP107]*

19689 Directing Implementation

19690 **GP 2.6 (DI 1) Manage Configurations**
 19691 *Place designated work products of the organizational environment*
 19692 *for integration process under appropriate levels of configuration*
 19693 *management. [GP109]*

19694 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**
 19695 *Identify and involve the relevant stakeholders of the organizational*
 19696 *environment for integration process as planned. [GP124]*

19717

MATURITY LEVEL: 4

19718 ORGANIZATIONAL PROCESS PERFORMANCE

19719 Maturity Level 4

19720 The purpose of Organizational Process Performance is to establish and
19721 maintain a quantitative understanding of the performance of the
19722 organization's set of standard processes, and to provide the process
19723 performance data, baselines, and models to quantitatively manage the
19724 organization's projects. [PA164]

19725 Specific and Generic Goals

19726 **SG 1 Establish Performance Baselines and Models**

19727 ***Baselines and models that characterize the expected process performance of***
19728 ***the organization's set of standard processes are established and maintained.***
19729 [PA164.IG101]

19730 **GG 3 Institutionalize a Defined Process**

19731 ***The process is institutionalized as a defined process.*** [CL104.GL101]

19732 Practices by Goal:

19733 **SG 1 Establish Performance Baselines and Models**

19734 ***Baselines and models that characterize the expected process performance of***
19735 ***the organization's set of standard processes are established and maintained.***
19736 [PA164.IG101]

19737 **SP 1.1 Select Processes**

19738 ***Select the processes or process elements in the organization's set***
19739 ***of standard processes that are to be included in the organization's***
19740 ***process performance analyses.*** [PA164.IG101.SP101]

19741 **SP 1.2 Establish Process Performance Measures**

19742 ***Establish and maintain definitions of the measures that are to be***
19743 ***included in the organization's process performance analyses.***
19744 [PA164.IG101.SP102]

19745 **SP 1.3 Establish Quality and Process Performance Objectives**
19746 *Establish and maintain quantitative objectives for quality and*
19747 *process performance for the organization.* [PA164.IG101.SP103]

19748 **SP 1.4 Establish Process Performance Baselines**
19749 *Establish and maintain the organization's process performance*
19750 *baselines.* [PA164.IG101.SP104]

19751 **SP 1.5 Establish Process Performance Models**
19752 *Establish and maintain the process performance models for the*
19753 *organization's set of standard processes.* [PA164.IG101.SP105]

19754 **GG 3 Institutionalize a Defined Process**
19755 *The process is institutionalized as a defined process.* [CL104.GL101]

19756 Commitment to Perform

19757 **GP 2.1 (CO 1) Establish an Organizational Policy**
19758 *Establish and maintain an organizational policy for planning and*
19759 *performing the organizational process performance process.* [GP103]

19760 Ability to Perform

19761 **GP 3.1 (AB 1) Establish a Defined Process**
19762 *Establish and maintain the description of a defined organizational*
19763 *process performance process.* [GP114]

19764 **GP 2.2 (AB 2) Plan the Process**
19765 *Establish and maintain the requirements and objectives, and plans*
19766 *for performing the organizational process performance process.*
19767 [GP104]

19768 **GP 2.3 (AB 3) Provide Resources**
19769 *Provide adequate resources for performing the organizational*
19770 *process performance process, developing the work products and*
19771 *providing the services of the process.* [GP105]

19772 **GP 2.4 (AB 4) Assign Responsibility**
19773 *Assign responsibility and authority for performing the process,*
19774 *developing the work products, and providing the services of the*
19775 *organizational process performance process.* [GP106]

19776 **GP 2.5 (AB 5) Train People**
19777 *Train the people performing or supporting the organizational*
19778 *process performance process as needed.* [GP107]

19779 **Directing Implementation**

19780 **GP 2.6 (DI 1) Manage Configurations**
19781 *Place designated work products of the organizational process*
19782 *performance process under appropriate levels of configuration*
19783 *management.* [GP109]

19784 **GP 2.7 (DI 2) Identify and Involve Relevant Stakeholders**
19785 *Identify and involve the relevant stakeholders of the organizational*
19786 *process performance process as planned.* [GP124]

19787 **GP 2.8 (DI 3) Monitor and Control the Process**
19788 *Monitor and control the organizational process performance*
19789 *process against the plan and take appropriate corrective action.*
19790 [GP110]

19791 **GP 3.2 (DI 4) Collect Improvement Information**
19792 *Collect work products, measures, measurement results, and*
19793 *improvement information derived from planning and performing*
19794 *the organizational process performance process to support the*
19795 *future use and improvement of the organization's processes and*
19796 *process assets.* [GP117]

19797 Verifying Implementation

19798 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

19799 *Objectively evaluate adherence of the organizational process*
19800 *performance process and the work products and services of the*
19801 *process to the applicable requirements, objectives, and standards,*
19802 *and address noncompliance. [GP113]*

19803 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

19804 *Review the activities, status, and results of the organizational*
19805 *process performance process with higher-level management and*
19806 *resolve issues. [GP112]*

19807 **QUANTITATIVE PROJECT MANAGEMENT**

19808 **Maturity Level 4**

19809 The purpose of the Quantitative Project Management process area is to
19810 quantitatively manage the project's defined process to achieve the
19811 project's established quality and process performance objectives. [PA165]

19812 **Specific and Generic Goals**

19813 **SG 1 Quantitatively Manage the Project**

19814 *The project is quantitatively managed using quality and process performance*
19815 *objectives.* [PA165.IG101]

19816 **SG 2 Statistically Manage Subprocess Performance**

19817 *The performance of selected subprocesses within the project's defined*
19818 *process is statistically managed.* [PA165.IG102]

19819 **GG 3 Institutionalize a Defined Process**

19820 *The process is institutionalized as a defined process.* [CL104.GL101]

19821 **Practices by Goal:**

19822 **SG 1 Quantitatively Manage the Project**

19823 *The project is quantitatively managed using quality and process performance*
19824 *objectives.* [PA165.IG101]

19825 **SP 1.1 Establish the Project's Objectives**

19826 *Establish and maintain the project's quality and process*
19827 *performance objectives.* [PA165.IG101.SP101]

19828 **SP 1.2 Compose the Defined Process**

19829 *Select the processes and process elements that comprise the*
19830 *project's defined process based on historical stability and*
19831 *capability data.* [PA165.IG101.SP102]

19832	SP 1.3	Select the Subprocesses to be Managed
19833		<i>Select the subprocesses of the project's defined process that will</i>
19834		<i>be statistically managed</i> [PA165.IG101.SP103]
19835	SP 1.4	Manage Project Performance
19836		<i>Monitor the project to determine whether the project's objectives</i>
19837		<i>for quality and process performance will be satisfied, and take</i>
19838		<i>corrective action as appropriate.</i> [PA165.IG101.SP104]
19839	SG 2	Statistically Manage Subprocess Performance
19840		<i>The performance of selected subprocesses within the project's defined</i>
19841		<i>process is statistically managed.</i> [PA165.IG102]
19842	SP 2.1	Select Measures and Analytic Techniques
19843		<i>Select the measures and analytic techniques to be used in</i>
19844		<i>statistically managing the selected subprocesses.</i> [PA165.IG102.SP101]
19845	SP 2.2	Apply Statistical Methods to Understand Variation
19846		<i>Establish and maintain an understanding of the variance of the</i>
19847		<i>selected subprocesses using the selected measures and analytic</i>
19848		<i>techniques.</i> [PA165.IG102.SP102]
19849	SP 2.3	Monitor Performance of the Selected Subprocesses
19850		<i>Monitor the performance of the selected subprocesses to</i>
19851		<i>determine their capability to satisfy their quality and process</i>
19852		<i>performance objectives, and take corrective action as necessary.</i>
19853		[PA165.IG102.SP103]
19854	SP 2.4	Record Statistical Management Data
19855		<i>Record statistical and quality management data in the</i>
19856		<i>organization's measurement repository.</i> [PA165.IG102.SP104]
19857	GG 3	Institutionalize a Defined Process
19858		<i>The process is institutionalized as a defined process.</i> [CL104.GL101]

19859 Commitment to Perform

19860 **GP 2.1 (CO 1) Establish an Organizational Policy**

19861 *Establish and maintain an organizational policy for planning and*
19862 *performing the quantitative project management process. [GP103]*

19863 Ability to Perform

19864 **GP 3.1 (AB 1) Establish a Defined Process**

19865 *Establish and maintain the description of a defined quantitative*
19866 *project management process. [GP114]*

19867 **GP 2.2 (AB 2) Plan the Process**

19868 *Establish and maintain the requirements and objectives, and plans*
19869 *for performing the quantitative project management process. [GP104]*

19870 **GP 2.3 (AB 3) Provide Resources**

19871 *Provide adequate resources for performing the quantitative project*
19872 *management process, developing the work products and*
19873 *providing the services of the process. [GP105]*

19874 **GP 2.4 (AB 4) Assign Responsibility**

19875 *Assign responsibility and authority for performing the process,*
19876 *developing the work products, and providing the services of the*
19877 *quantitative project management process. [GP106]*

19878 **GP 2.5 (AB 5) Train People**

19879 *Train the people performing or supporting the quantitative project*
19880 *management process as needed. [GP107]*

19881 Directing Implementation

19882	GP 2.6	(DI 1)	Manage Configurations
19883			<i>Place designated work products of the quantitative project management process under appropriate levels of configuration management.</i> [GP109]
19884			
19885			
19886	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
19887			<i>Identify and involve the relevant stakeholders of the quantitative project management process as planned.</i> [GP124]
19888			
19889	GP 2.8	(DI 3)	Monitor and Control the Process
19890			<i>Monitor and control the quantitative project management process against the plan and take appropriate corrective action.</i> [GP110]
19891			
19892	GP 3.2	(DI 4)	Collect Improvement Information
19893			<i>Collect work products, measures, measurement results, and improvement information derived from planning and performing the quantitative project management process to support the future use and improvement of the organization's processes and process assets.</i> [GP117]
19894			
19895			
19896			
19897			

19898 Verifying Implementation

19899	GP 2.9	(VE 1)	Objectively Evaluate Adherence
19900			<i>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.</i> [GP113]
19901			
19902			
19903			
19904	GP 2.10	(VE 2)	Review Status with Higher-Level Management
19905			<i>Review the activities, status, and results of the quantitative project management process with higher-level management and resolve issues.</i> [GP112]
19906			
19907			

19908

MATURITY LEVEL: 5

19909 ORGANIZATIONAL INNOVATION AND DEPLOYMENT

19910 Maturity Level 5

19911 The purpose of Organizational Innovation and Deployment is to select
19912 and deploy incremental and innovative improvements that measurably
19913 improve the organization's processes and technologies. The
19914 improvements support the organization's quality and process
19915 performance objectives as derived from the organization's business
19916 objectives. [PA161]

19917 Specific and Generic Goals

19918 **SG 1 Select Improvements**

19919 *Process and technology improvements that contribute to meeting quality and*
19920 *process performance objectives are selected.* [PA161.IG101]

19921 **SG 2 Deploy Improvements**

19922 *Measurable improvements to the organization's processes and technologies*
19923 *are continually and systematically deployed.* [PA161.IG102]

19924 **GG 3 Institutionalize a Defined Process**

19925 *The process is institutionalized as a defined process.* [CL104.GL101]

19926 Practices by Goal:

19927 **SG 1 Select Improvements**

19928 *Process and technology improvements that contribute to meeting quality and*
19929 *process performance objectives are selected.* [PA161.IG101]

19930 **SP 1.1 Collect and Analyze Improvement Proposals**

19931 *Collect and analyze process and technology improvement*
19932 *proposals.* [PA161.IG101.SP101]

19933 **SP 1.2 Identify Innovations**

19934 *Identify innovative improvements that would increase the*
19935 *organization's quality and process performance.* [PA161.IG101.SP102]

19936 **SP 1.3 Pilot Improvements**
19937 *Pilot process and technology improvements to select which ones*
19938 *to implement.* [PA161.IG101.SP103]

19939 **SP 1.4 Select Improvements for Deployment**
19940 *Select process and technology improvement proposals for*
19941 *deployment across the organization.* [PA161.IG101.SP104]

19942 **SG 2 Deploy Improvements**
19943 *Measurable improvements to the organization's processes and technologies*
19944 *are continually and systematically deployed.* [PA161.IG102]

19945 **SP 2.1 Plan the Deployment**
19946 *Establish and maintain the plans for deploying the selected*
19947 *process and technology improvements.* [PA161.IG102.SP101]

19948 **SP 2.2 Manage the Deployment**
19949 *Manage the deployment of the selected process and technology*
19950 *improvements.* [PA161.IG102.SP102]

19951 **SP 2.3 Measure Improvement Effects**
19952 *Measure the effects of the deployed process and technology*
19953 *improvements.* [PA161.IG102.SP103]

19954 **GG 3 Institutionalize a Defined Process**
19955 *The process is institutionalized as a defined process.* [CL104.GL101]

19956 Commitment to Perform

19957 **GP 2.1 (CO 1) Establish an Organizational Policy**
19958 *Establish and maintain an organizational policy for planning and*
19959 *performing the organizational innovation and deployment*
19960 *process.* [GP103]

19961 Ability to Perform

19962	GP 3.1	(AB 1)	Establish a Defined Process
19963			<i>Establish and maintain the description of a defined organizational innovation and deployment process. [GP114]</i>
19964			
19965	GP 2.2	(AB 2)	Plan the Process
19966			<i>Establish and maintain the requirements and objectives, and plans for performing the organizational innovation and deployment process. [GP104]</i>
19967			
19968			
19969	GP 2.3	(AB 3)	Provide Resources
19970			<i>Provide adequate resources for performing the organizational innovation and deployment process, developing the work products and providing the services of the process. [GP105]</i>
19971			
19972			
19973	GP 2.4	(AB 4)	Assign Responsibility
19974			<i>Assign responsibility and authority for performing the process, developing the work products, and providing the services of the organizational innovation and deployment process. [GP106]</i>
19975			
19976			
19977	GP 2.5	(AB 5)	Train People
19978			<i>Train the people performing or supporting the organizational innovation and deployment process as needed. [GP107]</i>
19979			

19980 Directing Implementation

19981	GP 2.6	(DI 1)	Manage Configurations
19982			<i>Place designated work products of the organizational innovation and deployment process under appropriate levels of configuration management. [GP109]</i>
19983			
19984			
19985	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
19986			<i>Identify and involve the relevant stakeholders of the organizational innovation and deployment process as planned. [GP124]</i>
19987			

19988 **GP 2.8** **(DI 3)** **Monitor and Control the Process**
19989 *Monitor and control the organizational innovation and deployment*
19990 *process against the plan and take appropriate corrective action.*
19991 [GP110]

19992 **GP 3.2** **(DI 4)** **Collect Improvement Information**
19993 *Collect work products, measures, measurement results, and*
19994 *improvement information derived from planning and performing*
19995 *the organizational innovation and deployment process to support*
19996 *the future use and improvement of the organization's processes*
19997 *and process assets.* [GP117]

19998 Verifying Implementation

19999 **GP 2.9** **(VE 1)** **Objectively Evaluate Adherence**
20000 *Objectively evaluate adherence of the organizational innovation*
20001 *and deployment process and the work products and services of*
20002 *the process to the applicable requirements, objectives, and*
20003 *standards, and address noncompliance.* [GP113]

20004 **GP 2.10** **(VE 2)** **Review Status with Higher-Level Management**
20005 *Review the activities, status, and results of the organizational*
20006 *innovation and deployment process with higher-level*
20007 *management and resolve issues.* [GP112]

20008 CAUSAL ANALYSIS AND RESOLUTION

20009 Maturity Level 5

20010 The purpose of Causal Analysis and Resolution is to identify causes of
20011 defects and other problems and take action to prevent them from
20012 occurring in the future. [PA155]

20013 Specific and Generic Goals

20014 **SG 1 Determine Causes of Defects**

20015 ***Root causes of defects and other problems are systematically determined.***
20016 [PA155.IG101]

20017 **SG 2 Address Causes of Defects**

20018 ***Root causes of defects and other problems are systematically addressed to***
20019 ***prevent their future occurrence.*** [PA155.IG102]

20020 **GG 3 Institutionalize a Defined Process**

20021 ***The process is institutionalized as a defined process.*** [CL104.GL101]

20022 Practices by Goal:

20023 **SG 1 Determine Causes of Defects**

20024 ***Root causes of defects and other problems are systematically determined.***
20025 [PA155.IG101]

20026 **SP 1.1 Select Defect Data for Analysis**

20027 ***Select the defects and other problems for analysis.*** [PA155.IG101.SP101]

20028 **SP 1.2 Analyze Causes**

20029 ***Perform causal analysis of selected defects and other problems***
20030 ***and propose actions to address them.*** [PA155.IG101.SP102]

20031 **SG 2 Address Causes of Defects**

20032 ***Root causes of defects and other problems are systematically addressed to***
20033 ***prevent their future occurrence.*** [PA155.IG102]

20034 **SP 2.1 Implement the Action Proposals**
20035 *Implement the selected action proposals that were developed in*
20036 *causal analysis.* [PA155.IG102.SP101]

20037 **SP 2.2 Evaluate the Effect of Changes**
20038 *Evaluate the effect of changes on process performance.*
20039 [PA155.IG102.SP102]

20040 **SP 2.3 Record Data**
20041 *Record causal analysis and resolution data for use across the*
20042 *project and organization.* [PA155.IG102.SP103]

20043 **GG 3 Institutionalize a Defined Process**
20044 *The process is institutionalized as a defined process.* [CL104.GL101]

20045 Commitment to Perform

20046 **GP 2.1 (CO 1) Establish an Organizational Policy**
20047 *Establish and maintain an organizational policy for planning and*
20048 *performing the causal analysis and resolution process.* [GP103]

20049 Ability to Perform

20050 **GP 3.1 (AB 1) Establish a Defined Process**
20051 *Establish and maintain the description of a defined causal analysis*
20052 *and resolution process.* [GP114]

20053 **GP 2.2 (AB 2) Plan the Process**
20054 *Establish and maintain the requirements and objectives, and plans*
20055 *for performing the causal analysis and resolution process.* [GP104]

20056	GP 2.3	(AB 3)	Provide Resources
20057			<i>Provide adequate resources for performing the causal analysis and resolution process, developing the work products and providing the services of the process. [GP105]</i>
20058			
20059			
20060	GP 2.4	(AB 4)	Assign Responsibility
20061			<i>Assign responsibility and authority for performing the process, developing the work products, and providing the services of the causal analysis and resolution process. [GP106]</i>
20062			
20063			
20064	GP 2.5	(AB 5)	Train People
20065			<i>Train the people performing or supporting the causal analysis and resolution process as needed. [GP107]</i>
20066			
20067	Directing Implementation		
20068	GP 2.6	(DI 1)	Manage Configurations
20069			<i>Place designated work products of the causal analysis and resolution process under appropriate levels of configuration management. [GP109]</i>
20070			
20071			
20072	GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders
20073			<i>Identify and involve the relevant stakeholders of the causal analysis and resolution process as planned. [GP124]</i>
20074			
20075	GP 2.8	(DI 3)	Monitor and Control the Process
20076			<i>Monitor and control the causal analysis and resolution process against the plan and take appropriate corrective action. [GP110]</i>
20077			
20078	GP 3.2	(DI 4)	Collect Improvement Information
20079			<i>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]</i>
20080			
20081			
20082			
20083			

20084 Verifying Implementation

20085 **GP 2.9 (VE 1) Objectively Evaluate Adherence**

20086 *Objectively evaluate adherence of the causal analysis and*
20087 *resolution process and the work products and services of the*
20088 *process to the applicable requirements, objectives, and standards,*
20089 *and address noncompliance.* [GP113]

20090 **GP 2.10 (VE 2) Review Status with Higher-Level Management**

20091 *Review the activities, status, and results of the causal analysis and*
20092 *resolution process with higher-level management and resolve*
20093 *issues.* [GP112]

20094

E. CMMI Project Participants

20095

20096

20097

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]

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20099

[FM116.T102]

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