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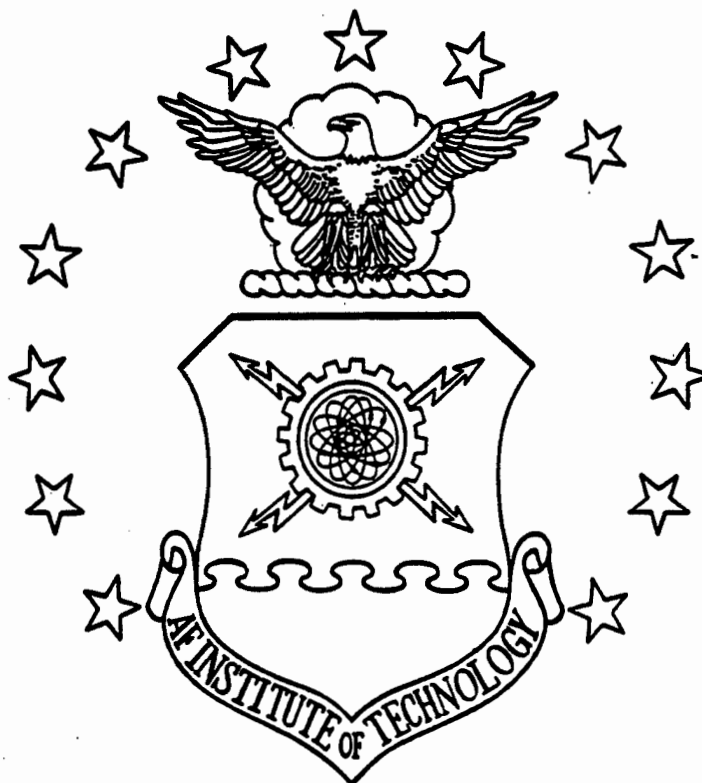
INTEGRATING THE CAPABILITY MATURITY MODEL

FOR SOFTWARE AND THE QUALITY AIR FORCE CRITERIA

THESIS

Marshall B. Messamore, Captain, USAF

AFIT/GCS/ENG/96D-19

DEPARTMENT OF THE AIR FORCE
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THESIS

Presented to the Faculty of the Graduate School of Engineering

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Systems

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Captain, USAF

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Abstract

As defense budgets decrease and it is required to do more with less, the Air Force

has chosen to use the Malcolm Baldrige National Quality Award (MBNQA) as the basis

for implementing quality principles. The Air Force program is known as Quality Air

Force (QAF), and the criteria are referred to as the QAF criteria [DEPA95b]. At about

the same time the Department of the Air Force implemented QAF, the software leaders in

the Air Force adopted the Capability Maturity Model for Software (CMM) as the internal

standard for Air Force software organizations [MOSE91]. Software organizations

strapped with both sets of requirements struggle with how to implement both models.

Many organizations implement redundant programs in an effort to satisfy both. This

research uses signature and specification matching techniques gleaned from the software

reuse domain to integrate the CMM and QAF criteria into a single set of requirements

that correlate to both models.

INTEGRATING THE CAPABILITY MATURITY MODEL

FOR SOFTWARE AND THE QUALITY AIR FORCE CRITERIA

I. Introduction

1.1 Background

In his 1993 book, *Decline and Fall of the American Programmer*, Ed Yourdon predicts the American programmer will "share the fate of the dodo bird" by the end of the decade [YOUR93]. Yourdon goes on to assert that international competition will be the downfall of American software companies based on three key organizational issues: cost of the staff, productivity of the staff, and quality of the systems developed [YOUR93]. To avoid Yourdon's predictions of doom, many American software companies have turned to the concepts of Total Quality Management (TQM) as the basis for addressing two of the three key issues--increasing productivity of the staff and improving quality of the systems developed.

The application of TQM principles comes in many forms, such as the Malcolm Baldrige National Quality Award (MBNQA), the Capability Maturity Model for Software (CMM), and the International Standards Organization (ISO) 9000 standards to name a

few. The various forms of TQM have many commonalties, but often differ in scope, depth, breadth, and applicability; therefore, many organizations use a combination of two or more approaches in their quality programs [FALL93]. To combine multiple approaches can be quite difficult; it is essential to comprehensively understand each of the approaches used, and how the approaches interact.

Air Force software organizations have found out just how difficult it can be. The Air Force adopted the MBNQA criteria as its approach to implementing TQM principles. The criteria are the cornerstone of the Air Force quality program known as Quality Air Force (QAF). All Air Force organizations, including software organizations, are required to implement assessment and improvement programs based on QAF criteria [DEPA95a]. Air Force software organizations have an additional requirement. In addition to assessments and improvements based on the QAF criteria, software organizations must also implement assessments and improvements based on the CMM [MOSE91].

Multiple assessments and improvement efforts can be very expensive, especially in terms of time and human resources. The assessments for either model involve a great deal of training, planning, and preparation. Both types of assessment include multiple interviews with a significant number of members in the organization. In fact, for the QAF assessment at the Air Force Test and Evaluation Center, nearly one fifth of its 800 employees were interviewed in the validation phase, which is only one portion of the assessment process [REED94]. CMM assessments are no different. Current guidance on CMM-based assessments describes the typical assessment as involving a team leader, along with eight team members, interviewing four project leaders and 40 functional area

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representatives, and expending about 200 person-days of effort [DUNA96]. Moreover, the assessment is only a small part of the overall cost of improvement programs. The Software Engineering Institute recommends investing one to three percent of development costs in CMM improvement activities [NEXT92]. In regards to the QAF criteria, commanders are not only required to perform assessments, but furthermore required to provide enough resources to implement the criteria [DEPA95b].

1.2 Problem

The QAF criteria and the CMM are meant to spur process improvements with the ultimate goal of increased productivity, quality, and customer satisfaction. Nevertheless, attempts to combine the two approaches often produce the opposite effects in many Air Force software organizations. These organizations have failed to integrate the CMM and the QAF criteria into a single, coherent improvement strategy. Consequently, as stated by Mara of the Air Force Standard Systems Groups, "Air Force software units spend valuable resources attempting to implement parallel improvement initiatives" [MARA96]--one based on the CMM and the other based on the QAF criteria. Inevitably, parallel initiatives result in redundant objectives, redundant assessments, and redundant infrastructures. The Software Management Division of the Air Force Communications Agency, the office of primary responsibility for assessing software maturity, receives frequent requests for a strategy to integrate the two improvement approaches. With redundancy in assessments and improvement programs, Air Force software organizations waste scarce resources.

Problem Statement:

Air Force software organizations are unable to integrate the CMM with the QAF criteria, leading to parallel improvement initiatives, and resulting in the wasted resources.

1.3 Research Objectives

The goal of this research is to demonstrate the use of signature and specification matching (as described in Section 3.4.1 and 3.4.2, respectively) to integrate the process requirements imposed by the Capability Maturity Model for Software and the Quality Air Force criteria. The following objectives support the achievement of this goal:

1. Specify the process requirements stipulated by the CMM.

2. Specify the process requirements stipulated by the QAF Criteria.

3. Integrate requirements from each model into one set of consistent requirements.

4. Demonstrate the use of signature matching to integrate requirements.

5. Demonstrate the use of specification matching to integrate requirements.

6. Demonstrate the use of the integrated set of requirements by applying it to an organization process description, specifically the Standard Systems Group's System Engineering Process (SEP).

7. Illustrate the consistency and compatibility of the models.

1.4 Approach

The following approach is used to meet the stated objectives and attain the overall goal of the research:

1. *Decompose the CMM and QAF Criteria into low level process requirements -* Each model is structurally partitioned into categories of logically-related process and sub-process requirements. Taking advantage of this structure, the requirements are further decomposed until each requirement specifies only one output, or a small number of strongly-connected outputs. Decomposing the models to this point is essential to fully understand each requirement with an aim towards formal specification of each requirement, if needed. (Supports Objectives 1 and 2.)

2. *Log process requirements into a framework for process documentation -* The primary purpose of the framework is to communicate process requirements to the sponsoring organization, as well as other process experts. A secondary purpose is to manage the many requirements. (Supports Objectives 6 and 7.)

3. *Specify signatures of each process requirement -* Signatures are identified in conjunction with the decomposition in Step 1. It is the linchpin of this approach. (Supports Objectives 3 and 4.)

4. *Integrate the requirements using signature matching -* The signature of each individual requirement is compared to the signature of all other requirements (including those from the same model) to determine a candidate list of redundant requirements. Contextual information is re-introduced to determine if any of the candidates can be definitively identified as matches. (Supports Objective 4.)

5. *Specify appropriate requirements in the Z specification language -* For those requirements not discernible as matches or non-matches using signature matching and contextual information, specification matching is used as the final discriminator. The requirements are specified in Z and then compared using specification matching. Using English, the requirements can only be compared in a conceptual, or notional manner. A formal language, on the other hand, provides the power of mathematically comparing inputs, outputs, and behaviors. (Supports Objective 5.)

6. *Integrate the remaining requirements using specification matching* - The behavioral specification for each requirement compared to other remaining requirements to definitively establish the relationship between the two. An exact match indicates redundancy, thus one of the requirements is eliminated. (Supports Objective 5.)

7. *Verify the integrated set of requirements* - Each requirement in the integrated set of requirements is correlated back to the model from which it originated. The set is checked for completeness by composing requirements (i.e., the processes they represent) from the final set into process descriptions. This step also provides information on the compatibility of the two models. (Supports Objective 3 and 7.)

8. *Apply the integrated set of requirements to a part of the sponsor's organizational process description* - A part of the Standard System Group's (SSG) Systems Engineering Process (SEP) is evaluated against the integrated set of requirements. Unmet requirements are identified and noted for the sponsor. The application step also acts as a validation for the integrated requirements. The process description is reviewed to identify processes or sub-processes with no corresponding requirement. The models are checked to determine if a requirement was lost in the approach or not provided. (Supports Objective 6.)

1.5 Assumptions

1.5.1 Pre-condition and Post-condition. The first assumption is that both the CMM and QAF criteria may be specified in a pre-condition, post-condition form. While the CMM is largely structured in this form, the QAF criteria are not and may be much more difficult to specify in this form. This assumption is crucial to comparing requirements using specification matching.

1.5.2 No Conflicts between the Models. Secondly, assume there are no outright conflicts between the models, e.g., the CMM requires A and the QAF criteria requires ¬A. This is a reasonable assumption since both models support the same principles and

are used together by many organizations. If such conflicts do occur, the organization must simply make a decision on which method benefits it most.

1.5.3 Key Processes Versus All Processes. Neither model describes every process an organization needs or uses. The QAF criteria, although described as a "comprehensive set of results-oriented requirements" [DEPA95c], primarily discusses *meta-processes*, or processes to manage processes. The criteria do not attempt to describe each organization's *production processes*. The CMM describes a software *production process*, along with *meta-processes*, but does not specify every process needed by an organization. For instance, the CMM barely addresses any human resource issues or processes outside of training.

Basically, both models are descriptive in nature; they describe what is to be done, but not how. In many cases, how a process is implemented involves many other processes not identified by either model. An example is data collection. Both models require data collection and give guidance on the type of data to collect, but neither describes the process to actually collect, store, or retrieve the data. This approach does not attempt to extend beyond the scope or depth already contained in the CMM and QAF criteria.

1.5.4 Goals in the CMM Are Accomplished by Activities Performed. The structure of the CMM contains goals for each *Key Process Area*. This approach assumes that performing all the practices in the *Activities Performed* and *Other Common Features* satisfies the goals. The goals are not explicitly addressed as process requirements.

1.6 Scope

This research addresses how to integrate two sets of requirements, namely the CMM and QAF Criteria, based on signature matching and specification matching. It does not include how to conduct assessments based on either model, nor how to implement the requirements of either model. Neither does it address the applicability, nor the effectiveness of using either model in the Air Force. Likewise, this research does not advocate the use of one model over the other, but rather views them as complementary. Finally, this research does not include a method for converting scores from one assessment method to the other.

1.7 Overview

The remainder of this document details the research outlined above. Chapter II discusses the literature reviewed in support of the research. It consists of sections on requirements analysis, process, software reuse, and the two models used in the research. Chapter III describes the approach followed in the research. It is divided into sections for each of the major steps in the approach. Chapter IV analyzes the approach and gives intermediate and final results. Chapter V addresses verifying results and applying them to a process description. The final chapter, Chapter VI discusses conclusions drawn from the research effort, how the approach can be used in other areas, and suggests some avenues for further research.

II. Literature Review

2.1 Introduction

The overall goal of this research is to demonstrate the use of signature matching and specification matching to integrate process requirements imposed by the Capability Maturity Model for Software and the Quality Air Force criteria. Several areas are reviewed to support this research. Section 2.2 contains a general discussion of requirements analysis, and includes formal methods, with an introduction to the Z language. The next section covers process; it consists of discussions on the software process, process modeling, and process improvement. Following that, Section 2.4 briefly discusses the current state of software reuse, along with two related methods for retrieving reusable components. Finally, Sections 2.5 and 2.6 preview the QAF Criteria and the CMM, respectively.

2.2 Requirements Analysis

The purpose of the requirements phase of the software lifecycle is to sufficiently describe the behavior of the system by specifying the requirements the software system must meet. The requirements are meant to describe *what* the system does, without detailing *how* the system will do it [DAVI90]. The *what* versus *how* is often a matter of perspective, but a commonly accepted view for software is the *what* describes the problem domain and restricts the solution space. The *how* begins the design phase which chooses a particular solution to implement. The design phase begins with a description of

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architectural components, major functions, and relationships, which are successively refined into the detailed design and code for the system [RUMB91].

Describing the problem domain involves activities such as interviewing, brainstorming, flowcharting, diagramming, and modeling. The objective is to fully understand the problem at hand and identify any constraints on the solution. Managing the data and information gathered and created is a key challenge to this part of the analysis phase. How well the data and information are managed has a direct bearing on the success of the next part of the analysis phase. In this part, there is a shift from the problem domain to the solution space, i.e., the *what* of the product is described. The goal is to completely specify the behavior of possible systems which solve the problem. Concisely documenting system behavior, resolving conflicts, and eliminating inconsistencies are the key challenges to this part of the analysis phase [DAVI90]. The analysis phase culminates in a requirements document.

2.2.1 Informal Methods. There are a variety of methods and methodologies to describe the *what* and the *how* of the software system. Informal methods are the most common. Informal methods include the use of natural language, flowcharts, data flow diagrams, entity-relationship diagrams, and control charts to name a few. Other informal methods such as Structured Analysis and Design Technique (SADT) and Object Modeling Technique (OMT) add structure and rigor to requirements analysis. Informal methods can be quite effective, but suffer from some limitations. One limitation is difficulty teaching the methods. Because informal methods often rely on art and experience rather than science and theory, it is hard to convey the knowledge to others.

Another limitation concerns automation. Automation, when used correctly, can significantly increase productivity and quality, but informal methods rely heavily on the human component, and are thus hard to automate. An additional limitation is the chance for error. Informal methods increase the possibility of misinterpreting or misstating requirements. More often than not, such errors promulgate through the design phase and into code. This is especially significant since it may be as much as 100 times more costly to fix an error in the maintenance phase than in the requirements phase [DAVI90, HART95].

2.2.2 Formal Methods. In an attempt to alleviate some of the limitations of informal analysis methods, formal methods were developed. Formal methods, unlike the informal ones mentioned above, are based in mathematics. The mathematics are typically expressed in the form of a formal specification language. Specification languages may be classified as property-oriented or model-oriented. Property-oriented specification languages indirectly describe system behavior in the form of axioms the system must satisfy. Model-oriented specification languages directly describe system behavior in the form of functions, relations, tuples, sets and sequences. Some examples of property-oriented specification languages are Larch, Anna, and OBJ. Some examples of model-oriented specification languages are VDM, state machines, and Z [MARC94].

2.2.3 Z Specification Language. Z is a model-oriented specification language, but it is also used for property-oriented specifications. Z specifications consist of a formal notation based on logic and set theory and an informal part written in natural language. Natural language is used for explanation and serves as a bridge between the real world

and the mathematics of the formal notation. The formal notation is organized by means of a *schema*. A schema is a collection of objects and axioms relating the objects to each other. Schemas may be combined through the use of schema calculus, providing a wealth of expressive power [MARC94, POTT91, SPIV88].

2.3 Process

This section provides an overview of process, specifically the software process and how it relates to the business process. It also surveys methods for understanding and improving the software process.

2.3.1 Software Process. The CMM defines the software process as a "set of activities, methods, practices, and transformations that people use to develop and maintain software and the associated products" [PAUL93b]. This definition does not mention the management infrastructure and support processes necessary to successfully develop software products. The management and support structures are often referred to as the business process. The business process has been the subject of great interest in recent years, as evidenced by the number of papers, books, and World Wide Web sites addressing business process engineering and re-engineering. The business process is also of interest to the software community, especially how it relates to the software process.

The software community has begun to appreciate the many similarities between the software process and business process [BOYD94]. In a panel discussion titled "Are Software Processes Business Processes Too?" at the *Third International Conference on the Software Process*, Henderson proposes a simple view of the relationship. He views

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the software process as simply a special case of the business process. He defines the business process as "what the business does to make a profit" [HEND94]. In the case of a business that produces software to make a profit, the software process is a business process. Others on the panel, including Boyd [BOYD94], Scacchi [SCAC94], and Thomas [THOM94], share similar views to that of Henderson, namely that the software process and business process are closely related and tightly coupled to one another. Regardless of the particular viewpoint of how they are related, most would agree the critical process issues in both the software and business arenas are to define the process, manage it, and improve it. Processes to perform these functions are called meta-processes [DOWS94].

2.3.2 Process Modeling. To effectively manage and improve processes, organizations must first understand those processes [HUMP89]. An effective method for understanding a process is process modeling. Process modeling not only contributes to understanding processes currently in use in an organization, but also facilitates understanding what constitutes good, effective processes in general [DOWS94].

The notion of process modeling stems from Osterweil's 1987 paper "Software Processes are Software Too," presented at the 9th International Conference on Software Engineering [OSTE87]. In this seminal work in the process field, Osterweil makes a strong case for considering software processes the same as a software programs, i.e., using the same "techniques and formalisms" to describe them. He introduces the idea of *process programming*, or rigorously describing the software process much in the same way a software program is rigorously described using a programming language

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[OSTE87]. Process programming is more commonly known today as process definition or process modeling.

There are several taxonomies for process models and associated techniques. Process models may be descriptive or active. Descriptive models describe what steps or activities must be accomplished, but do not address how they are accomplished. Active models, often called process enactment systems, prescribe actions, how to do them, and usually aid the software developer in accomplishing the task [SNOW96]. Another delineation between modeling techniques is static versus dynamic. Static models textually or graphically describe a process, while dynamic models are executable in some way. Static models are useful for understanding processes at a high level, but often do not provide the deeper understanding obtained by using dynamic models [BARG94]. These taxonomies may be used together to further characterize process models. A descriptive model may be static or dynamic, and an active model may be static or dynamic. Most actives models are dynamic, as with Computer Aided Software Engineering (CASE) tools.

The selection of which technique or type of model to use depends on the goals of the modeling effort. Descriptive models are frequently used for determining how a particular process behaves under various conditions. For this purpose, the model is normally executable, or dynamic. Thus, the modeler is able to make experimental changes to the input conditions or the process model itself to identify opportunities for improvement. As mentioned above, active models are often used to enact, or help perform, the process. These active models must include specific information on the structure of the process, agents in the process, and artifacts produced or consumed by the process. Because of the

amount of detail involved, these type models are often called process definitions [DOWS93].

2.3.3 Process Improvement. In the past decade, software organizations around the country and around the world have searched for the engine to pull them out of the software crisis. Many have hoped for a "silver bullet" in the form of a technological advance which would slay the software werewolf [BROO87]. Humphrey notes this is not only wrong thinking, but dangerous thinking. Technology is limited by the process it supports. Poor process management brought about by an insufficient knowledge of the process severely degrades productivity and quality [HUMP89]. Productivity and quality gains are realized by a firm understanding and improvement of the underlying process. In the late 1980s, the software industry started to adopt Humphrey's emphasis on the process as the leverage point for improving productivity and quality [NASE94].

As mentioned above, the objective of defining the process is to understand and improve it, but process improvement is not the end itself. Process improvement efforts must be firmly linked to the business goals of the organization. Business goals provide a context for improvement efforts [BOYC95]. For example, a process improvement effort may support a goal to increase productivity by eliminating steps in a process or otherwise decreasing execution time. When aligned with business goals, process improvement can be quite successful as evidenced by Hughes Aircraft [HUMP91], Raytheon Equipment Division [DION90], and Oklahoma City Air Logistics Center [BUTL95].

2.4 Software Reuse

Software reuse is a major player in the software development field. By reusing code alone, an organization can increase productivity and quality. Productivity increases because portions of a system are already analyzed, designed, and developed. Quality increases because reused code is managed more tightly and tested with each new use [YOUR93]. Although the gains from code reuse may be significant, it is even more lucrative to extend reuse beyond code to requirements, designs, tests, plans, architectures, and processes [BASI94]. Yourdon points out that coding comprises only 10-15% of the resources for a typical project, yet most of the efforts in reuse have focused on reusing code. This narrow focus, however, has begun to widen [YOUR93].

Despite the potential pay back, reuse (including code reuse) is far from prolific in the software community due to several factors. The factors hindering the application of software reuse in most organizations can be categorized as managerial, psychological, or technical. First of all, management must be committed to reuse before it will be effective and productive. Like any other major organizational direction, commitment means a long-term investment in the resources, tools, and training necessary for it to work. Management must address internal issues such as measurement of reuse products and processes, as well as explore external issues such as legalities and marketing [ZAND95]. Psychological factors also inhibit reuse. These factors primarily affect the programmers who are responsible for implementing reuse. Programmers take pride in creating their own solutions to problems, and do not fully trust the solutions of others. Combine these with a lack of incentive for reuse and a lack of understanding of reuse and it makes the

programmer's choice to apply reuse a difficult one to make [YOUR93]. Although managerial and psychological factors are recognized as important, most of the research addresses the technical factors limiting reuse. Technical factors include creating, classifying, storing, retrieving, verifying, and modifying components of a library. The major impediment is efficiently retrieving a component that meets current needs. Despite the amount of research in this area, "current techniques to represent and manage software components are not sufficient," according to Jeng [JENG95]. Jeng and Cheng's approach relies on formal methods to specify components and mathematically determine matches with requirements [JENG95]. Zaremski and Wing propose a similar method to match signatures and specifications[ZARE95a, ZARE95b].

2.4.1 Signature Matching. Signature matching is a simple method for identifying and retrieving components from a reuse repository [ZARE95a]. Identification and retrieval must be done effectively and economically for reuse to be profitable. Signature matching provides the economical means of identifying and retrieving candidate components from a repository based on match predicate and query. Zaremski and Wing define the general form of signature matching as [ZARE95a]:

$$Signature\ Match(q,M,C) = \{c \in C: M(c,q)\}$$

This says given a query *q*, a match predicate *M*, and a library of components *C*, *Signature Match* returns a set of components such that each component *c* is in the library and matches the query *q* based on the predicate *M*, i.e., *c* and *q* satisfy *M* [ZARE95a].

Signature matching can be applied to functions or modules. Modules are essentially a collection of functions which operate on an abstract data type. Signature matching on

functions is essentially type matching on inputs and outputs. The match predicates for functions can take on several forms including *Exact Match, Generalized Match,* and *Specialized Match* [ZARE95a]. *Exact Match* means query and component match exactly. For example, the signature of a component that concatenates two strings might look like:

$$Catenate:\ string,\ string \longrightarrow string$$

For *Exact Match* to find and return this component, the query would also have to be:

$$q_1 = string,\ string \longrightarrow string$$

Generalized Match finds library components that are generalized forms of the query. Re-using q_1 as the query, *Generalized Match* would return components that require two inputs of the same type and return that type. The signature of such components is:

$$c_1:\ X,\ X \longrightarrow X$$

Specialized Match means the library component is a specialized form of the query. In this case, c_1 becomes the query, q_2:

$$q_2 = X,\ X \longrightarrow X$$

This query would return *Catenate*, in addition to any other component with a signature of this form. For example, the following components would also be returned:

$$AddInt:\ int,\ int \longrightarrow int$$

$$MergeFiles:\ file,\ file \longrightarrow file$$

Signature matching on modules involves matching types for the set of user-defined types used in the module, along with matching the function types for all functions in the module. *Exact Match* is as expected; all user-defined types must match, as well as all

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function types for each function in the component and each function in the query. The mapping of functions in the query to functions in the component is *one-to-one* and *onto*. *One-to-one* means that for each function in the query there is only one function in the component that matches it. *Onto* means all the functions in the component are matched to functions in the query. *Partial Match* entails using queries that specify only a subset of the functions contained in the library module. The mapping from query function to component function does not need to be *onto* [ZARE95a].

2.4.2 Specification Matching. Specification matching is essentially the same concept as signature matching. The purpose is to identify and retrieve components from a reuse repository. The difference is the depth at which components are matched. In signature matching only the input/output types are compared to determine a match. This technique provides a good filter for identifying candidate components, but may lead to some surprises. To illustrate this point, consider the signature of two possible string operations, *Catenate* and *Replace*:

$$Catenate: string, string \longrightarrow string$$

$$Replace: string, string \longrightarrow string$$

The two have the same signature and would match the same queries; however, the two behave very differently. For this reason, specification matching must be used as a tighter filter to identify reuse components.

Specification matching at a simple level is merely a logical equivalence or logical implication between the query specification and the component specification [ROLL90].

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At a deeper level, matching can be divided into *Pre/Post Matches* and *Predicate Matches.* *Pre/Post Matches* are comparisons of the query pre-conditions against the component pre-conditions and the query post-conditions against the component post-conditions. There are a variety of matches depending on the nature--implication or equivalence--and the direction of comparison. The *Predicate Match* addresses all predicates in the specification of the query and component. Again there is a variety mirroring those of the *Pre/Post Matches* [ZARE95b].

2.5 Quality Air Force Criteria

2.5.1 QAF History. As defense budgets decrease and it is required to do more with less, the Department of Defense (DOD) has chosen to use Total Quality Management (TQM) as the means for increasing productivity, quality, and customer satisfaction. One well-known method for implementing TQM is the Malcolm Baldrige National Quality Award (MBNQA). The MBNQA, established in 1987 and named after then-Secretary of Commerce Malcolm Baldrige, has a strong reputation as a quality award. It is awarded annually to companies that exemplify the quality ideals and concepts embodied in the criteria [KAN95]. Because of this strong reputation, the Air Force arm of the DOD has chosen the MBNQA as the basis for implementing TQM in Air Force organizations. The Air Force program is known as Quality Air Force (QAF), and the criteria are referred to as the QAF criteria [DEPA95b].

2.5.2 Overview of the QAF Criteria. The criteria are built upon four basic elements as seen in Figure 1 [DEPA95c]. The *driver* is organizational leadership. Organizational leadership drives the *planning process* in a comprehensive approach to setting goals and

making plans based on customer requirements. Progress toward goals is determined by

measures of progress also used to manage the system. Ultimately, the *goal* is to increase

value to the customer [DEPA95a, DEPA95c, FALL93].

To be successful, my organization must achieve...	7.0 Customer Focus	6.0 Performance Results	**GOAL**
We will produce results through goals, objectives and action plans for key systems... (These will provide focused activity for performance and improvement)	7.0 Customer Focus	5.0 Process Management	**MEASURES OF PROGRESS**
	4.0 Human Resource Development & Management		
	2.0 Information & Analysis		
Our goals and plans will be the result of a comprehensive and deliberate planning process...	3.0 Strategic Planning		**PLANNING PROCESS**
Establishing direction and providing support requires...	1.0 Leadership		**DRIVER**

Figure 1 Quality Air Force Criteria. [DEPA95c]

These four elements provide the basis for assessing a "unit's leadership and

management, as shown in mission and functional area performance, installation support,

people programs, service to customers, and conformance" to customer requirements

[DEPA95a].

2.5.3 QAF Criteria Structure. The QAF criteria are functionally structured into

seven inter-related *Categories* to aid assessment. The categories are sub-divided into 24

Examination Items, which are further divided into 54 *Areas to Address*. Each

examination item is scored on three dimensions: *approach, deployment,* and *results.* The *approach* is how the organization addresses the requirement. The *deployment* is the extent to which all areas of the requirement are addressed, and *results* "refer to the outcomes in achieving the purposes given in the item" [DEPA95c]. All Air Force units are required to conduct QAF assessments (QAFA) [DEPA95a]. The next section provides short descriptions of each of the seven categories.

2.5.4 QAF Categories.

2.5.4.1 Leadership. This category provides the focus within the criteria for the organizational leadership and strategic direction. Leadership is the driver for moving the organization. The category addresses the entire management infrastructure and how it translates mission objectives into performance results [DEPA95c].

2.5.4.2 Information and Analysis. This category covers the management of the key information required to assess and improve the organization's overall performance. The processes in this category provide the mechanism for senior leadership to align organizational processes with strategic directions. Furthermore, this category provides the foundation for all measures of progress [DEPA95c].

2.5.4.3 Strategic Planning. Strategic planning involves setting a vision for the organization based on customer needs and operational performance requirements, and translating that vision into a coherent plan for achieving quality, increasing customer satisfaction, and improving business performance. Key issues in this category are effective deployment of plans, continuous improvement of processes, and optimization of resources [DEPA95c].

2.5.4.4 Human Resource Development and Management. This category is the focal point in the criteria for all human resource issues such as training, morale, and quality of life. The purpose of the category is to ensure human resources are effectively managed to create a high performance workplace that supports the strategic direction of the organization [DEPA95c].

2.5.4.5 Process Management. Process management emphasizes the importance of managing the processes essential to providing products and services to meet customer needs. This includes production line processes, as well as support processes. Proper process management is a principal part of the capability to accomplish strategic goals [DEPA95c].

2.5.4.6 Performance Results. In short, this category is a measure of how well an organization meets its goals. Data is collected based on product and service quality, operational performance, customer satisfaction, and mission effectiveness indicators to provide "real-time information for evaluation and improvement of processes." [DEPA95c].

2.5.4.7 Customer Focus and Satisfaction. This category captures the essence of the QAF criteria. It is both a goal and a measure of progress. As a goal, customer focus is the foundation for determining organizational priorities and planning improvement activities. As a measure of progress, customer satisfaction helps the organization determine development toward the customer focus goals [DEPA95c].

2.6.1 CMM History. At about the same time the DOD was adopting TQM, the Air Force was searching for a method to assess the software capability of its contractors. The Air Force turned to the Software Engineering Institute (SEI) for help. Watts Humphrey of the SEI applied the quality principles of W. Edwards Deming, Joseph Juran, and Philip Crosby to the software field and developed an initial framework for assessing process capability. Using knowledge gained from using the framework and associated questionnaire, along with comprehensive feedback from government and industry, the SEI extended the framework into an extensive model of organizational practices in 1991. The model was updated in 1993 based on additional feedback from government and industry. The current version of the CMM is contained in CMU/SEI-93-TR-24 [PAUL93a]. The key practices are listed in CMU/SEI-93-TR-25 [PAUL93b].

2.6.2 CMM Structure. The CMM is functionally structured into 18 *Key Process Areas(KPAs)*. *KPAs* are divided into five subcategories called *Common Features*. The *Activities Performed Common Feature* describes the activities an organization should perform in the respective *KPA*. The other *Common Features* relate to institutionalizing the activities described [PAUL93b]. The following section previews the CMM.

2.6.3 CMM Overview. The primary purpose of the CMM is to help software organizations gain control of their software process, changing their culture to one of software engineering excellence, and ultimately decreasing risk while increasing productivity and quality. To fulfill this purpose, the CMM is structured in a manner that facilitates an evolutionary approach to improving processes [PAUL93a]. It is divided

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into levels which characterize the process maturity of an organization as it progresses toward continuous improvement. Figure 2 captures the essence of the CMM by depicting each *Maturity Level* along with the focus and key process areas which describe that level [PAUL93a].

Capability Maturity Model (CMM)

Level	Focus	Key Process Areas	Result
5 Optimizing	Continuous Process Improvement	Defect prevention Technology innovation Process change management	Productivity & Quality
4 Managed	Product and Process Quality	Quantitative Process Mgt Software Quality Management	
3 Defined	Engineering Process	Organization process focus Organization process defn. Peer reviews Training program Intergroup coordination Software product engineering Integrated software mgt.	
2 Repeatable	Project Management	Software project planning Software project tracking Software subcontract mgt. Software quality assurance Software configuration mgt. Requirements mgt.	
1 Initial	Heroes		Risk

Figure 2 Capability Maturity Model (CMM) for Software. [PAUL93a].

Each maturity level represents a plateau in an organization's progression toward continuous improvement. The *Focus* column lists the issues which characterize an organization at that maturity level. The *Key Process Areas* are the critical competencies the organization must have mastered to have reached that maturity level. The *Result* column depicts the payoff for an organization moving up the maturity model--as risk decreases, productivity and quality increase.

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III. Approach

3.1 Introduction

As stated in Section 1.3, the overall goal of this research is to demonstrate the use of signature matching and specification matching to integrate the process requirements imposed by the CMM and the QAF criteria. To accomplish this goal, the CMM and QAF criteria are viewed as sets of process requirements for organizations to fulfill. Based on Osterweil's conception of software process as software [OSTE87], the *process requirements* are analyzed as *software requirements* using software analysis methods such as functional decomposition, object diagrams, and formal specification. Each set of requirements is analyzed, decomposed, and logged using a simple framework. The signatures are specified and matched using contextual information as a backdrop. Requirements requiring further examination are formally specified using the specification language Z, and the specifications compared. The final integrated set of requirements represents all process requirements enjoined by the two models; thus, it is applied against a real process description to identify unmet requirements in the process description, or omissions in the integrated set of requirements. The following paragraphs expound on this approach.

3.2 Requirements View of Models

The QAF criteria and the CMM are often used as references to set organizational goals and plan process improvements. Viewed from a slightly different perspective, these

two models provide a description of *what* an organization must do to achieve organizational goals and realize process improvements. This description is a requirements specification for the organizational system. The overviews of both models corroborate the requirements specification view. The QAF criteria are depicted as a non-prescriptive, yet comprehensive set of process requirements for organizations to fulfill [DEPA95c]. The CMM verbiage is less direct, using the word *criteria* instead of *requirements*. The CMM is described as a set of "criteria describing the characteristics of mature software organizations" [PAUL93a]. Hence, both models are considered as informal requirements documents.

The next issue concerns what to do with these requirements documents. The goal of this research is to integrate the two sets of requirements into one comprehensive, consistent set. However, in their current form, Air Force software organizations have difficulty integrating the models. One major difficulty relates to the scope of the models. The CMM is more project focused with a flavor of the organization level. By contrast, the QAF criteria is more organization focused with a flavor of the project level. The different scopes make them complementary in concept, but in practice the exact boundaries and interactions between the models are difficult to discern. Another difficulty relates to the language used by each model. The QAF criteria is meant for a broad range of organizational missions. The language is very general; it does not mention specific roles, documents, or organizational structures. Conversely, the CMM is meant for software organizations. It discusses roles such as the project software manager, documents such as the software development plan, and organizational structures such as

the software engineering group. Due to such differences, it is necessary to translate the models into a form more amenable to integration. The first step toward that objective involves analyzing and decomposing each model into the lowest level requirements.

3.3 Functionally Decompose Requirements

The QAF criteria and the CMM are each structured along functional lines, as described in Section 2.5.3 and Section 2.6.2, respectively. The functional structures serve as backdrops for decomposing the models even further. The aim is to decompose the models until all requirements represent a process or activity with a single output or two to three tightly-coupled outputs. Decomposing to this level more readily allows comparisons between requirements. Another motivation for decomposing to this level relates to complexity. At this lowest level, the complexity resulting from the relationships and interfaces between multiple functional components is greatly mitigated. Each low-level requirement is more easily understood and managed.

Understanding the requirements is the key to building any complex system. The requirements analyst must have a solid grasp of the problem domain in order to constrain it sufficiently to derive the solution space. The analyst obtains the knowledge from the user's problem statement or requirements document. The analysis process produces a more concise description, while eliminating redundancy, inconsistency, and ambiguity [RUMB91]. Although the goal of this research is not to build a system, understanding the requirements is no less important. The CMM and QAF criteria are considered user requirements documents. Each document must be well-understood, and transformed into

a concise, consistent, unambiguous format. The result of this step is a restatement of requirements from both models in a simple, understandable format.

Managing the numerous requirements is another important aspect of this approach. This approach uses a framework as the means to manage the requirements. The framework includes the following fields: *Name, ID, Purpose, Agents, Correlates to, Inputs, Outputs, Entrance Criteria, Exit Criteria,* and *Comments.* In addition to being a management tool, the framework serves as an informal method of communicating the results of requirements analysis to the sponsor of the research. The idea of using this type of framework is taken from Hollenbach and Frakes [HOLL96]. Their framework is used to document and define processes, and place them in a process library for the purpose of reuse. Since this approach deals completely with process requirements, as opposed to actual processes, the framework used here is far less elaborate.

3.4 Integrate Requirements into One Set

Integrating the two sets of requirements from the respective models into a single non-redundant, complete set of requirements is the crux of this problem. The primary vehicle for eliminating redundancy in this approach is *signature matching.* Signature matching involves comparing the signatures, or interfaces, to identify potentially similar components. The signature of a requirement is specified by the types associated with the inputs and outputs of the process the requirement represents. The signature is the interface of the process. As the requirements are decomposed to the lowest level, the

types of the inputs and outputs are identified and recorded for use in signature matching, which is explained in the following section.

3.4.1 Signature Matching. Signature matching is paramount to this research. Recall that signature matching entails comparing the interfaces, or input/output types of functions or modules. (No concern is paid here to the order of types in the signature. The actual process of matching signatures is primarily accomplished using a spreadsheet, thus the order is easily transformed. Zaremski and Wing illustrate an automated proof system which must handle the transformation without human intervention [ZARE95a].) The general form of the signature match is:

Signature Match(q,M,C) = {c ∈ C: M(c,q)}

In this research, the process requirements from both models are considered to be functions that make up the component library *C*. A process requirement is drawn from *C* to act as the query *q*. (In theory, this specification may be drawn at random; however, in practice, the requirements are sorted by signatures and requirements likely to be redundant are chosen.) The match predicate *M* for this approach is *Exact Match* or *Partial Match*. The Z form of *Exact Signature Match* and *Partial Signature Match* for this approach follow in Figures 3 and 4:

$$\_esm\_ : Procreq \leftrightarrow Procreq$$

$$P_1 \ esm \ P_2 \Leftrightarrow$$
$$ran \ P_1.inputs = ran \ P_2.inputs \ \wedge$$
$$ran \ P_1.outputs = ran \ P_2.outputs$$

Figure 3 Exact Signature Match.

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$$
\begin{array}{|l|}
\hline
\_psm\_ : Procreq \leftrightarrow Procreq \\
\hline
P_1\, psm\, P_2 \Leftrightarrow \\
\qquad ran\, P_1.inputs \subseteq ran\, P_2.inputs \wedge \\
\qquad ran\, P_1.outputs \subseteq ran\, P_2.outputs \\
\hline
\end{array}
$$

Figure 4 Partial Signature Match.

As an example, the signature of a process to measure a product might look like:

MeasureProduct: {product},{indicator} $\longrightarrow$ {data}

Another process to measure the quality of a product might be represented by the following signature:

MeasureQuality: {product} $\longrightarrow$ {data}

In this situation, it is desired to identify these as potentially matching processes. *Exact Signature Match* would fail, but *Partial Signature Match* would identify these as potentially redundant requirements. In this simple case a decision can be made at this point to eliminate the less general of the two. In this example, *MeasureQuality* would be eliminated in favor of *MeasureProduct*, and any information in the *Correlates to* and *Comments* fields of *MeasureQuality* would be included in *MeasureProduct*. For this research, signature matches along with contextual information generally suffice to determine redundancies. However, in more complicated situations, *specification matching* is needed to determine if two specifications match under tighter constraints.

3.4.2 Specification Matching. Specification matching is used sparingly in this approach since most matches may be determined using signature matching outcomes and contextual information. Nonetheless, some situations warrant this level of comparison.

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The objective of the step is to represent the process requirements in first order predicate logic. This can be done in Z.

3.4.2.1 Formally Specify the Appropriate Requirements in Z. The information in the informal framework is translated into the formal specification language Z. A formal language such as Z offers a more precise description of requirements without sacrificing brevity. In addition to precision, a formal language allows the use of mathematics as a means of eliminating ambiguity and demonstrating parts of the specification [POTT91].

Formal languages also facilitate abstraction during requirements analysis and specification. Abstraction plays a significant role in this approach. Both models refer to a number of entities such as people, data, products, processes, etc. Generally, the internal structure of an entity is unimportant to analyzing the process requirement in this approach. The set theory of Z allows the establishment of global sets representing these abstractions. For example, a global set *WORKFORCE* may be used to represent all the members of an organization. In this form, specifications are compared to determine if matches exist.

3.4.2.2 Match Specifications. The formally specified requirements are compared using specification matching as described by [ZARE95b]. The match predicates for specification matching are those associated with *Pre/Post Matches.* The internal behaviors of the processes are not of consequence, but rather the pre- and post-conditions. The Z forms of the Exact Specification Match and Partial Specification Match are given in Figures 5 and 6:

$$
\begin{array}{|l|}
\hline
\quad \_espm\_ : Procreq \leftrightarrow Procreq \\
\hline
P_1 \ espm \ P_2 \Leftrightarrow \\
\qquad P_1 \ esm \ P_2 \\
\qquad P_1.pre \Leftrightarrow P_2.pre \\
\qquad P_1.post \Leftrightarrow P_2.post \\
\qquad P_1.subproc = P_2.subproc \\
\hline
\end{array}
$$
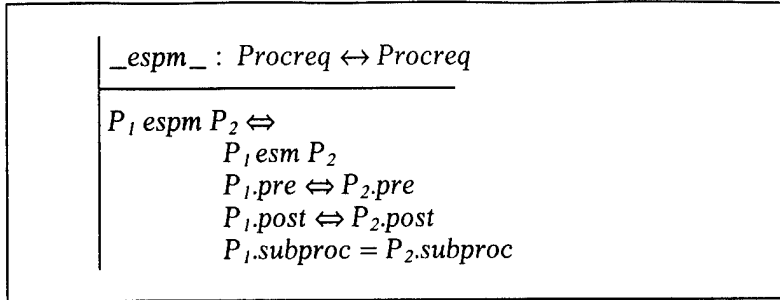
Figure 5 Exact Specification Match

$$
\begin{array}{|l|}
\hline
\quad \_pspm\_ : Procreq \leftrightarrow Procreq \\
\hline
P_1 \ pspm \ P_2 \Leftrightarrow \\
\qquad P_1 \ psm \ P_2 \\
\qquad P_1.pre \Rightarrow P_2.pre \\
\qquad P_2.post \Rightarrow P_1.post \\
\qquad P_1.subproc \subseteq P_2.subproc \\
\hline
\end{array}
$$
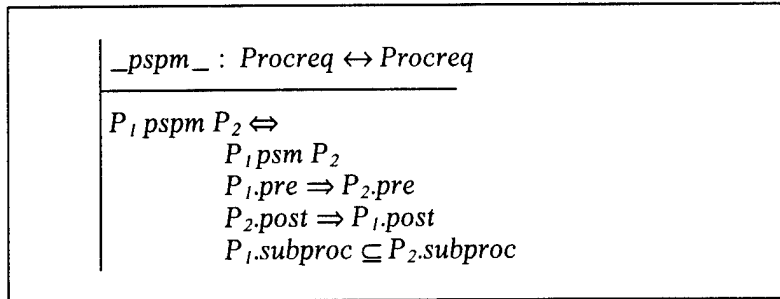
Figure 6 Partial Specification Match

In the Partial Specification Match, $P_1.pre \Rightarrow P_2.pre$, but the order is reversed for the post-conditions, namely $P_2.post \Rightarrow P_1.post$. Consequently, if the relationship between pre-conditions and post-conditions is also $pre \Rightarrow post$, then it is guaranteed that $P_1 \Rightarrow P_2$. This indicates P_2 is the more general of the two process requirements. Of course, in the Exact Signature Match the match predicate is equivalence and the order does not matter.

3.5 Verify Integrated Set

To verify the integrated set completely represents both models, each *Area to Address* from the QAF criteria and *Key Practice* from the CMM is correlated to the requirements that specify it. This ensures the models are adequately covered. Another means of verification is to compose requirements (i.e., the processes they represent) into process

descriptions which represent a functional area such as process management. Composing requirements in this manner also provides insight into the compatibility between the models.

3.6 Apply to Process Description

The result of the integration step achieves the overall goal of this research--to demonstrate the use of signature and specification matching to integrate the process requirements imposed by the CMM and QAF criteria. However, an additional objective is to demonstrate the use of this set.

In the software lifecycle, the requirements phase culminates in a requirements document describing *what* the system does. The design phase initiates to determine *how* the system behaves to meet those requirements. In this research, the integrated set of process requirements, along with the associated framework documentation comprise the requirements document. Naturally this document is used to design processes to meet all the stated requirements.

The sponsor of this research (as well as many other Air Forces software organizations) already has a process design intended to meet these requirements. Thus, the requirements document is used as a validation tool to determine if the design of Standard Systems Group's systems engineering process (SEP) meets the design requirements. The validation is accomplished simply by tracing requirements identified by the requirements document to actual processes in the SEP. The absence of processes to fulfill requirements indicates inadequacies in the SEP design. Since the QAF criteria

and especially the CMM identify only key process requirements (see Section 1.5.3), some SEP processes may not trace back to the requirements document. The necessity of these processes must be determined by other requirements (which could also be integrated into the requirements document using this approach). Backwards tracing also acts as a partial verification of the requirements document by possibly illuminating missing requirements.

The requirements trace will be done on a limited basis to demonstrate the utility of the requirements document. If the processes in the SEP were formally specified (and given the appropriate tools), formal queries could be formed to trace process requirements to all occurrences in the design--in this case, the SEP.

IV. Analysis and Results

This chapter discusses analysis of the research approach, along with intermediate and final results. The first section examines the approach itself and its effectiveness. The next section covers issues related to the analysis and decomposition of the two models. Finally, the last section provides a look at the results of the approach at the intermediate steps, as well as at the end.

4.1 Analysis of Approach

4.1.1 Functional Decomposition. Functional decomposition is a valuable step in this approach. The purpose of decomposing the requirements is to reduce complexity of multiple inputs, outputs, and conditions on a process, and to gain deeper understanding of the given requirements. The deeper understanding provides contextual information necessary for making decisions on which requirement specification to keep when matching signatures and specifications.

However, the purpose of this step may be accomplished through other tools or methods. In particular, the ad hoc use of tools such as data flow, IDEF0, and entity-relationship diagrams may be helpful; however, to receive the maximum benefit from these tools, they must be planned for, and integrated into, the approach. In addition to better utilizing tools, different methods of analysis may also be beneficial. Although the CMM and QAF criteria are functionally designed, an object-oriented approach to analyzing these models may be better. The heart of this approach is matching the process

requirement signatures, which consist of the input/output types. These types normally translate into object or object classes in object-oriented analysis. Using object-oriented analysis, the focus is on input/output types, or objects, from the beginning of the approach, thus facilitating signature matching. Additionally, the processes (or process requirements) themselves may be viewed as objects. The object view eases the task of composing integrated processes back together into a coherent model of an entire organization or some piece of it, such as a division or project.

4.1.2 Framework. The framework has a twofold purpose. The primary purpose of the framework is as a communication device. In this role, the framework is very effective. It provides a standard template for presenting all the information on each requirement to the customer. The framework used in this approach is a greatly scaled-down version of Hollenbach and Frake's [HOLL96] since most requirements are simply for a process to exist. Hollenbach and Frake's framework is used to record more detailed information on processes, such as tools, procedures, and metrics. Nonetheless, with a large number of required processes, the framework can quickly get unwieldy.

The secondary purpose of the framework is as a tool for managing the requirements as they are gleaned from the models. As a requirements management tool for this approach, the framework adds little value. A spreadsheet is a much better alternative for managing the requirement during the decomposition and matching steps. With the spreadsheet, subsets of the information put into the framework are easily created, thus enhancing signature matching. However, as a tool for managing the requirements or

associated processes on a long-term basis, the framework is a good choice. Thus, for this approach, the framework is best produced near the end, after all the analysis is done.

4.1.3 Use of Formal Language. The use of a formal language in this approach is central to the signature and specification matching paradigms. However, in this particular application of integrating the CMM and QAF criteria, using a formal language does not add a great deal of value. The primary reason for this is the nature of the CMM and QAF criteria. Both models are descriptive, rather than prescriptive. They tell what to do, but do not specify how. As a result, the requirements derived from the models generally state a process must exist and be used by an organization, but seldom specify any behavioral aspects of the process. Some process behaviors are specified in the models, but these behaviors may be viewed as sub-processes instead of pre-conditions or post-conditions.

There is also a secondary reason that this particular application of the approach does not benefit significantly from a formal language. The secondary reason is lack of automation for the formal language. For this application, signature matching bears the bulk of the workload. Although Z's types and schemas are ideal for use in signature matching, it lacks an automated proof-checker and associated search engine. Consequently, Z brings little to the signature matching table. Most of the signature matching work is done more efficiently by a spreadsheet. Even specification matching is as easily done without the use of Z or another formal language.

4.1.4 Modeling in Z. Modeling the requirements in Z is a bit troublesome, although not directly due to the nature of Z. The troublesome question is whether to model the

process requirements as static objects or as operations. The difference may be seen by considering the Z schemas in Figures 7 and 8.

```
┌─Procreq──────────────────────────────────
│ name: NAME
│ id: ID
│ correlates: ℘ STANDARDS
│ agents: ℘ Workerset
│ inputs: ℘ ARTIFACT × TYPE
│ outputs: ℘ ARTIFACT × TYPE
│ pre: ℘ PREDICATE
│ post: ℘ PREDICATE
│ subproc: ℘ Procreq
├──────────────────────────────────
│ inputs ≠ ∅
│ outputs ≠ ∅
│ agents ≠ ∅
│ pre ⇒ post
└──────────────────────────────────
```
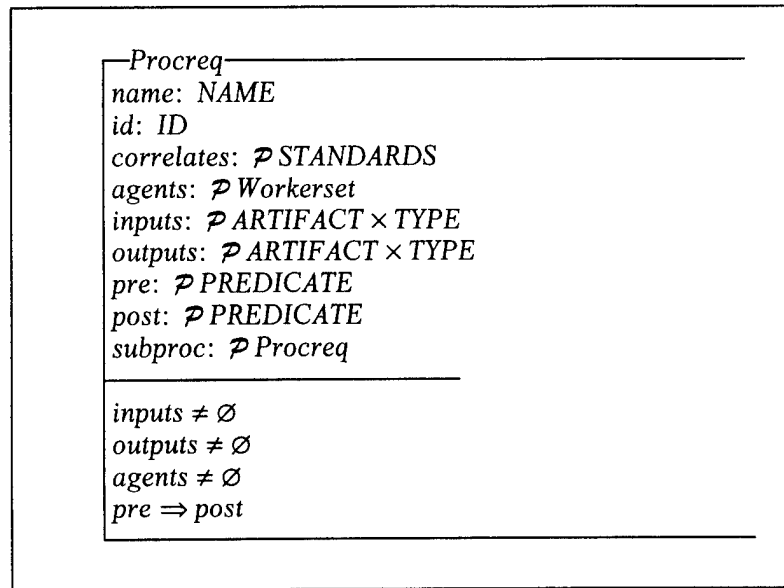
Figure 7 Process Requirement as a Static Object.

In Figure 7, the schema describes attributes of the object called *Procreq*. *Procreq* is merely a translation of a process requirement specified in the CMM or QAF criteria. The information related to the required process is provided in the signature using the components: *name, id, correlates, agents, inputs, outputs, pre, subproc*, and *post*. The predicate part of the schema states invariant constraints on all objects of this type.

The schema in Figure 8 specifies an actual process (in contrast to a process requirement) as an operation on the organization. Inputs and outputs are separate components, and pre-conditions and post-conditions are given in the predicate part of the schema. Sub-processes may also be listed in the predicate. When placed in the predicate

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in this way, the sub-processes are mandatory parts of the current process. The schema, when instantiated with actual values, is the skeleton of an actual process specification. It can be used in the skeletal form as a query for more complete processes, or be expanded to serve as a process specification.

```
┌─Process──────────────────────────
│ ΔOrganization
│ name: NAME
│ id: ID
│ correlates: ℘ STANDARDS
│ agents: ℘ Workerset
│ input1: TYPE
│ input2: TYPE
│ ...
│ subproc1: Process
│ subproc2: Process
│ ...
│ output1: TYPE
│ output2: TYPE
│ ...
├──────────────────────────────────
│ pre1
│ pre2
│ ...
│ subproc1
│ subproc2
│ ...
│ post1
│ post2
│ ...
└──────────────────────────────────
```

Figure 8 Process Requirement as Operation.

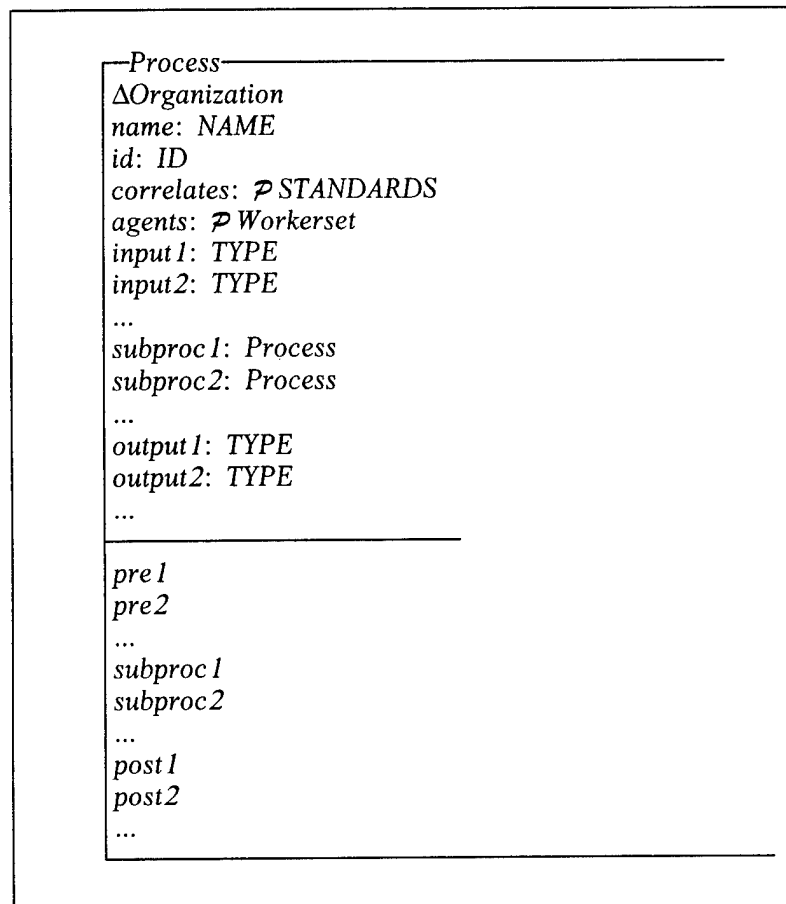The question of whether to model the process requirements as objects or as operations is best answered based on the application of the approach. In this particular

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application, process requirements are modeled as objects to be compatible with [HIBD95]. This issue is discussed in Section 6.3.1.1.

4.1.5 Signature and Specification Matching. Signature matching is the real workhorse of this approach. As mentioned in Section 3.2, merging the two models in their present form is quite difficult. The difficulty arises in large part from the semantics associated with the process requirements. Terms such as *key performance drivers* and *work organizations* from the QAF criteria, and *requirements allocated to software* and *project's defined software process* from the CMM are difficult to translate from one context to another because they hide their basic identity or type. However, signature matching focuses on the syntax of requirements. It uses the fundamental types of process artifacts, not the names of artifacts. In other words, the concept of signature matching provides a method for distilling out semantics and leaving syntax. Once matches are found, semantics are restored to provide context for determining a true match.

Although specification matching is integrated into this approach, for this application it is used sparingly. Comparisons based on matching signatures and context are sufficient to identify most redundant requirements. Specification matching is not needed as much due to the nature of the two models, as described above. The models mostly require the existence of the processes, but not much beyond that. Furthermore, process requirements are compared to other process requirements, not full-blown requirements specifications, which typically have more information to consider.

4.2 Analysis Issues

4.2.1 Comments on the Models.

    4.2.1.1 QAF Criteria. The QAF criteria is certainly a comprehensive document, which embodies the tenets of the quality movement. However, it is not particularly well-written, nor well-structured at a low level. The structure of *Categories*, *Items*, and *Areas to Address* do not adequately partition the requirements. A single *Area to Address* may impose several process requirements. A case in point is the description of the very first *Area to Address*:

> **Area 1.1.a.** calls for information on the major aspects of senior leadership - creating values and expectations, setting directions, developing and maintaining an effective leadership system, and building organization capabilities. Senior leaders need to reflect these values, and the leadership system needs to include teamwork at the headquarters level. [DEPA95c]

There are several process requirements embedded in these two sentences, including *Set Values*, *Set Expectations*, *Set Directions*, *Develop Leadership System*, and *Maintain Leadership System*. In addition to the descriptions, such as the one given above, the QAF criteria also include criteria and guidance for assessment. Instead of the descriptions and assessment criteria reflecting and complementing each other, the two often identify different requirements related to the same *Area to Address*. These often add further requirements for the organization to meet.

    Another criticism is the lack of pictures or diagrams. The diagram shown in Section 2.5.2 is the only diagram (other than linkage diagrams) for understanding the criteria. This diagram is insufficient to explain the cyclic nature of the QAF system. Process flow

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diagrams showing the interaction among the categories, such as the one provided by Brown in [BROW94], page 224, greatly increase understandability of the QAF system. The readability of linkage diagrams mentioned above could also be improved.

4.2.1.2 CMM. The CMM, by contrast, is a very readable document. The structure consisting of *Key Process Areas (KPA)*, *Goals*, *Common Features*, and *Key Practices* is explained up front and used throughout the document. The authors use a standard template to relay the information to the reader. When referencing other parts of the model, the CMM identifies the exact location for the reference. Although no diagrams appear in the practices, the pictures in the overview sufficiently convey the essence of the CMM. Moreover, the CMM explains peculiar terms and concepts very well in the overview and glossary sections.

4.2.2 Analysis Decisions.

4.2.2.1 Relation of Inputs to Outputs. All inputs are assumed to be non-empty, unless otherwise stated, and contribute to the outputs. Empty inputs may occur when a process requirement is specified at Maturity Levels 2 (ML2) and 3 (ML3) of the CMM. At ML3, the process is required to take as input the Project's Defined Software Process (PDSP), but at ML2 this formalized process does not yet exist. The input for the PDSP may be empty. See the requirement for *Project Planning* in Appendix A, page A-42 for an example. The assumption that all inputs contribute to producing outputs is particularly relevant to process requirements that specify that X is the basis for A. An example of this situation is found in the QAF criteria Area 1.2.b where it specifies that "...stated values

and expectations are actually the basis for organization actions and key decisions" [DEPA95c].

4.2.2.2 Meta-Processes. The CMM and the QAF criteria contain a number of what may be considered *meta-process* requirements. Meta-processes, as mentioned in Section 2.3.1, are processes that concern the development, assessment, measurement, improvement, or maintenance of a process. In the CMM, meta-processes are located in *Measurement and Analysis* and *Verifying Implementation*, in addition to certain *KPAs*, such as *Organization Process Definition* and *Process Change Management*, that are designed as meta-processes. A large part of the QAF Criteria falls into the meta-process realm. Categories 2 and 5, in particular, involve meta-processes, but also portions of other categories that mention measuring and improving the respective processes. Meta-processes are specified with one process requirement in the framework, then correlated to all the specific references and once to general references in the models. For instance, the requirement to *Measure Process* can be applied to any process. It is specified once, then correlated to specific references, such as in the CMM Quantitative Process Management Activity 4, and to general references, such as CMM Measurement and Analysis for every Key Process Area.

4.2.2.3 CMM - Other Common Features. Processes specified in the *Other Common Features (OCF)* of the CMM are used to help establish and institutionalize production processes in the organization. In describing the institutionalization processes, there are a few key phrases that merit special attention. First is the phrase "the project (*or organization*) follows a written organizational policy ..." from the *Commitment to*

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Perform OCF [PAUL93b]. It is explicitly stated in the CMM, but is implicitly embodied in the QAF in requirements to align plans, and determine key performance drivers and objectives based on goals. This is not so much a requirement for a process as it is a precondition for other required processes. However, it is not listed as a pre-condition to every process requirement. Instead, an explicit process requirement is included once in the framework and correlated to the appropriate references in the models. The second special phrase occurs in the *Ability to Perform* OCF. The phrase is "adequate resources and funding are provided for ..." [PAUL93b]. This phrase also should apply to every process executed in the organization and is not explicitly listed as a pre-condition for each process. Again, it is specified as a separate requirement. The phrases "... are trained ..." and "... receive orientation ..." in the *Ability to Perform* OCF are similar situations and are treated the same way as stated before. Finally, the phrase "... according to a documented procedure" occurs in the *Activities Performed* Common Feature. This phrase is applied to many activities in the CMM to emphasize repeatability and institutionalization [PAUL93b]. The assumption of this analysis is that procedures are documented as part of a process, hence should not be included as an input to the process.

There is one final note on the exclusion of certain conditions or inputs. Although there are some equivalent ideas in the QAF criteria, these phrases are unique to the CMM. Thus including these preconditions and inputs contributes little to the overall integration goal.

4.2.2.4 Naming Requirements. The names of the process requirements are generally drawn directly from the models, though in some cases, names are changed to

make them more generic and inclusive. These changes mostly occur with the CMM since process and agent names are domain specific. The term *subcontractor* is used in the CMM, while *supplier* is used in the QAF criteria. This research opts for the more general term, thus *Plan Subcontractor Work* becomes *Plan Supplier Work.*

Consistency in naming process requirements is also an aim. For example, all uses of *Evaluate* should be for similar situations and ideally result in the same output. Specifically, *Evaluate Process* and *Evaluate Supplier* both involve evaluating and both have actions as outputs. Other terms like *Assess*, *Supplier*, *Measure*, and *Review* are used consistently throughout the framework.

4.2.2.5 Agents versus Inputs. For the most part, people, or groups of people, are designated as agents in the framework. Agents are those who conduct or perform the processes. In a few cases, however, people or groups are designated as inputs to the process and treated as artifacts. In still other cases, the same people are treated as both agent and input. If the people or group are involved in the process, but take no active part, they are considered as inputs or artifacts. This occurs in situations such as identifying and selecting customer groups. In these cases, an attempt to distinguish between the two is made by naming the agent *Worker* and the input *Member*, for example. *Worker* implies action, whereas *Member* implies belonging. For those processes that employ the same people as agent and input, the same name is used for the agent and input. An instance of this situation is the *Evaluate Member* process requirement. The members being evaluated are included as agents and as inputs to this process. The rationale is that the process is being performed on the members, and the

members play an active role in their evaluations, as in Air Force mandated feedback sessions.

4.2.3 Artifact Types.

4.2.3.1 Hierarchy of Data. Both models require organizations to collect large amounts of relevant process and product data. In this approach, the type *DATA* is used for any data referred to by the models. However, output names uniquely identify the source or the characteristics of the data.

4.2.3.2 Data and Analysis. The *DATA* type is used to imply raw data, whereas the *ANALYSIS* type is used to imply analyzed data. Raw data are the primary output of measurement and assessment processes, and the secondary output of various other processes. Raw data are the input to only a few process requirements other than *Analyze Data*. In general, data are assumed to be analyzed before being used by other processes.

4.2.3.3 Actions. The *ACTION* type is the output of reviews, evaluations, and audits, along with various other process requirements. As an output of a process requirement, the *ACTION* type is considered a special form of information that describes sets of possible operations to be performed. The type does not imply the actions are actually executed as sub-processes or outputs of a process. For this application, the subtle difference does not have an impact, but the difference would have an impact in building an executable model based on these specifications. Precisely, the decision must be made to view the output actions as operations to perform--in which case the actions may be put on an event queue and eventually executed--or as a special form of information, as in this application.

4.2.3.4 Products. The *PRODUCT* type is used for work products and end products. It is a super type that encompasses practically any of the other artifact types in certain situations. A case in point concerns the REQUIREMENT type. Product requirements specified by the user are considered of type *REQUIREMENT*, but may also be a PRODUCT type when in the form of a software requirements document (SRD). *Review Allocated Requirements* is used to review the allocated requirements, which are the REQUIREMENT type, to ensure requirements are feasible, testable, correct, etc. *Review Product* is used to review the SRD, which is a PRODUCT type, to ensure the product meets organizationally-established criteria.

4.2.3.5 Plans and Planning. The QAF criteria specifies a number of planning processes and the CMM requires a number of plans at the organization and project levels. The importance of plan requirements lies not in the documents themselves, but in the process of planning. The process of planning is fundamentally the same for each of the planning processes; despite this, there are eleven planning requirements in the framework. One process requirement addresses strategic level, or organization planning, another addresses tactical, or project planning. These two process requirements have matching signature and specifications, but it is felt the two demand vastly different considerations and require different skills, and are thus separated. Other planning requirements are very specific to an area, but may employ the same methods. Examples are *Plan Community Involvement, Plan Peer Review,* and *Develop Integration Test Plan.*

The *PLAN* type is viewed as a special kind of the *PRODUCT* type. Thus, *Review Product* is an appropriate process requirement to apply to plans. Plans may also be regarded as embodying other artifacts like goals, schedules, processes, requirements, etc.

4.3 Results

4.3.1 Intermediate Results.

4.3.1.1 QAF Criteria.
The QAF Criteria are made up of 7 Categories, 24 Assessment Items, and 54 Areas to Address. Functional decomposition of the QAF criteria results in 148 requirements. Some of the 148 requirements are used more than once to provide complete coverage. Consequently, the QAF criteria are represented by a total of 209 requirements. The exact numbers are not significant since different analysts will make different decisions on how to decompose a particular English paragraph. The numbers do provide general insight into the purpose and intended use of the model. In the QAF criteria, nearly 40 percent of the 148 requirements involve measuring products and processes, analyzing data, evaluating products and processes, or improving them. Close to 25 percent of the distinct requirements correlate to the Process Management category alone. These numbers indicate the emphasis the QAF criteria places on process. About 15 percent relate to the customer, and another 7 percent relate to the supplier.

4.3.1.2 CMM.
The CMM is comprised of 18 Key Process Areas and 150 Activities to Perform, along with practices in the OCFs. These practices are broken into 190 requirements. Many of the 190 requirements are used more than once to provide complete coverage. Hence, the CMM is represented by a total of 350 requirements. The

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majority of the repeat process requirements involves the institutionalization processes referenced in the OCFs. The 190 distinct requirements include a number of requirements addressing the same processes, but from the different perspectives of different maturity levels. This dynamic especially occurs in the areas of project management, process management and improvement, quality management and improvement, and data gathering and analysis.

4.3.2 Final Set of Integrated Requirements. The following paragraphs discuss the final results of this application of the requirements matching approach. The final set of integrated requirements are available in Appendix A, with cross references in Appendices B through E.

4.3.2.1 Signature Matching. Most of the comparisons between requirements are performed using signature matching and contextual information. As mentioned in Section 4.1.3, signature matching is most efficiently done by using a spreadsheet. Nonetheless, it is important to recognize what operations are actually being performed. Recalling Exact Signature Match from Section 3.4.1, consider Figures 9 and 10, *Measure Process* and *Collect Measurement Data*, respectively.
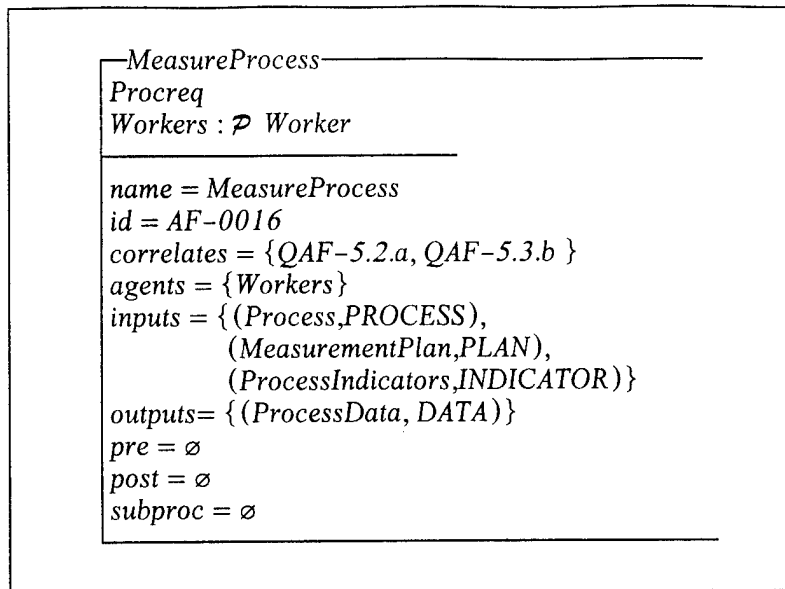
```
┌──────────────────────────────────────────────────────┐
│                                                        │
│   ┌─MeasureProcess──────────────────────────────       │
│   │ Procreq                                            │
│   │ Workers : ℘ Worker                                 │
│   │ ──────────────────────────────────                │
│   │ name = MeasureProcess                              │
│   │ id = AF-0016                                       │
│   │ correlates = {QAF-5.2.a, QAF-5.3.b }               │
│   │ agents = {Workers}                                 │
│   │ inputs = { (Process,PROCESS),                      │
│   │            (MeasurementPlan,PLAN),                 │
│   │            (ProcessIndicators,INDICATOR)}          │
│   │ outputs= { (ProcessData, DATA)}                    │
│   │ pre = ∅                                            │
│   │ post = ∅                                           │
│   │ subproc = ∅                                        │
│   └──────────────────────────────────────              │
└──────────────────────────────────────────────────────┘
```

Figure 9 Requirement to Measure Process.

```
┌──────────────────────────────────────────────────────┐
│                                                        │
│   ┌─CollectMeasurementData──────────────────────       │
│   │ Procreq                                            │
│   │ Collectors : ℘ Worker                              │
│   │ ──────────────────────────────────                │
│   │ name = CollectMeasurementData                      │
│   │ id = AF-0366                                       │
│   │ correlates = {CMM-QP.Ac4}                          │
│   │ agents = {Collectors}                              │
│   │ inputs = { (Process,PROCESS), (QPMPlan,PLAN),      │
│   │            (DatatoCollect,INDICATOR)               │
│   │ outputs= { (MeasurementData,DATA)}                 │
│   │ pre = ∅                                            │
│   │ post = ∅                                           │
│   │ subproc = ∅                                        │
│   └──────────────────────────────────────              │
└──────────────────────────────────────────────────────┘
```
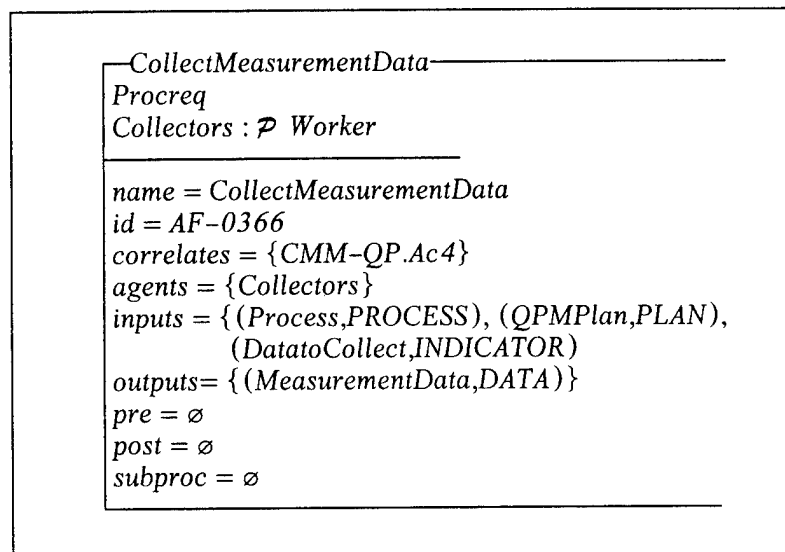
Figure 10 Requirement to Collect Measurement Data

Figure 11 shows that by simply substituting types for artifact names, a comparison

can be made between these two process requirements by attempting to satisfy the axioms

of the Exact Signature Match. If the axioms are satisfied resulting in a final result of

TRUE, the two signatures exactly match. The two process may be redundant.

$P_1 = MeasureProcess$
$P_2 = CollectMeasurementData$

$MeasureProcess\ esm\ CollectMeasurementData \Leftrightarrow$
  $ran\ SQAReview.inputs = ran\ CollectMeasurementData.inputs \land$
  $ran\ SQAReview.outputs = ran\ CollectMeasurementData.outputs$

$MeasureProcess\ esm\ CollectMeasurementData \Leftrightarrow$
  $\{PROCESS, PLAN, INDICATOR\} = \{PROCESS, PLAN, INDICATOR\}$
  $\land\ \{DATA\} = \{DATA\}$

$MeasureProcess\ esm\ CollectMeasurementData \Leftrightarrow (TRUE \land TRUE)$

$MeasureProcess\ esm\ CollectMeasurementData \Leftrightarrow TRUE$

Figure 11 Application of Exact Signature Match

Measure Process and *Collect Measurement Data* are substituted for P₁ and P₂, respectively. The set of input and output types for *Measure Process* are compared to those of *Collect Measurement Data*. If the sets are equal, Exact Signature Match returns a TRUE, indicating the two signature have identical signatures. It is important to note that the comparison is made based on the type of an input or output, rather than on an arbitrary, albeit informative, name.

The prior example explains the conceptual foundation for matching signatures. However, since the majority of signature matching in this research is performed using a spreadsheet, the example is shown again using the spreadsheet. Table 1 shows a partial listing representing the signatures of *Measure Process* and *Collect Measurement Data*, as well as several other process requirements with DATA as the output type. (The actual spreadsheet includes as many input and output columns as needed. For this research, 7 input and 3 output columns are needed. Other fields such as ID number are also helpful.)

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Name	Input1	Input2	Input3	Output1
Measure Activity	Activity	Indicator	Plan	Data
Measure Process	Process	Indicator	Plan	Data
Collect Measurement Data	Process	Indicator	Plan	Data
Measure Leader Involvement	Process	Indicator	Plan	Data
Analyze OSSP	Process	Technology	Requirement	Data
Gather Product Quality Data	Product	Indicator		Data
Measure Product Quality	Product	Indicator		Data
Measure Product	Product	Indicator	Plan	Data
Gather Service Quality Data	Service	Indicator		Data
Gather Supplier Data	Source	Indicator		Data
Gather Financial Data	Source	Indicator		Data

Table 1 Sample Excel Spreadsheet of Process Requirement Signatures.

From this example, it is easy to see that *Measure Process* and *Collect Measurement Data*

have matching signatures. Additionally, *Measure Leader Involvement* is identified as a

candidate for matching these two requirements. Furthermore, it is clear *Measure Product*

Quality and *Gather Product Quality Data* are partial matches with *Measure Product*. A

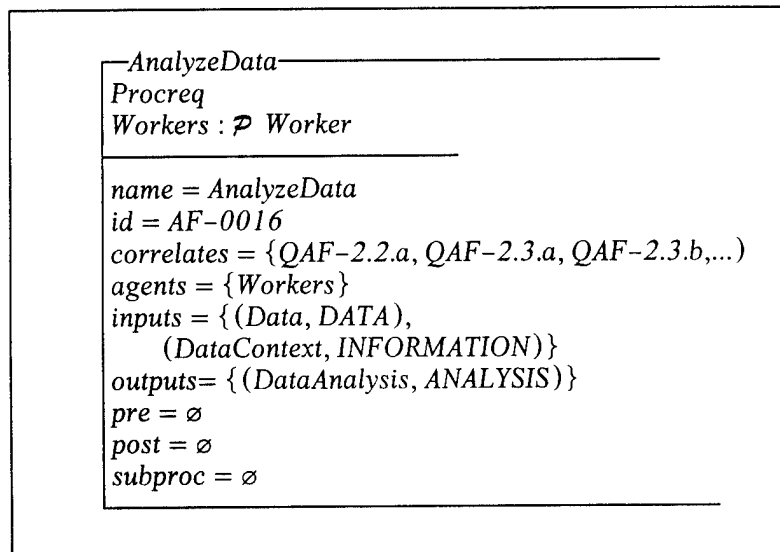more formal presentation of Partial Signature Match follows in Figures 12-14.

```
┌─AnalyzeData────────────────┐
│Procreq                     │
│Workers : ℘ Worker          │
├────────────────────────────┤
│name = AnalyzeData          │
│id = AF-0016                │
│correlates = {QAF-2.2.a, QAF-2.3.a, QAF-2.3.b,...)│
│agents = {Workers}          │
│inputs = {(Data, DATA),     │
│     (DataContext, INFORMATION)}│
│outputs= {(DataAnalysis, ANALYSIS)}│
│pre = ∅                     │
│post = ∅                    │
│subproc = ∅                 │
└────────────────────────────┘
```
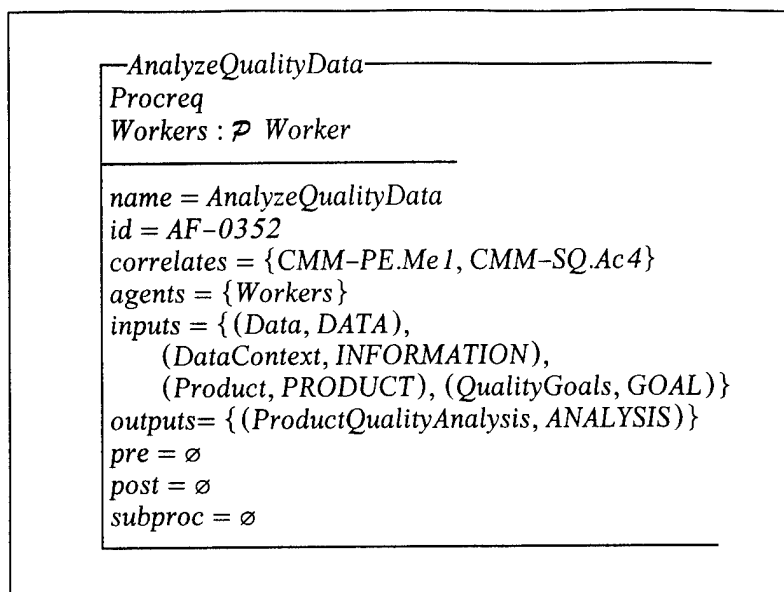
Figure 12 Requirement to Analyze Data

```
┌─────────────────────────────────────────────────────┐
│                                                     │
│   ┌──AnalyzeQualityData──────────────────────       │
│   │ Procreq                                         │
│   │ Workers : P Worker                              │
│   ├────────────────────────────                     │
│   │ name = AnalyzeQualityData                       │
│   │ id = AF-0352                                    │
│   │ correlates = {CMM-PE.Me1, CMM-SQ.Ac4}           │
│   │ agents = {Workers}                              │
│   │ inputs = {(Data, DATA),                         │
│   │     (DataContext, INFORMATION),                 │
│   │     (Product, PRODUCT), (QualityGoals, GOAL)}   │
│   │ outputs= {(ProductQualityAnalysis, ANALYSIS)}   │
│   │ pre = ∅                                         │
│   │ post = ∅                                        │
│   │ subproc = ∅                                     │
│   └──────────────────────────────                   │
│                                                     │
└─────────────────────────────────────────────────────┘
```

Figure 13 Requirement to Analyze Quality Data

```
┌─────────────────────────────────────────────────────┐
│                                                     │
│  P₁ = AnalyzeData                                   │
│  P₂ = AnalyzeQualityData                            │
│                                                     │
│  AnalyzeData psm AnalyzeQualityData ⟺               │
│      ran SQAReview.inputs ⊆ ran AnalyzeQualityData.inputs ∧ │
│      ran SQAReview.outputs ⊆ ran AnalyzeQualityData.outputs │
│                                                     │
│  AnalyzeData psm AnalyzeQualityData ⟺               │
│      {DATA, INFORMATION} ⊆                          │
│          {DATA, INFORMATION, PRODUCT, GOAL} ∧       │
│          {ANALYSIS}⊆ {ANALYSIS}                     │
│                                                     │
│  AnalyzeData psm AnalyzeQualityData ⟺ (TRUE ∧ TRUE) │
│                                                     │
│  AnalyzeData psm AnalyzeQualityData ⟺ TRUE          │
│                                                     │
└─────────────────────────────────────────────────────┘
```

Figure 14 Application of Partial Signature Match.

4.3.2.2 Specification Matching. Specification matching is used sparingly in

this approach, but is necessary in a few cases. Specification matching is performed

manually, much in the way it is presented here (other than signature matching, which is

performed using a spreadsheet as described in the last section.)

Figures 15 and 16 contain specifications for *Develop Training Course* from the CMM and *Design Training* from the QAF criteria. Even though the Agents do not exactly match, Exact Specification Match is still satisfied as seen in Figure 17. Neither Exact Specification Match, nor Exact Signature Match consider Agents for a match since it is Agent skills that are important and not the name attached to the Agent. Further discussion of this point is in Section 6.3.1.

$$
\begin{array}{|l|}
\hline
\text{—DevelopTrainingCourse—} \\
Procreq \\
Developers : \mathcal{P}\ Worker \\
TrainingGroup : \mathcal{P}\ Worker \\
\hline
name = DevelopTrainingCourse \\
id = AF\text{-}0304 \\
correlates = \{CMM\text{-}TP.Ac4\} \\
agents = \{Developers, TrainingGroup\} \\
inputs = \{(OrgTrainingPlan, PLAN), \\
\qquad\quad (TrainingNeeds, REQ)\} \\
outputs = \{(TrainingCourse, COURSE)\} \\
pre = \varnothing \\
post = MEETS(TrainingCourse, TrainingNeeds) \\
subproc = \varnothing \\
\hline
\end{array}
$$
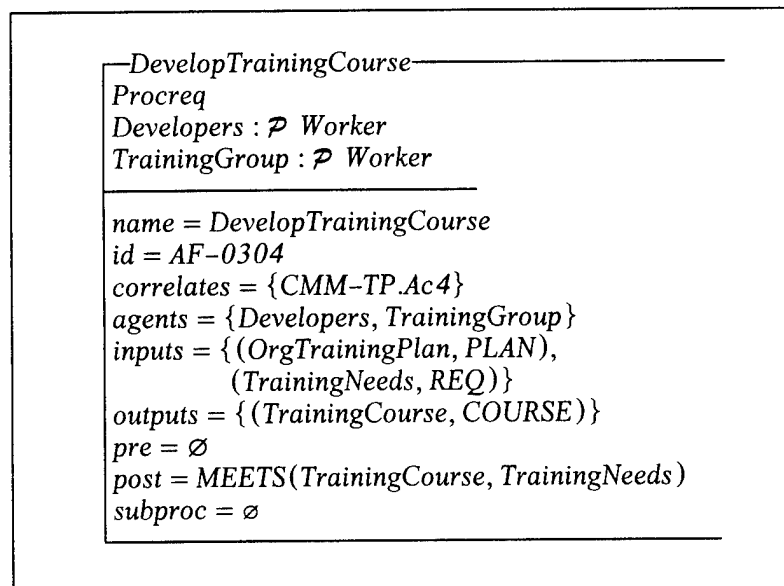
Figure 15 Requirement to Develop Training Course

In Figure 17, the Exact Specification Match is applied to *Develop Training Course* and *Design Training*. Exact Signature Match is applied to ensure the signatures match and the pre-conditions and post-conditions of each requirement are compared to ensure they are equivalent. Moreover, any sub-processes of the two requirements are required to be equal for an exact specification match.

```
┌─DesignTraining────────────────────────────────
│ Procreq
│ Designers : ℗ Worker
├───────────────────────────────────────────────
│ name = DesignTraining
│ id = AF-0082
│ correlates = {QAF-4.3.b}
│ agents = {Designers}
│ inputs = {(TrainingPlan, PLAN),(TrainingNeeds, REQ)}
│ outputs = {(TrainingCourse, COURSE)}
│ pre = ∅
│ post = MEETS(TrainingCourse, TrainingNeeds)
│ subproc = ∅
└───────────────────────────────────────────────
```
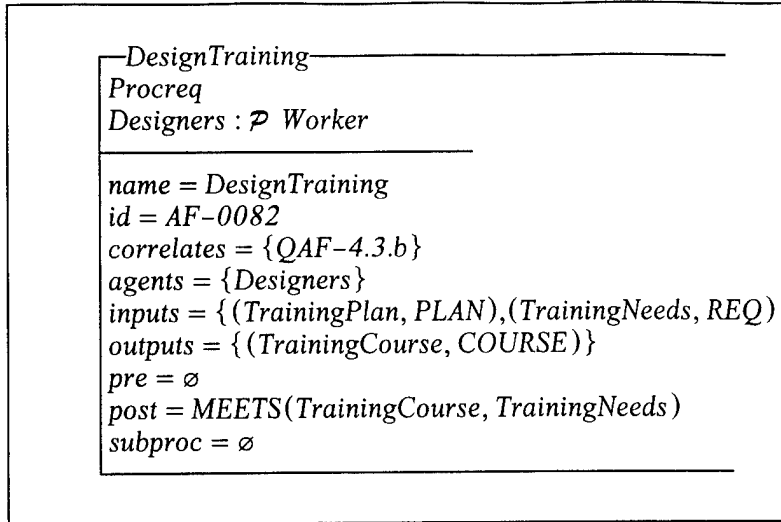
Figure 16 Requirement to Design Training.

P_1 = DevelopTrainingCourse
P_2 = DesignTraining

DevelopTrainingCourse espm DesignTraining ⇔
    DevelopTrainingCourse esm DesignTraining ⇔
       (ran DevelopTrainingCourse.inputs = ran
DesignTraining.inputs ∧
       ran DevelopTrainingCourse.outputs = ran
DesignTraining.outputs) ∧
    DevelopTrainingCourse.pre ⇔ DesignTraining.pre ∧
    DevelopTrainingCourse.post ⇔ DesignTraining.post ∧
    DevelopTrainingCourse.subproc = DesignTraining.subproc

DevelopTrainingCourse espm DesignTraining ⇔
    DevelopTrainingCourse esm DesignTraining ⇔
       ({PLAN, REQ} = {PLAN, REQ} ∧
       {COURSE} = {COURSE}) ∧
    TRUE ⇔ TRUE ∧
    Meets(COURSE,REQ) ⇔ Meets(COURSE,REQ)
    ∅ = ∅

DevelopTrainingCourse espm DesignTraining ⇔
    DevelopTrainingCourse esm DesignTraining ⇔ (TRUE ∧TRUE) ∧
    TRUE ∧ TRUE ∧ TRUE

DevelopTrainingCourse espm DesignTraining ⇔ TRUE ∧ TRUE

DevelopTrainingCourse espm DesignTraining ⇔ TRUE

Figure 17 Application of Exact Specification Match.

Figures 18-20 show an example of the Partial Specification Match.

```
┌─IndependentSQAReview──────────────────────
Procreq
SQAGroup : 𝒫 Worker
───────────────────────────────────────────
name = IndependentSQAReview
id = AF-0274
correlates = {QA.Ac10}
agents = {Reviewers}
inputs = {(SQAActivities, ACTIVITY),
     (IndependentSQAPlan, PLAN),
     (ReviewCriteria, CRITERIA)}
outputs= {(SQAActionItems, ACTION),
     (Report, INFORMATION)}
pre = {[agents ∩ SQAGroup = ∅]}
post = {[¬Meets(SQAActivities, ReviewCriteria)
          ⇒ SQAActionItems ≠ ∅]}
subproc = {Document(SQAActionItems)}
```

Figure 18 Requirement for Independent SQA Review.

```
┌─SQAReview──────────────────────────────────
Procreq
───────────────────────────────────────────
name = SQAReview
id = AF-0205
correlates = {QA.Ac4}
agents = {SQAGroup}
inputs = {(ProjectActivities, ACTIVITY),
     (SQAPlan, PLAN),
     (ReviewCriteria, CRITERIA)}
outputs= {(CorrectiveActions,ACTION),
     (Report,INFORMATION)}
pre = ∅
post = {[¬Meets(ProjectActivities,ReviewCriteria)
          ⇒ CorrectiveActions ≠ ∅]}
subproc = {Document(CorrectiveActions)}
```
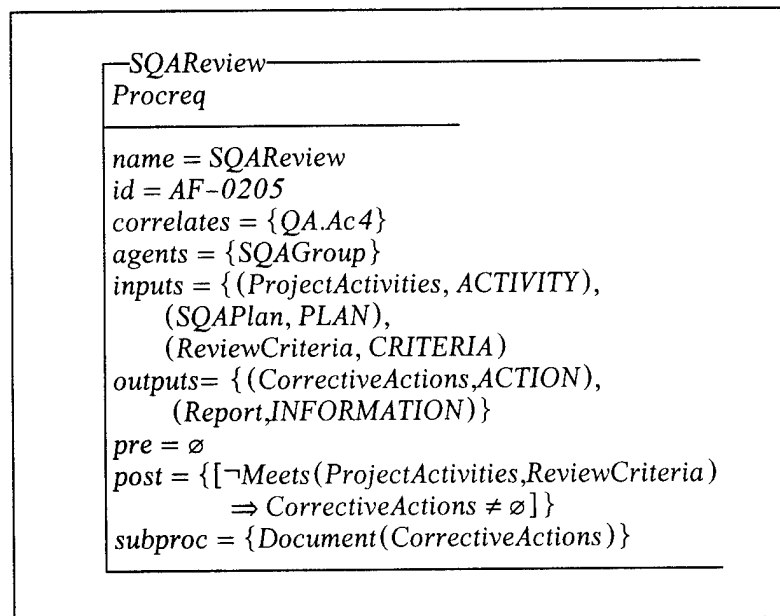
Figure 19 Requirement for SQA Review

As seen here in Figure 20, Partial Specification Match is applied to *SQA Review* and

Independent SQA Review:

$P_1 = SQAReview$
$P_2 = IndependentSQAReview$

$SQAReview\ pspm\ IndependentSQAReview \Leftrightarrow$
$\quad SQAReview\ psm\ IndependentSQAReview \Leftrightarrow$
$\quad\quad (ran\ SQAReview.inputs \subseteq ran\ IndependentSQAReview.inputs \wedge$
$\quad\quad ran\ SQAReview.outputs \subseteq ran\ IndependentSQAReview.outputs)$
$\quad\quad \wedge$
$\quad\quad SQAReview.pre \Rightarrow IndependentSQAReview.pre \wedge$
$\quad\quad IndependentSQAReview.post \Rightarrow SQAReview.post \wedge$
$\quad\quad SQAReview.subproc \subseteq IndependentSQAReview.subproc$

$SQAReview\ pspm\ IndependentSQAReview \Leftrightarrow$
$\quad SQAReview\ psm\ IndependentSQAReview \Leftrightarrow$
$\quad\quad (\{ACTIVITY, PLAN, CRITERIA\} \subseteq \{ACTIVITY, PLAN, CRITERIA\} \wedge$
$\quad\quad\quad \{ACTION, INFORMATION\} \subseteq \{ACTION, INFORMATION\} \wedge$
$\quad\quad TRUE \Rightarrow (GROUP \cap GROUP = \varnothing) \wedge$
$\quad\quad (\neg Meets(ACTIVITY, CRITERIA) \Rightarrow ACTION \neq \varnothing) \Rightarrow$
$\quad\quad\quad (\neg Meets(ACTIVITY, CRITERIA) \Rightarrow ACTION \neq \varnothing)$
$\quad\quad Document(ACTION) \subseteq Document(ACTION)$

$SQAReview\ pspm\ IndependentSQAReview \Leftrightarrow$
$\quad SQAReview\ psm\ IndependentSQAReview \Leftrightarrow (TRUE \wedge\ TRUE) \wedge$
$\quad TRUE \wedge TRUE \wedge TRUE$

$SQAReview\ pspm\ IndependentSQAReview \Leftrightarrow TRUE \wedge TRUE$

$SQAReview\ pspm\ IndependentSQAReview \Leftrightarrow TRUE$

Figure 20 Application of Partial Specification Match.

For a successful match, *SQA Review* must be more specific than (or equivalent to)

Independent SQA Review. In other words, the signature of *SQA Review* must be equal to,

or a subset of, the signature of *Independent SQA Review*. The pre-conditions of *SQA*

Review must imply the pre-conditions of *Independent SQA Review* and the post-

conditions of *Independent SQA Review* must imply the post-conditions of *SQA Review*.

Finally, the sub-processes of *SQA Review* must be equal to, or a subset of, the sub-

processes of *Independent SQA Review*. It is important to note that Partial Specification Match also returns TRUE, indicating a match, for two requirements with signatures satisfying Partial Signature Match (but not Exact Signature Match) and specifications that are equivalent.

4.3.2.3 Final Results. The final set of integrated requirements consists of 196 distinct process requirements. Of these, 82 are uniquely correlated to the CMM, 71 are uniquely correlated to the QAF criteria, and 43, or about 22 percent, are correlated to both models. At first glance, these numbers seem to indicate a significant, but not overwhelming, relationship between the two models. However, this viewpoint is misleading. A better measure of the relationship depends on the number of QAF requirements that relate to CMM requirements and vice versa. Using this measure, 43 out of 54, or nearly 80 percent, of the QAF Areas to Address relate to CMM practices, while 90 out 150, or 60 percent of the CMM practices relate to QAF Areas to Address. (This does not include practices in the Other Common Features.) The more important relationships are discussed in Section 6.1.

V. Verification and Application

5.1 Verification

In developing software, it is important to ensure each transformation from requirements to design to implementation is accurate. In this research, there are two major transformation steps. The first transformation involves decomposing CMM and QAF requirements into low-level requirements. The second transformation involves integrating these low-level requirements into a single set. As in software development, each of these transformations are verified.

5.1.1 Decomposed Requirements. The verification for this step is twofold. One part of the verification is to ensure each element of the CMM and QAF criteria are represented in the respective set of low-level requirements. This check is facilitated by a cross-reference similar to Appendix D or E. The second part of the verification is to ensure each low-level requirement, or group of requirements, accurately defines the respective component from the CMM or QAF criteria. Ideally, this is accomplished by someone other than the one who performed the decomposition. In this effort, this is accomplished by the researcher.

5.1.2 Integrated Requirements. After integrating the requirements, it is important to assure the completeness of the integrated set. Appendices B and C are cross-references providing this assurance. Another important part of verifying the integrated set relates to compatibility. The assumption is the two models are compatible, thus the integrated set should represent a set of processes that can be composed together to form systems. For

example, the process improvement system is composed of several processes meeting the requirements given in the integrated set. Figure 21 shows how these processes might be put together to create a process improvement system in the organization.
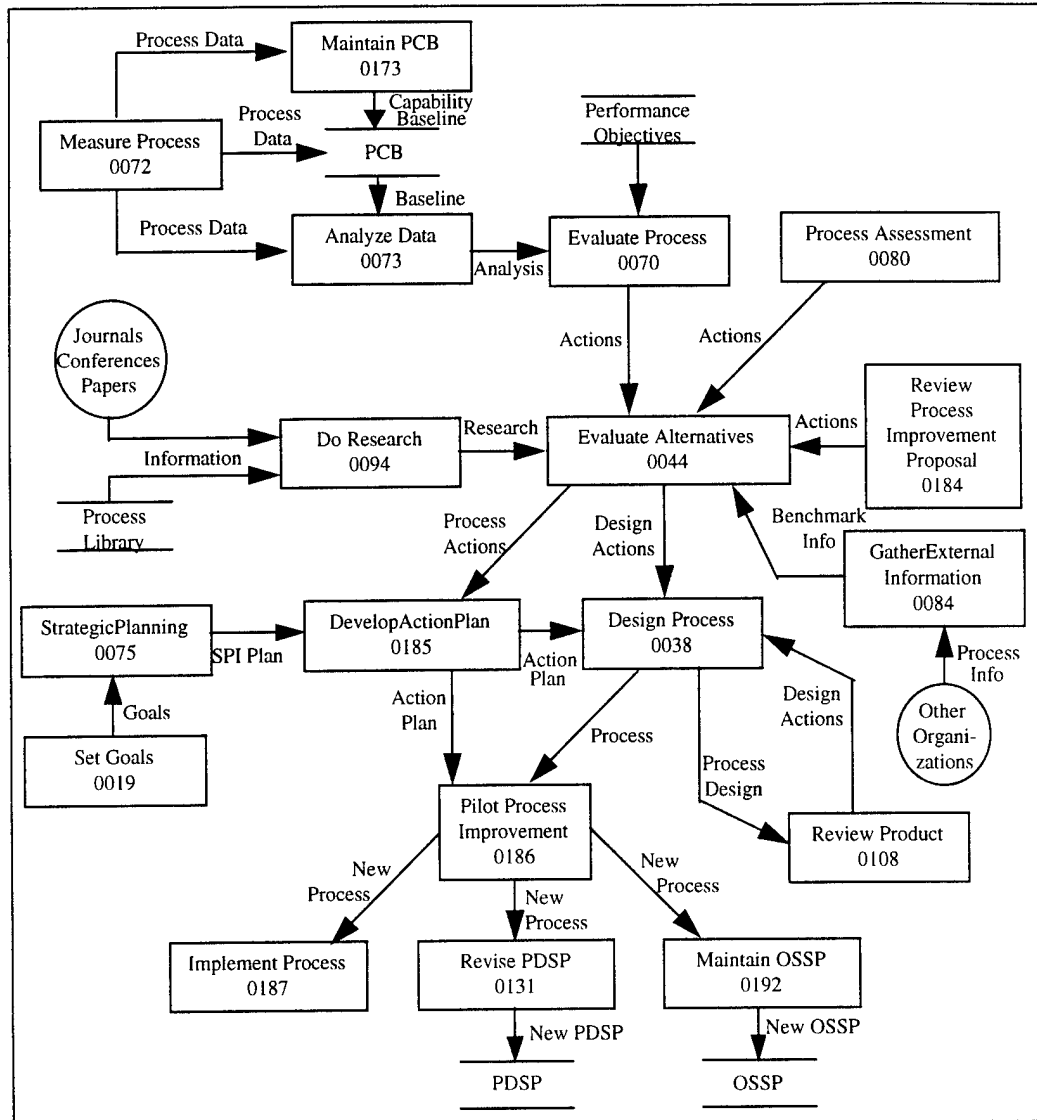
Figure 21 Composition of Processes to Form a Process Improvement System.

This example also illustrates the essence of an organization's Process Asset Library (PAL). The PAL is essentially a reuse library for process components. For a particular

application, the user simply identifies process components that meet requirements, and composes them into processes or systems.

5.2 Application

5.2.1 Overview of SSG's Systems Engineering Process (SEP). The SEP is a description of the processes used by the Standard Systems Group (SSG) to produce software systems. In terms of the CMM, it is the Organization Standard Software Process, or OSSP. It describes the system lifecycle and provides templates and tailoring guidelines for users. In terms of the QAF Criteria, it contains the designs of the various production and support processes.

The SEP is divided into three phases, designated as Pre-Development, Development, and Post-Development. These phases are subdivided into nine processes. The Development phase consists of five processes, while the other two phases have two processes each. Each process is composed of four stages: Perform Activity, Work Review, Update Project Indicators, and Management Review. These four stages are common to all nine processes across all three phases. The stages are broken into activities, tasks, and procedures, with activities the most general and procedures the most specific [STAN96]. The requirements from the CMM and QAF Criteria are generally at the activity or task level. The SEP does not explicitly identify linkage to either model.

5.2.2 Applying the Integrated Set of Requirements to the SEP. In software development, the design phase begins after sufficiently describing the problem domain and restricting the solution space. With the integrated set of process requirements, process design may begin. However, in this application the SEP, or the process design,

already exists. Therefore, the integrated requirements are compared to the SEP to identify linkage from the SEP to either of the models through the integrated set. A sample of this comparison is provided in Table 2 on the following page. Each reference from the SEP is mapped to a process requirement from the integrated set and the appropriate linkage to the models. The mapping is not accomplished by matching signatures or specifications since the SEP does not give inputs and outputs at the activity and task levels. Instead, the mapping is performed by using the integrated requirement information given in the framework, and comparing it to the activities, tasks, and procedures specified in the SEP. Some SEP requirements, such as Negotiate Estimates with Group(s) and Create Project Plan, map very closely to the related integrated requirements. Other requirements in the SEP, like Analyze CSRD and Level of Effort Baseline, are more specific than the integrated requirements. This is to be expected, since the integrated requirements, like the models from which are derived, are meant to be general, reusable requirements that are applied as needed throughout the organization. Additionally, as addressed in Section 1.5.3, there may be requirements for activities, tasks, or procedures in the SEP that are not linked to any requirement in the integrated set.

SEP Reference	Linkage	ID	Level
4.1.1 Needs Analysis: Perform Activity			
Analyze CSRD	RM.Ac1, RM.Ac3, PE.Ac2	AF-0149	Task
Level of Effort Baseline	Ab	AF-0055	Task
POM/Funding Documentation	Ab	AF-0056	Task
4.1.2 Needs Analysis Work Review			
Review Preparation	PR.Ac1	AF-0170	Act
Analyze CSRD	RM.Ac1, RM.Ac3, PE.Ac2	AF-0149	Task
Review Follow-up	RM.Ac1, PE.Ac2	AF-0150	Task
4.2.1 Project Planning: Perform Activity			
Complete SEP Tailoring Worksheet	QA.Ac3, PF.Ac3, IM.Ac1, PE.Ac1	AF-0130	Task
Develop Estimates and Schedules	PP.Ac10, PP.Ac15, PF.Ac4, IM.Ac4, IM.Ac5, IM.Ac7	AF-0134	Task
Develop Estimates and Schedules	PP.Ac10, PP.Ac15, PF.Ac4, IM.Ac4, IM.Ac5, IM.Ac7	AF-0135	Task
Develop Estimates and Schedules	PP.Ac12, PP.Ac15, PF.Ac4, IM.Ac4, IM.Ac5, IM.Ac9	AF-0137	Act
Negotiate estimates with group(s)	PF.Co2, PF.Co3, PF.Ac4, PD.Ac5	AF-0111	Task
Create Project Plans	5.1.a, 5.2.a, 5.3.b, PP.Ac2, PP.Ac3, PP.Ac5, PP.Ac6, PP.Ac7, PP.Ac14, PT.Ac1, PT.Ac2, QA.Ac1, QA.Ac3, CM.Ac1, TP.Ac1, IM.Ac3, IM.Ac4, IM.Ac5, IC.Ac3, IC.Ac4, QP.Ac1, SQ.Ac1, DP.Ac1	AF-0114	Act
Project Level Training Plan	4.3.b, TP.Ac1	AF-0089	Task
Test and Evaluation Master Plan	PE.Ac7	AF-0161	Task
4.2.3 Project Planning: Update Project Indicators			
Number of man-hours expended	Me, PT.Ac11	AF-0110	M

Table 2 Sample Mapping of SEP to Integrated Requirements.

The Standard Systems Group, or any other Air Force software organization, can use the integrated set of requirements to determine what processes it needs in it OSSP to satisfy both the CMM and QAF Criteria. The requirements are mapped back to each model, so the organization is able to refer the model to understand the context and subtleties of a process that would satisfy a particular requirement. Thus there may be multiple variations of any particular process. The integrated set of process requirements, along with the two models, provide the basis for designing or acquiring organizational processes.

VI. Conclusions, Generalization, and Recommendations

6.1 Conclusions

The overall goal of this research is to integrate the CMM and QAF criteria. The successful accomplishment of this goal is represented by the integrated set of requirements in Appendix A and the associated cross-references in Appendices B-E. The successful integration of the two models represents a 42% reduction in the number of requirements an organization must manage and meet. This reduction translates into a large savings in the staffing and resources needed to design, implement, and manage the processes required to satisfy the two models.

Intuitively, the two models fit together well since they are both based on the same quality principles. As the 42% reduction shows, the two models are, in fact, strongly linked. As noted in Section 4.3.2.3, nearly 80 percent of the QAF criteria relate to CMM practices, and about 60 percent of the CMM relates to QAF Areas to Address. This should not be too surprising a result, since the QAF criteria is meant to be applied to a wide range of businesses. The CMM, on the other hand, pertains specifically to software, and thus contains many practices that are too domain-specific to appear in the QAF criteria. One example is the requirement to *Develop Software Code*. This requirement obviously does not appear in the QAF criteria. Removing this type of domain-specific requirement increases the CMM-to-QAF linkage to 70 percent.

Some of the relationships consist of using the same process for different purposes. For instance, the *Strategic Planning* requirement calls for a planning process for any strategic level plans, such as the organization's business plans, process improvement plans, or human resource plans. Although some relationships fall into this category, most are much more direct. The *Identify Training Needs* requirements is a one-to-one relationship between a requirement in the CMM (TP.Ac1) and the QAF criteria (4.3.b).

In addition to these direct relationships, there are also implicit relationships among many of the Assessment Items in the QAF criteria and practices or Key Process Areas in the CMM. The more important relationships are expounded below.

6.1.1 Process Management. The strongest relationship between the two models emphasizes the process. Category 5.0 of the QAF criteria concerns managing--evaluating and improving--production, support, and supplier processes. The CMM also accentuates the importance of this concept. Organization Process Focus (PF), Organization Process Definition (PD), Quantitative Process Management (QP), and Process Change Management (PC) all relate to managing processes. Nearly all the practices in these key process areas of the CMM are correlated to areas in the QAF. The converse is true for the QAF criteria. One place this is especially evident is the software process improvement example shown in Figure 21 of Section 5.1.2. This system consists of 18 process requirements, 11 from both models, 4 from the CMM, and 3 from the QAF criteria.

Another strong, process-related relationship between the models concerns institutionalizing processes in the organization. The CMM addresses this aspect through OCFs by requiring policies and standards, adequate resources, measurement and analysis,

and verification by senior leaders and quality assurance. The QAF criteria addresses institutionalization by requiring data collection, review, and improvement cycles.

6.1.2 Training. Training is another strong link between the two models. Category 4.0 of the QAF criteria address human resources. One aspect crucial to the development of human resources is training. Item 4.3 of the QAF criteria specifically addresses the training aspect. The CMM does not extend beyond training in the Human Resource realm, but the Training Program (TP) ties tightly to the Areas to Address in the QAF criteria. This linkage, in addition to the process management linkage, shows the importance both models place on building infrastructure throughout the organization.

6.1.3 Supplier Management. A somewhat surprising linkage between the two models relates to managing suppliers. The CMM refers to this as Subcontractor Management (SM), but there is also some linkage in the InterGroup Coordination (IC) key process area. Many software organizations in the Air Force have trouble relating the SM key process area to its processes. In fact, in software assessments, SM is often considered to be "not applicable." Viewing these practices as supplier processes from the perspective of the QAF criteria, it is clearly applicable to all Air Force software organizations. There are also references to internal suppliers in the IC key process area. These also are applicable to the QAF Item 5.4.

6.1.4 Data Gathering. Data gathering and measurement are addressed in very general terms in both models. This is due to their non-prescriptive natures. Each model tries to guide the organization to make informed decisions about what to measure and why. The linkage between the two models in this area is fairly strong. Both models

identify the kind of measurements to make and give guidance on what to do with the data. Specifically, the *Gather Internal Data* requirement from the QAF criteria and the *Maintain Process Database* requirement from the CMM call for the organization to collect data from across the organization to gain an organizational perspective. This perspective is explicitly called for by the QAF criteria in Item 1.2, and implicitly in the CMM in the Process Definition and Process Change key process areas.

6.1.5 Plans. One area that is not so clear pertains to plans. The CMM is rife with requirements for informal and formal plans. The essence is to "plan the work and work the plan." However, the sheer number of plans is quite large. In the QAF Criteria, the verbiage leads the organization to place more focus on the planning process rather than the output plan. In any case, it is a matter of judgment for the organization to determine which plans are necessary and which are of little or no value. In the integrated set of requirements, there are two major planning requirements, *Strategic Planning* and *Project Planning*, in addition to several other more specific requirements such as *Plan Community Involvement* and *Develop Software Risk Management Plan.*

6.2 Generalization

This approach may be used to integrate any kind of requirements, including software requirements and security requirements. Formally specified software requirements may be integrated using the signature and specification matching of this approach. Just like examples given by Zaremski [ZARE95a, ZARE95b] for software code components, any software requirements may be matched to ensure consistency and eliminate redundancy.

Security requirements are often a concern in military systems. These requirements can be integrated along with other requirements to ensure a software system completely addresses software requirements, as well as security requirements. A possible place of application would be in comparing security requirements to configuration management requirements. Configuration management involves controlling access, which security for software systems also addresses. This approach would ensure both sets of requirements are addressed while eliminating redundancy.

6.3 Recommendations

6.3.1 Use Object Modeling Technique (OMT).
One very promising avenue for extending this approach relies on the object modeling technique (OMT) espoused by Rumbaugh [RUMB91]. OMT is an object-oriented method for analyzing, designing, and implementing software systems. The following sections describe how the results of this approach relate OMT, in general, and how they specifically relate to the Hibdon model mentioned in Section 4.1.4.

6.3.1.1 Relationship to OMT.
The process requirements that result from this approach are easily modeled using Rumbaugh's OMT. Each particular process requirement is an instance of the process requirement class. Requirements can be aggregated together, as appropriate, to form the key requirements for projects, sub-systems, or whole organizations. The software process improvement sub-system shown in Figure 21 is an excellent example. The process requirements, i.e., process objects, are

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composed together to form the fundamental requirements for the software process improvement sub-system.

Process objects can be aggregates of sub-processes, tasks, or procedures. Special relationships between process requirements, such as those between *Measure Process* and *Evaluate Process* can be shown explicitly in the OMT. Furthermore, other objects needed to model an organization, such as people and tools, can be included in the model along with relationships to the process requirement objects. This is the type of model Hibdon uses to represent and Air Force wing [HIBD95].

6.3.1.2 Relationship to Hibdon's Model. Hibdon uses OMT to create an organizational model of an Air Force wing, and then goes on to describe how the model is generalized to most any type of organization. His model consists of a *ToolSet*, a *ManningPlan*, a *Workforce*, and any number of *Projects* [HIBD95], which agrees closely with the Software Engineering Institute's view of a software organization consisting of people, process, and technology integrated into a system to produce software [NEXT92]. Thus Hibdon's model may be used to provide an infrastructure to compose the integrated set of requirements into a full-blown organization with a variety of projects and subsystems, as described in the previous section. The following paragraph describes some of the relationships between Hibdon's model and the integrated set of requirements.

Hibdon identifies the most basic objects in his model as *Tool, Worker, Position,* and *Job,* [HIBD95]. No specific tools are addressed in the integrated set; however, there are requirements that relate to measuring, evaluating, and improving technology in the project or organization. Requirements like *Identify Technology Change Areas* would

operate on the *Tool* object or the *ToolSet* that contains it. Similarly, there are requirements that would operate on the *Worker* object such as *Evaluate Member*, and one that would operate on the *Workforce* object such as *Assess Workforce Motivation*. The *Position* object relates closely to the *Agent* field in the integrated set. The *Agent* field is identifies roles needed for a particular task, and the *Position* object likewise identifies the skills a particular worker has. The *qualified_for* association in Hibdon's model provides the linkage between these two concepts, although the association is between a *Worker* and a *Job*. The *Job* object is at a lower level of detail than any of the process requirements. The process requirements relate more closely to the *Task* object, but do have some relationship the *Job* object, as seen in the last paragraph. Even though Hibdon's model fits very well with the integrated requirements, the exact nature of the many relationships and their implementations in an executable model need more in-depth study to determine the plausibility and benefits of modeling a software organization in this manner.

6.3.2 Process Asset Library (PAL). As mentioned earlier, the process asset library, or PAL, is a repository for process assets of the organization. It is essentially the same as a component library for software components. If processes are formally specified, then signature and specification matching can be used to identify and retrieve required processes from the PAL. The concept behind the CMM's Organization's Standard Software Process (OSSP) and Project's Defined Software Process (PDSP) is the same as the PAL. The OSSP is the library of processes for a project to choose and use. Using tailoring guidelines provided in the OSSP, the project manager selects process components to compose into the PDSP. Signature and specification matching provide a

robust search engine for identifying and retrieving the needed process components. Further research into an Air Force-wide PAL with search and retrieval capabilities is recommended.

6.3.3 Study Data Requirements. The requirements for collecting and analyzing data in both models are a point for further study. As related to this research, the data requirements for an organization can be determined and compared to guidelines such as the Software Engineering Institute's core measures or the Air Force core measures. These measures give context for requirements to identify what to measure, when, and how. By using the integrated set of requirements in concert with this guidance, Air Force organizations may more easily determine their key performance drivers, the indicators to measure them, and the objectives they want to obtain.

6.4 Final Comments

This research successfully demonstrates signature and specification matching to integrate the CMM and the Quality Air Force criteria. Appendix A contains a set of requirements integrated from the two models and correlated back to the source for reference purposes. This research shows that the CMM and QAF criteria complement and support each other in concept and in application. Air Force software organizations may use the appendices to this document as resources to determine which requirements they satisfy and which they are missing. By using these resources as the basis for designing organization processes, Air Force software organizations eliminate redundant efforts and save resources, funding, and staffing.

Appendix A - Integrated Set of Process Requirements

1.0 Purpose

The overall purpose of this document is to provide a set of process requirements completely representing the key requirements specified by the Capability Maturity Model for Software (CMM) and the Quality Air Force (QAF) criteria.

2.0 Overview

This document contains 196 process requirements obtained from the CMM and QAF criteria. These process requirements represent all the key requirements specified in both models. This set of requirements is derived by functionally decomposing each model into low-level requirements, comparing the requirements to each other based on signatures and specifications, and eliminating redundancies by integrating matching requirements into single representative requirements. Most matches are identified by matching signatures, or input/output types, while some are identified by matching specifications, or pre-conditions and post-conditions.

Each process requirement is presented in a framework as shown below:

Name	Descriptive name of the process requirement.
ID	Arbitrary identification number assigned as part of managing the requirements.
Purpose	Brief description of the purpose of the process requirement.
Correlates to	Code correlating the process requirement back to one of the original models, i.e., the CMM or QAF criteria. The code key is given in Section 4.
Agents	Descriptive name(s) of people who perform, control, or act in the process.
Inputs	Descriptive name(s) of process artifacts needed to conduct the process.
Outputs	Descriptive name(s) of process artifacts produced by the process.
Entrance Criteria	Pre-conditions that must exist before the process can begin and be successfully performed.
Exit Criteria	Post-conditions that must exist for the process to have finished successfully.
Comments	Explanatory remarks to better understand the process requirement and its use.

3.0 Intended Use

The intended use of this document is as a reference for Air Force software organizations to definitively determine if they are addressing and meeting the process requirements specified by both the CMM and QAF criteria. It is not meant to replace or supplant either model, but rather to supplement and complement both of the models. Toward that end, this document should be used in conjunction with the following associated documents:

Appendix B   *Capability Maturity Model Relations to Quality Air Force and Integrated Requirements*

Appendix C   *Quality Air Force Relations to Capability Maturity Model and Integrated Requirements*

Appendix D   *Capability Maturity Model Map to Integrated Requirements*

Appendix E   *Quality Air Force Criteria Map to Integrated Requirements*

These are quick-reference mappings of the two models to each other and to the integrated set of requirements contained in this document. This set of five documents may be used in a variety of fashions. The following paragraphs give a brief description of a few possible uses.

3.1 Start with the Integrated Set. An organization may start with this document containing the integrated set of requirements. Using the index, the organization is able to identify categories of requirements such as those related to evaluating processes or products, and locate requirements fitting that category. These requirements may be mapped back to the CMM or QAF criteria to determine which activities or areas are met.

3.2 Start with the CMM. An organization may start with the CMM as the source of requirements for its software process and may begin implementing processes to meet

those requirements. Using Appendix B, *Capability Maturity Model Relations to Quality Air Force and Integrated Requirements*, and Appendix D, *Capability Maturity Model Map to Integrated Requirements*, the organization is able to identify the requirements in the QAF criteria that it has met, as well as the ones it has not met.

3.3 Start with the QAF Criteria. An organization may start with the QAF criteria as the source of requirements for its software process and may begin implementing processes to meet those requirements. Using Appendix C, *Quality Air Force Relations to Capability Maturity Model and Integrated Requirements*, and Appendix E, *Quality Air Force Criteria Map to Integrated Requirements*, the organization is able to identify the requirements in the CMM that it has met, as well as the ones it has not met.

3.4 Start with the Current Process. Most organizations have some level of process description accomplished at present. For these organizations (especially those that have an organization process description as described at Maturity Level 3 of the CMM), it may be most beneficial to map the process description to the integrated set of requirements or the converse. From this mapping, the organization will see what requirements from either model are missing from its process descriptions since the integrated set is correlated to both models.

4.0 Guide to Codes

4.1 Capability Maturity Model Codes.

4.1.1 Key Process Areas (KPAs):

RM	Requirements Management
PP	Software Project Planning
PT	Software Project Tracking & Oversight
SM	Software Subcontract Management
QA	Software Quality Assurance
CM	Software Configuration Management
PF	Organization Process Focus
PD	Organization Process Definition
TP	Training Program
IM	Integrated Software Management
PE	Software Product Engineering
IC	InterGroup Coordination
PR	Peer Reviews
QP	Quantitative Process Management
SQ	Software Quality Management
DP	Defect Prevention
TC	Technology Change Management
PC	Process Change Management

4.1.2 Other Common Features (OCFs):

Co	Commitment to Perform
Ab	Ability to Perform
Me	Measurement and Analysis
Ve	Verifying Implementation

4.2 Quality Air Force Criteria Codes

1.0 Leadership

   1.1 Senior Executive Leadership

   1.2 Leadership System and Organization

   1.3 Public Responsibility and Citizenship

2.0 Information and Analysis

   2.1 Management of Information and Data

   2.2 Comparisons and Benchmarking

   2.3 Analysis and Use of Organization-Level Data

3.0 Strategic Planning

   3.1 Strategy Development

   3.2 Strategic Deployment

4.0 Human Resource Development and Management

   4.1 Human Resource Planning and Evaluation

   4.2 High Performance Work Systems

   4.3 Member Education, Training, and Development

   4.4 Well Being and Satisfaction

5.0 Process Management

   5.1 Design and Introduction of Products and Services

   5.2 Key Process Management: Product and Service Production
       and Delivery

   5.3 Process Management: Support Services

   5.4 Supplier Performance Management

6.0 Performance Results

   6.1 Product and Service Quality

   6.2 Operational Performance and Financial Results

   6.3 Supplier Performance Results

7.0 Customer Focus and Customer Satisfaction

   7.1 Customer Knowledge

   7.2 Customer Management

   7.3 Customer Satisfaction Determination

   7.4 Customer Satisfaction Results

   7.5 Customer Satisfaction Comparison

Name	Develop Organizational Values
ID	AF-0001
Purpose	To develop organizational values based on Air Force values, member values, ethics, standards of conduct, etc.
Correlates to	1.1.a
Agents	Senior Leaders
Inputs	AF Values, Member Values, Customer Values, Ethics, Legalities, Public Concerns
Outputs	Organizational Values
Entrance Criteria	
Exit Criteria	
Comments	

Name	Set Directions
ID	AF-0002
Purpose	To set organizational directions based on customer requirements, internal and external factors, while considering public concerns
Correlates to	1.1.a
Agents	Senior Leaders
Inputs	Customer Requirements, Customer Expectations, Organizational Data Analysis, External Data Analysis, Public Concerns
Outputs	Organizational Directions
Entrance Criteria	
Exit Criteria	
Comments	

Name	Set Expectations
ID	AF-0003
Purpose	To set organizational expectations based on organizational direction, internal and external environments, and customer requirements
Correlates to	1.1.a
Agents	Senior Leaders
Inputs	Customer Requirements, Organizational Directions, Organizational Data Analysis, External Data Analysis
Outputs	Organizational Expectations
Entrance Criteria	
Exit Criteria	
Comments	

Name	Review Organizational Performance
ID	AF-0004
Purpose	To find improvement opportunities by reviewing and assessing organizational performance against customer requirements, external factors, and strategic plans.
Correlates to	1.2.c
Agents	Senior Leaders
Inputs	Customer Requirements, Strategic Plans, Organizational Data Analysis, External Data Analysis
Outputs	Organizational Performance Review Actions, Review Information
Entrance Criteria	
Exit Criteria	
Comments	

Name	Review Organizational Structure
ID	AF-0005
Purpose	To review the organizational structure with respect to customer requirements and organizational performance, for improvement opportunities
Correlates to	1.2.a, 1.1.b
Agents	Reviewers
Inputs	Organizational Structure, Key Performance Drivers, Organizational Performance Review Actions, Organizational Data Analysis
Outputs	Organizational Structure Review Actions, Review Information
Entrance Criteria	
Exit Criteria	
Comments	

Name	Determine Customer Data Requirements
ID	AF-0006
Purpose	To determine customer data requirements such as the types, formats, media, frequency, etc.
Correlates to	2.1.a
Agents	Workers
Inputs	Customer Requirements, Customer Data Analysis
Outputs	Customer Data Requirements
Entrance Criteria	
Exit Criteria	
Comments	

Name	Determine Benchmarking Requirements
ID	AF-0007
Purpose	To determine benchmarking needs based on processes, organizational goals, and performance drivers
Correlates to	2.2.a
Agents	Workers
Inputs	Organizational Goals, Performance Objectives, Organizational Data Analysis
Outputs	Benchmarking Requirements
Entrance Criteria	
Exit Criteria	
Comments	

Name	Set Benchmarking Priorities
ID	AF-0008
Purpose	To determine benchmarking priorities based on processes, organizational goals, performance drivers, and benchmarking needs
Correlates to	2.2.a
Agents	Senior Leaders, Workers
Inputs	Organizational Goals, Performance Objectives, Organizational Data Analysis, Benchmarking Requirements
Outputs	Benchmarking Priorities
Entrance Criteria	
Exit Criteria	Benchmarking Priorities include all Benchmarking Requirements
Comments	

Name	Determine Benchmarking Data Criteria
ID	AF-0009
Purpose	To determine the criteria for selecting benchmarking data based on processes, organizational goals, performance drivers, and benchmarking needs
Correlates to	2.2.a
Agents	Workers
Inputs	Performance Indicators, Benchmarking Priorities
Outputs	Benchmarking Data Selection Criteria
Entrance Criteria	
Exit Criteria	
Comments	

Name	Aggregate Data
ID	AF-0010
Purpose	To aggregate data from across the organization in order to get an organizational perspective of that data.
Correlates to	2.3.a
Agents	Workers
Inputs	Input Data
Outputs	Aggregate Data
Entrance Criteria	
Exit Criteria	
Comments	

Name	Build Organizational Capabilities
ID	AF-0011
Purpose	To build organizational capabilities based on customer requirements, external environment, organizational goals, and values
Correlates to	1.1.a, 4.3.a
Agents	Senior Leaders, Workers
Inputs	Organizational Goals, Organizational Information, Current Capabilities, Customer Requirements
Outputs	Organizational Capabilities
Entrance Criteria	
Exit Criteria	
Comments	This requirement involves a lot of other requirements including training, process improvements, technology management, etc. Linkage between Organizational Capabilities & Customer Requirements is key.

Name	Improve Leadership System
ID	AF-0012
Purpose	To improve the processes which make up the leadership system as a whole.
Correlates to	1.1.b
Agents	Senior Leaders, Workers
Inputs	Leadership System, Process Improvement Actions, Improvement Priorities, System Data Analysis
Outputs	Leadership System
Entrance Criteria	
Exit Criteria	
Comments	

Name	Improve Organization Structure
ID	AF-0013
Purpose	To improve how the organization is structured, based on the input actions.
Correlates to	1.1.b, 1.2.a
Agents	Workers
Inputs	Organizational Structures, Structure Review Actions
Outputs	Organizational Structures
Entrance Criteria	
Exit Criteria	
Comments	

Name	Set Objectives
ID	AF-0014
Purpose	To set objective based on higher level goals
Correlates to	3.1.b, PP.Ac7
Agents	Workers
Inputs	Goals
Outputs	Objectives
Entrance Criteria	
Exit Criteria	All Goals Supported by Objectives
Comments	

Name	Determine Key Performance Drivers
ID	AF-0015
Purpose	To determine key performance drivers based on customer requirements, organizational plans, and analysis of strategic data.
Correlates to	3.1.b
Agents	Workers
Inputs	Strategic Plans, Customer Requirements, Organizational Data Analysis, External Data Analysis
Outputs	Key Performance Drivers
Entrance Criteria	
Exit Criteria	
Comments	Key Performance Drivers are a set of requirements that emphasize what is most important to the organization.

Name	Project Key Indicator Data
ID	AF-0016
Purpose	To project key data 2-5 years in the future based on current and past data.
Correlates to	3.2.b
Agents	Workers
Inputs	Indicators, Current Data, Current Data Analysis, Current Data Context
Outputs	Projected Data
Entrance Criteria	Current Data associates to Indicators
Exit Criteria	
Comments	Indicators may identify any type of data the organization deems important to predicting future performance.

Name	Determine Benefits
ID	AF-0017
Purpose	To determine the benefits due to process improvements by looking at projected data analysis.
Correlates to	3.2.b
Agents	Workers
Inputs	Projected Data Analysis
Outputs	Improvement Benefits
Entrance Criteria	
Exit Criteria	
Comments	

Name	Evaluate Training
ID	AF-0018
Purpose	To evaluate training and education and the processes that determine how they are delivered.
Correlates to	4.3.a, 4.3.b, TP.Ve3
Agents	Evaluators
Inputs	Training Courses, Training Processes, Training Needs, Training Data Analysis
Outputs	Training Actions
Entrance Criteria	
Exit Criteria	
Comments	Training includes education and OJT. The evaluation addresses Training Processes including reinforcement of training, how training is identified, or any other processes associated with training. One key aspect is the linkage between training and organizational capabilities.

Name	Set Goals
ID	AF-0019
Purpose	To set goals at the organizational level based on direction, customer requirements, values, and community concerns.
Correlates to	1.1.a, PC.Ac2, PC.Ac4
Agents	Senior Leaders, Planners
Inputs	Organizational Directions, Customer Requirements, Customer Expectations, Organizational Expectations, Organizational Values, Organizational Capabilities, Supplier Capabilities, Financial Risks, Mission Risks, Technological Risks Organizational Data Analysis, External Data Analysis
Outputs	Organizational Goals
Entrance Criteria	
Exit Criteria	
Comments	Other Planners may be involved, but at the organizational level, Senior Leaders must be deeply involved and be the driver of this process. Not all these Inputs may be applicable or have much impact on a particular organization, but should be considered, as well as any other issues or situations that may affect setting or accomplishing organizational goals.

Name	Assess Community Involvement
ID	AF-0020
Purpose	To determine the quantity and quality of community involvement by the organization.
Correlates to	1.3.b
Agents	Senior Leaders, Workers
Inputs	Community Involvement Plans, Community Activities
Outputs	Community Involvement Data, Community Involvement Information
Entrance Criteria	
Exit Criteria	
Comments	Senior Leaders may not do the assessment, but the information and data is theirs.

Name	Improve Community Involvement
ID	AF-0021
Purpose	To improve the quantity and/or quality of community involvement activities by the organization.
Correlates to	1.3.b
Agents	Senior Leaders, Workers
Inputs	Citizenship Goals, Community Actions, Community Activities, Community Data Analysis
Outputs	Community Activities
Entrance Criteria	
Exit Criteria	
Comments	

Name	Develop Breakthrough Approach
ID	AF-0022
Purpose	To develop or find a design for a process, job, product, service, etc., which vastly improves over the current design. To do research and development.
Correlates to	2.2.a
Agents	Workers
Inputs	Benchmarking Priorities, Organizational Data Analysis, External Data Analysis, Process Designs, Service Designs, Product Designs
Outputs	New Approaches, Approach Information
Entrance Criteria	
Exit Criteria	
Comments	New Approaches are the processes needed to implement breakthroughs. Approach Information contains the expected benefits of the breakthrough.

Name	Assess Member Well-Being
ID	AF-0023
Purpose	To assess the well-being of members of the organization.
Correlates to	4.1.b, 4.4.c
Agents	Workers
Inputs	Members, Organizational Environments, Human Resource Information
Outputs	Well Being Data, Well Being Information
Entrance Criteria	
Exit Criteria	
Comments	Member is distinguished from Worker. The Worker is doing the assessment, the Member is an "artifact" of this process, i.e., the Member is being acted upon, and therefore is an Input.

Name	Assess Member Development
ID	AF-0024
Purpose	To assess the development of members in the organization.
Correlates to	4.1.b, 4.3.b
Agents	Workers
Inputs	Members, Organizational Environments, Human Resource Information
Outputs	Development Data, Development Information
Entrance Criteria	
Exit Criteria	
Comments	Member is distinguished from Worker. The Worker is doing the assessment, the Member is an "artifact" of this process, i.e., the Member is being acted upon, and therefore is an Input.

Name	Improve Work Organization
ID	AF-0025
Purpose	To improve the formal and informal work structures throughout the organization.
Correlates to	4.2.a
Agents	Workers
Inputs	Improvement Priorities, Work Organizations, Work Organization Actions
Outputs	Work Organizations
Entrance Criteria	
Exit Criteria	
Comments	Job Structures are the way jobs (or processes) are laid out, for example the layout of desktop computers. Work Organizations refer to the way people are organized and relate to each other.

Name	Improve Job Design
ID	AF-0026
Purpose	To improve the formal and informal job structures throughout the organization.
Correlates to	4.2.a
Agents	Workers
Inputs	Improvement Priorities, Job Designs, Job Design Actions
Outputs	Job Designs
Entrance Criteria	
Exit Criteria	
Comments	Job Structures are the way jobs (or processes) are laid out, for example the layout of desktop computers. Work Organizations refer to the way people are organized and relate to each other.

Name	Recognize Member
ID	AF-0027
Purpose	To recognize members for demonstrating the values of the organization.
Correlates to	1.1.a, 4.2.b
Agents	Senior Leaders, Workers
Inputs	Members, Organizational Values, Recognition Criteria
Outputs	Recognition
Entrance Criteria	
Exit Criteria	
Comments	Organizational Values should relate performance ideals in addition to tenets such as honesty, integrity, duty, honor, country, etc. This is one way to reinforce Organizational Values. Recognition Criteria specify the requirements. Also Relates to informal recognition for which criteria is inappropriate. Although any Worker may recognize other Members, it is incumbent on Senior Leaders to be an integral part of recognition activities.

Name	Compensate Member
ID	AF-0028
Purpose	To compensate members for performing their roles, including special compensations as rewards.
Correlates to	4.2.b
Agents	Workers
Inputs	Members, Member Compensation, Special Compensation
Outputs	Compensated Members
Entrance Criteria	
Exit Criteria	
Comments	Compensation may include days off, free time, or special events in the context of military organizations.

Name	Evaluate Member
ID	AF-0029
Purpose	To evaluate members based on the criteria for their jobs and how well the members perform them.
Correlates to	4.2.b
Agents	Evaluators, Members
Inputs	Members, Member Data Analysis, Job Criteria
Outputs	Member Actions
Entrance Criteria	
Exit Criteria	Job Criteria NOT Met Implies Member Actions Identified
Comments	Members are included as agents to this process, as well as an input. Members should play an active role in their evaluations, e.g. Air Force mandated feedback sessions . This should be considered when choosing processes to meet this requirement.

Name	Improve Training
ID	AF-0030
Purpose	To improve training for organization members and how it is delivered.
Correlates to	4.3.b
Agents	Workers, Training Group
Inputs	Training Courses, Training Processes, Training Actions, Improvement Priorities, Training Data Analysis
Outputs	Training Courses
Entrance Criteria	
Exit Criteria	
Comments	

Name	Review Work Environment
ID	AF-0031
Purpose	To review the work environment to ensure it is healthy and safe, and to identify actions to improve it.
Correlates to	4.4.a
Agents	Workers
Inputs	Work Environment, Human Resource Data Analysis
Outputs	Work Environment Actions, Work Environment Information
Entrance Criteria	
Exit Criteria	
Comments	

Name	Improve Work Environment
ID	AF-0032
Purpose	To improve the work environment in the organization by making it healthier and safer.
Correlates to	4.4.a
Agents	Workers
Inputs	Improvement Priorities, Work Environment, Work Environment Actions
Outputs	Work Environment
Entrance Criteria	
Exit Criteria	All Work Environment Actions Addressed
Comments	

Name	Build Workforce Well-Being
ID	AF-0033
Purpose	To improve the well-being of the workforce.
Correlates to	4.4.b
Agents	Workers
Inputs	Members, Improvement Priorities, Workforce Well-Being Actions
Outputs	Members
Entrance Criteria	
Exit Criteria	All Workforce Well-Being Actions Addressed
Comments	The "Outputs" are Members with better well-being as measured by Assess Member Well-Being.

Name	Build Workforce Satisfaction
ID	AF-0034
Purpose	To improve the satisfaction of the workforce.
Correlates to	4.4.b
Agents	Workers
Inputs	Members, Improvement Priorities, Workforce Satisfaction Actions
Outputs	Members
Entrance Criteria	
Exit Criteria	All Workforce Satisfaction Actions Addressed
Comments	The "Outputs" are Members with greater job satisfaction as measured by Assess Workforce Satisfaction.

Name	Assess Member Services
ID	AF-0035
Purpose	To determine the adequacy of services provided by the organization to its members.
Correlates to	4.4.b
Agents	Workers
Inputs	Member Services, Human Resource Information
Outputs	Member Service Data, Member Service Information
Entrance Criteria	
Exit Criteria	
Comments	

Name	Assess Member Facilities
ID	AF-0036
Purpose	To determine the adequacy of facilities provided by the organization to its members.
Correlates to	4.4.b
Agents	Workers
Inputs	Member Facilities, Human Resource Information
Outputs	Member Facility Data, Member Facility Information
Entrance Criteria	
Exit Criteria	
Comments	

Name	Assess Member Activities
ID	AF-0037
Purpose	To determine the adequacy of activities provided by the organization for its members.
Correlates to	4.4.b
Agents	Workers
Inputs	Member Activities, Human Resource Information
Outputs	Member Activity Data, Member Activity Information
Entrance Criteria	
Exit Criteria	
Comments	

Name	Design Process
ID	AF-0038
Purpose	To support process improvement by improving process designs based on required process actions.
Correlates to	5.1.a, PD.Ac1, PD.Ac2
Agents	Workers
Inputs	Processes, Process Actions, Improvement Plans, Process Requirements
Outputs	Processes
Entrance Criteria	
Exit Criteria	Processes Meet Process Requirements
Comments	

Name	Design Service
ID	AF-0039
Purpose	To support process improvement by improving service designs.
Correlates to	5.1.a
Agents	Workers
Inputs	Services, Service Actions, Improvement Plans, Service Requirements
Outputs	Services
Entrance Criteria	
Exit Criteria	Services Meet Service Requirements
Comments	

Name	Maintain Improvement Program
ID	AF-0040
Purpose	To ensure members are empowered to make positive change in the organization.
Correlates to	PF.Co2, PF.Co3, PC.Ac1
Agents	Senior Leaders, Workers
Inputs	Organization
Outputs	Improvement Program
Entrance Criteria	
Exit Criteria	Members Empowered
Comments	The program consists of all the improvement processes, plans, and activities. Senior Leaders are primarily responsible for establishing, sponsoring, and maintaining such a program. Workers from the organization participate on an as needed basis, i.e., to serve on improvement teams or process focal group.

Name	Test Product
ID	AF-0041
Purpose	To test the product design to ensure it meets design requirements and performance objectives spelled out in the implementation plan.
Correlates to	5.1.b
Agents	Workers
Inputs	Products, Implementation Plans, Design Requirements
Outputs	Design Actions, Design Data
Entrance Criteria	
Exit Criteria	(Design Requirements NOT Met) OR (Performance Objectives NOT Achieved) Implies Design Actions Identified Design Data Recorded
Comments	Performance Objectives are in the Implementation Plans, and based on design requirements, Key Performance Objectives, and Key Performance Drivers.

Name	Test Service
ID	AF-0042
Purpose	To test the service design to ensure it meets design requirements, performance objectives spelled out in the implementation plan, and determine if there are ways to improve the design before fully implementing it.
Correlates to	5.1.b
Agents	Workers
Inputs	Services, Implementation Plans, Service Design Requirements
Outputs	Service Design Actions, Service Design Data
Entrance Criteria	
Exit Criteria	Service Meets Service Design Requirements AND Service Achieves Service Performance Objectives) OR (Service Design Actions Identified) Service Data Recorded
Comments	Service Performance Objectives should be documented as part of the Implementation Plans, and are based on the design requirements, Key Performance Objectives, and Key Performance Drivers.

Name	Determine Root Cause
ID	AF-0043
Purpose	To determine the root cause of a process, product, service problem or variation.
Correlates to	5.2.a, 5.3.b, DP.Ac3, DP.Ac5
Agents	Workers
Inputs	Problem Information, Problem Data Analysis, Variation Data, Requirements, Performance Objectives
Outputs	Root Cause, Proposed Actions
Entrance Criteria	
Exit Criteria	Root Cause Documented
Comments	For DP.Ac3, Workers include the Defect Prevention Group.

Name	Evaluate Alternatives
ID	AF-0044
Purpose	To evaluate alternative courses of action and choose a set of actions which will eliminate the root cause of variation, keeping in mind requirements and goals of the processes, products, and services involved.
Correlates to	5.2.b, 5.3.c
Agents	Workers
Inputs	Possible Actions, Root Cause, Research, Data Analysis, Key Performance Drivers, Key Performance Objectives
Outputs	Process Actions
Entrance Criteria	
Exit Criteria	
Comments	This requirement may be satisfied by one or more common methods for choosing alternatives, e.g. Nominal Group Technique or Multi-voting. Care must be given to ensure the actions solve or eliminate the root cause.

Name	Build Supplier Relationship
ID	AF-0045
Purpose	To build a strong relationship with suppliers in order to facilitate communication and cooperation between the supplier and the organization.
Correlates to	5.4.b
Agents	Workers
Inputs	Suppliers, Supplier Relationship, Supplier Processes, Supplier Requirements, Supplier Data Analysis
Outputs	Supplier Relationship
Entrance Criteria	
Exit Criteria	
Comments	Supplier Relationship implies the infrastructure, i.e. the lines of communication, formal and informal systems, that are the architecture for using processes Supplier Requirements are used for context in understanding the relationship. In a newly formed relationship, or a newly formed focus, the Supplier Relationship information, Supplier Processes and Supplier Data Analysis may be not be available.

Name	Determine Customer Requirements
ID	AF-0046
Purpose	To determine customer requirements for the organization.
Correlates to	7.1.a
Agents	Workers, Customers
Inputs	Customer Expectations, Customer Goals, Customer Information, Customer Data Analysis
Outputs	Customer Requirements
Entrance Criteria	
Exit Criteria	Customer Requirements Documented
Comments	This requirement differs from AF-0166. It is focused on the problem domain, i.e., determining customer needs. AF-0166 addresses the solution space, i.e. what system is needed. This requirement would normally be fulfilled by requirements elicitation processes, as well as informal discussions and interaction with the customer. Customers are considered Agents of the this process not as Inputs. The subtle difference is as Agents they are active participants that help guide the process; as Inputs are being acted upon by Agents and may not be seen as part of the team. The difference is important in selecting a process to fulfill the requirement. Customer Information includes Values and Expectations, as well as any other information the organization may have on the customer.

Name	Determine Customer Expectations
ID	AF-0047
Purpose	To determine customer expectations for the organization.
Correlates to	7.1.a
Agents	Workers, Customers
Inputs	Customer Goals, Customer Information, Customer Data Analysis
Outputs	Customer Expectations
Entrance Criteria	
Exit Criteria	
Comments	This requirement concerns expectations the customer has for the organization as a whole, and also to specific expectations related to the work to be done. Customers are considered Agents of this process not Inputs. The subtle difference is that Agents are active participants that help guide the process; Inputs are being acted upon by Agents and may not be seen as part of the team. The difference is important in selecting a process to fulfill the requirement. Customer Information includes Values, as well as any other information the organization may have on the customer.

Name	Determine Future Customer Requirements
ID	AF-0048
Purpose	To take a long-term approach to meeting customer needs by determining possible future customer requirements based on current requirements, expectations, and customer goals for the future.
Correlates to	7.1.b
Agents	Workers, Customers
Inputs	Customer Goals, Customer Information, Customer Requirements, Projected Customer Data Analysis
Outputs	Future Customer Requirements
Entrance Criteria	
Exit Criteria	
Comments	Customers are considered Agents of this process not Inputs. The subtle difference is that Agents are active participants that help guide the process; Inputs are being acted upon by Agents and may not be seen as part of the team. The difference is important in selecting a process to fulfill the requirement. Customer Information includes Values and Expectations, as well any other information the organization may have on the customer.

Name	Determine Future Customer Expectations
ID	AF-0049
Purpose	To take a long term approach to meeting customer needs by determining future customer expectations based on current expectations and customer goals for the future.
Correlates to	7.1.b
Agents	Workers, Customers
Inputs	Customer Goals, Customer Information, Customer Expectations, Projected Customer Data Analysis
Outputs	Future Customer Expectations
Entrance Criteria	
Exit Criteria	
Comments	Customers are considered Agents of this process not Inputs. The subtle difference is that Agents are active participants that help guide the process; Inputs are being acted upon by the Agents and may not be seen as part of the team. The difference is important in selecting a process to fulfill the requirement. Customer Information includes Values, as well as any other information the organization may have on the customer.

Name	Develop Listening Strategies
ID	AF-0050
Purpose	To develop strategies for learning more about the customer through formal and informal meetings and interactions.
Correlates to	7.1.b
Agents	Workers, Customers
Inputs	Customer Goals, Customer Information, Customer Expectations, Projected Customer Data Analysis
Outputs	Listening Strategies
Entrance Criteria	
Exit Criteria	
Comments	Customers are considered Agents of this process not Inputs. The subtle difference is that Agents are active participants that help guide the process; Inputs are being acted upon by the Agents and may not be seen as part of the team. The difference is important in selecting a process to fulfill the requirement. Customer Information includes Values, as well as any other information the organization may have on the customer.

Name	Evaluate Mission Effectiveness
ID	AF-0051
Purpose	To determine the level of mission effectiveness based on some established measurement scale and determine corrective actions, if necessary.
Correlates to	7.2.c, 7.3.a
Agents	Workers
Inputs	Mission Information, Mission Effectiveness Data Analysis, Measurement Scale
Outputs	Mission Effectiveness Actions
Entrance Criteria	
Exit Criteria	
Comments	

Name	Evaluate Measurement Scale
ID	AF-0052
Purpose	To evaluate the input measurement scale.
Correlates to	7.3.c
Agents	Workers
Inputs	Measurement Scales, Measurement Scale Criteria, Data Analysis
Outputs	Measurement Scale Actions
Entrance Criteria	
Exit Criteria	
Comments	

Name	Improve Measurement Scale
ID	AF-0053
Purpose	To improve the measurement scales and how they are used, based on the input actions.
Correlates to	7.3.c
Agents	Workers
Inputs	Measurement Scales, Measurement Scale Actions
Outputs	Measurement Scales
Entrance Criteria	
Exit Criteria	
Comments	

Name	Follows Policy
ID	AF-0054
Purpose	To ensure alignment of activities and processes performed at every level of the organization with the organizational policies based on the directions, values, expectations, goals of the organization.
Correlates to	Co
Agents	None
Inputs	Process
Outputs	Boolean
Entrance Criteria	
Exit Criteria	
Comments	This is not so much a requirement for a process as it is a pre-condition for other required processes. It is stated in Commitment to Perform in the , but is embodied in the in requirements to align plans, determine key performance drivers and objectives based on goals, and so forth.
It may be beneficial to initiate explicit review cycles (like Align Internal Plans) to ensure policies are in place; reflect the organization's goals, values, expectations, and objectives; and are followed at all levels of the organization.

Name	Adequate Resources
ID	AF-0055
Purpose	To ensure a process or activity has the proper resources to be able to accomplish its purpose.
Correlates to	Ab
Agents	None
Inputs	Process
Outputs	Boolean
Entrance Criteria	
Exit Criteria	
Comments	This is not so much a requirement for a process as it is a pre-condition for required processes. It is stated in Ability to Perform in the , but is embodied in the in requirements to review status and feedback into planning processes. The requirement addresses human resources, technology, paper, pencils, etc. Any resource a process requires to meet its purpose. It is beneficial to explicitly address this issue for all processes executed.

Name	Adequate Funding
ID	AF-0056
Purpose	To ensure a process or activity has the proper funding to be able to accomplish its purpose.
Correlates to	Ab
Agents	None
Inputs	Process
Outputs	Boolean
Entrance Criteria	
Exit Criteria	
Comments	This is not so much a requirement for a process as it is a pre-condition for required processes. It is stated in the CMM, but is embodied in the QAF in requirements to review financial status and feedback into planning processes. The requirement addresses money for production processes, but also support processes and business processes. It is beneficial to explicitly address this issue for all processes executed.

Name	Adequate Training
ID	AF-0057
Purpose	To ensure agents of a process or activity have the proper training be able to accomplish its purpose.
Correlates to	Ab
Agents	None
Inputs	Process
Outputs	Boolean
Entrance Criteria	
Exit Criteria	
Comments	This is not so much a requirement for a process as it is a pre-condition for required processes. It is stated in the CMM, but is embodied in the QAF in requirements in Human Resource Planning, specifically the training area. The requirement addresses training and education in all aspects. It is beneficial to explicitly address this issue for all processes executed.

Name	Follows Procedure
ID	AF-0058
Purpose	To ensure institutionalization of standard processes, practices, and activities to provide the basis for quantitative management of processes. A second purpose is to facilitate alignment of activities and processes performed to organizational policies.
Correlates to	Co
Agents	None
Inputs	Process
Outputs	Boolean
Entrance Criteria	
Exit Criteria	
Comments	This is not so much a requirement for a process as it is a pre-condition for other required processes. It is stated in CMM, but is embodied in the QAF in requirements to design, plan, deploy, measure, and manage processes. It may be beneficial to initiate explicit review cycles (similar to those based Align Internal Plans) to ensure procedure are in place and reflect the organization's policies. The specifically requires reviews used to ensure procedures are performed as documented.

Name	Determine Status
ID	AF-0059
Purpose	To determine the status of the activity based on the data collected.
Correlates to	Me
Agents	Workers
Inputs	Activities, Data
Outputs	Project Status
Entrance Criteria	
Exit Criteria	
Comments	

Name	Allocate Requirements
ID	AF-0060
Purpose	To allocate system requirements to software, hardware, or other system components.
Correlates to	RM.Ab1, RM.Ab2
Agents	Systems Engineering Group, SW Engineering Group, H W Engineering Group
Inputs	System Requirements
Outputs	Allocated Software Requirements, Hardware Requirements, Other Requirements
Entrance Criteria	
Exit Criteria	All Requirements Documented
Comments	This may be a responsibility of the Systems Engineering Group, but should have input and involvement from the SW Engineering Group and H W Engineering Group.

Name	Assess Requirements Change
ID	AF-0061
Purpose	To assess the impact of changes to the allocated requirements.
Correlates to	RM.Ac3
Agents	SW Engineering Group
Inputs	Allocated Requirements, Change Requirements, Project Data Analysis
Outputs	Impact Data, Impact Information
Entrance Criteria	
Exit Criteria	
Comments	

Name	Evaluate Improvement Linkage
ID	AF-0062
Purpose	To analyze the connection between the customer, processes, and improvements. Answers the question, "Are improvements directly related to improving mission effectiveness, customer satisfaction, performance, etc.?"
Correlates to	2.3.b
Agents	Workers
Inputs	Customer Requirements, Processes, Improvement Plans, Organizational Data Analysis,
Outputs	Improvement Actions, Improvement Information
Entrance Criteria	
Exit Criteria	
Comments	Related to assessing processes, but also to aligning plans. The point of this requirement is to ensure improvements directly support the business of the organization. Organizational Data Analysis may be practically any analysis that contributes to understanding these linkages. Specifically, it should include analysis of Customer Data, Mission Effectiveness Data, Performance Data, Quality Data, and Financial Data.

Name	Develop Project Proposal
ID	AF-0063
Purpose	To develop a project proposal which encompasses all areas including hardware, software, and other components of the system.
Correlates to	PP.Ac1
Agents	Proposal Team
Inputs	SOW, Customer Information
Outputs	Proposal
Entrance Criteria	
Exit Criteria	
Comments	Customer Information includes Values, Expectations, Goals, etc.

Name	Perform Supplier Acceptance Tests
ID	AF-0064
Purpose	To test the supplier's product to ensure it meets acceptance criteria.
Correlates to	5.4.a, SM.Ac12
Agents	Organization Testers
Inputs	Supplier Products, Acceptance Criteria, Testing Plans, Test Procedures
Outputs	Corrective Actions, Accepted Products
Entrance Criteria	
Exit Criteria	
Comments	

Name	Handle Deviations
ID	AF-0065
Purpose	To handle process or product deviations.
Correlates to	QA.Ac2, QA.Ac7
Agents	QA Group, Senior Leaders, Affected Groups
Inputs	Software Deviation Actions, Software Work Products, QA Plan
Outputs	Implemented Changes, Status Reports
Entrance Criteria	
Exit Criteria	All Actions Tracked to Closure
Comments	Senior Leaders are not a required input to this process. Deviations are elevated to them on an exceptional basis.

Name	Establish CM Library System
ID	AF-0066
Purpose	To establish the CM library system based on the requirements for the project.
Correlates to	CM.Ac2, CM.Ac3
Agents	CM Group
Inputs	Library Requirements, CM Plan
Outputs	CM Library System
Entrance Criteria	
Exit Criteria	
Comments	This requirement may already be fulfilled for each project if an organization uses a standard CM system. However, it should be evaluated to determine if it meets the particular needs of the project. The CM System is a set of processes, tools, procedures, and standards. It is based on requirements listed in Activities 4-10 of the . The CM Library is NOT considered an input to other process requirements.

Name	Identify Software Configuration Items
ID	AF-0067
Purpose	To identify the software configuration items for the project.
Correlates to	CM.Ac2, CM.Ac4
Agents	SW Engineering Group, CM Group
Inputs	Software Development Plan, Software Requirements, Selection Criteria
Outputs	SCIs
Entrance Criteria	
Exit Criteria	
Comments	

Name	Handle Change Requests
ID	AF-0068
Purpose	To handle change requests or problem reports for software configuration items.
Correlates to	CM.Ac2, CM.Ac5
Agents	SCCB, CM Group
Inputs	Change Requests
Outputs	Approved Change Requests, disapproved Change Requests
Entrance Criteria	Change Requests Documented
Exit Criteria	
Comments	The number of Approved and Disapproved requests should be tracked.

Name	Change Baseline
ID	AF-0069
Purpose	To make changes to software baselines.
Correlates to	CM.Ac2, CM.Ac6
Agents	SW Engineering Group, CM Group
Inputs	Software Baseline, Approved Changes
Outputs	Software Baseline
Entrance Criteria	
Exit Criteria	Only Approved Changes Made, Regression Tests Passed
Comments	This requirement is related to Configuration Control and ensures there are procedures for making changes to the baseline. It does not address how changes are submitted, approved, or implemented into designs, code, etc.

Name	Evaluate Process
ID	AF-0070
Purpose	To evaluate the input processes against comparable processes and benchmarks and evaluation criteria to identify improvement actions.
Correlates to	1.1.b, 2.1.b, 2.2.b, 3.1.c, 4.1.b, 5.1.c, 5.2.b, 5.3.c, 5.4.b, 7.1.c, 7.2.d, 7.3.c, Ve, SM.Ac13, IM.Ac11
Agents	Workers
Inputs	Processes, Performance Objectives, External Data Analysis, Process Data Analysis, Process Criteria
Outputs	Process Improvement Actions
Entrance Criteria	
Exit Criteria	Performance Objectives NOT Achieved) OR (Process Criteria NOT Satisfied) Implies Process Improvement Actions Identified
Comments	

Name	Determine Indicators
ID	AF-0071
Purpose	To determine the appropriate indicators based on objectives, priorities and criteria.
Correlates to	2.1.a, 2.2.a, 5.4.a, 7.1.a, QP.Ac3, QP.Ac4
Agents	Workers
Inputs	Performance Drivers, Performance Objectives, Priorities, Criteria
Outputs	Indicators
Entrance Criteria	
Exit Criteria	
Comments	

Name	Measure Process
ID	AF-0072
Purpose	To collect process data based on the input indicators
Correlates to	1.1.a, 5.2.a, 5.3.b, 5.4.a, 6.2.a, 6.3.a, QP.Ac2, QP.Ac4, PC.Ac8, PC.Me1, Me
Agents	Workers
Inputs	Processes, Process Indicator, Plans
Outputs	Process Data
Entrance Criteria	
Exit Criteria	Process Data Documented in Process Database
Comments	At ML2, Process Database may not be formalized.

Name	Analyze Data
ID	AF-0073
Purpose	To analyze data based on the input criteria and the context of where the data comes from.
Correlates to	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b, PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me
Agents	Workers
Inputs	Input Data, Measured Process, Measured Product, Measurement Criteria, Performance Objectives, Contextual Information
Outputs	Data Analysis
Entrance Criteria	
Exit Criteria	
Comments	Data is analyzed based on its numerical characteristics, as well as the context from which it is gathered. All collected data should be analyzed. Analysis of data includes comparison with other data, i.e. comparisons of benchmarking data, comparative performance data, customer satisfaction data called for by the QAF criteria are all covered by this requirement Methods, tools, and criteria for analyzing data is coordinated at the organization level for ML3 and higher.

Name	Set Performance Objectives
ID	AF-0074
Purpose	To set performance objectives based on data analysis and organizational goals.
Correlates to	2.2.a, SQ.Ac3, QP.Ac1, QP.Ac2, QP.Ac4
Agents	Workers
Inputs	Plan, Data Analysis, Goals
Outputs	Performance Objectives
Entrance Criteria	
Exit Criteria	
Comments	

Name	Strategic Planning
ID	AF-0075
Purpose	To plan long term strategies for the organization based on goals, customer requirements, expectations, values, capabilities, risks, and analysis internal and external data.
Correlates to	3.1.a, 4.1.a, PF.Ac2, TP.Ac2, TC.Ac1, PC.Ac3
Agents	Senior Leaders, Planners
Inputs	Organizational Goals, Requirements, Environment, Capabilities, Risks, Data Analysis
Outputs	Strategic Plans
Entrance Criteria	
Exit Criteria	All Goals Implemented, Plan reviewed
Comments	Planners are the appropriate group at a minimum, e.g. Training Group, Process Focal Group, Technology Change Group, etc. , Some inputs may be empty if not appropriate; however, in most cases all inputs should have some values

Name	Evaluate Job Design
ID	AF-0076
Purpose	To evaluate the structures, methods, and ways of working associated with low-level tasks.
Correlates to	4.2.a, 4.3.b
Agents	Workers
Inputs	HR Plans, HR Performance Drivers, Job Designs, Data Analysis
Outputs	Job Design Actions
Entrance Criteria	
Exit Criteria	
Comments	Evaluate Job Design addresses low-level methods and ways of working, such as the desktop arrangements or software interfaces. Evaluate Work Organization addresses high-level interactions, interfaces, and organizations, such as team make-ups and organization charts.

Name	Evaluate Work Organization
ID	AF-0077
Purpose	To evaluate how members are organized, both formally and informally, to accomplish the work and meet customer requirements
Correlates to	1.2.a, 4.2.a
Agents	Workers
Inputs	HR Plans, Performance Drivers, Work Organization, Data Analysis
Outputs	Organization Actions
Entrance Criteria	
Exit Criteria	
Comments	Evaluate Work Organization addresses high-level interactions, interfaces, and organizations, such as team make-ups and organization charts. Evaluate Job Design addresses low-level methods and ways of working, such as the desktop arrangements or software interfaces.

Name	Reinforce Organizational Values
ID	AF-0078
Purpose	To ensure the members of the organization know the importance of the values and follow them in conducting their everyday business.
Correlates to	1.1.a
Agents	Senior Leaders
Inputs	Members, Organizational Values
Outputs	Organizational Values
Entrance Criteria	
Exit Criteria	
Comments	

Name	Communicate Leadership Information
ID	AF-0079
Purpose	For senior leaders to communicate organizational values, expectations, direction, and other relevant information throughout the organization.
Correlates to	1.2.b
Agents	Senior Leaders, Workers
Inputs	Members, Information
Outputs	Information
Entrance Criteria	
Exit Criteria	All Members Informed
Comments	Workers may aid in communicating this information, but it is up to Senior Leaders to be the primary voice, and to ensure the communication cycle is completed. This is a special case of AF-0097, Communicate Information.

Name	Process Assessment
ID	AF-0080
Purpose	To qualitatively compare a process to a standard, i.e., a set of criteria.
Correlates to	1.1.a, 1.2.c, SM.Ac2, PF.Ac1
Agents	Assessors
Inputs	Processes, Process Criteria
Outputs	Process Actions
Entrance Criteria	
Exit Criteria	Process Criteria NOT Met Implies Process Actions Identified
Comments	This differs from evaluation, in that it is a qualitative assessment based on criteria, i.e. requirements such as those listed in the CMM, QAF, or QA standards.

Name	Set Citizenship Goals
ID	AF-0081
Purpose	To set goals relating to community involvement and citizenship based on organizational goals and values.
Correlates to	1.3.a
Agents	Senior Leaders, Workers
Inputs	Public Concerns, Organizational Goals, Organizational Values
Outputs	Citizenship Goals
Entrance Criteria	
Exit Criteria	
Comments	Senior Leaders should be the driver of this process.

Name	Assess Community Impact
ID	AF-0082
Purpose	To look at how a new or existing product, service, or process affects people, other organizations, or the community at large.
Correlates to	1.3.a
Agents	Workers
Inputs	Item, Public Concerns
Outputs	Impact Data, Impact Information
Entrance Criteria	
Exit Criteria	
Comments	

Name	Plan Community Involvement
ID	AF-0083
Purpose	To plan how the organization can be involved in the local community.
Correlates to	1.3.b
Agents	Senior Leaders, Workers
Inputs	Citizenship Goals, Community Activities, Community Data Analysis
Outputs	Community Involvement Plans
Entrance Criteria	
Exit Criteria	Community Involvement Plan Implements Citizenship Goals
Comments	Senior Leaders should be heavily involved in this process.

Name	Gather External Information
ID	AF-0084
Purpose	To gather data and information from external sources to use in benchmarking or comparisons.
Correlates to	2.2.a
Agents	Workers
Inputs	Priorities, Indicators, Sources
Outputs	Information, Data
Entrance Criteria	
Exit Criteria	
Comments	

Name	Determine Partnering Activities
ID	AF-0085
Purpose	To determine what activities can not or will not be performed by the organization, but will be accomplished by seeking a partner or supplier to perform the activity.
Correlates to	5.4.b, SM.Ac1
Agents	Senior Leaders, Workers
Inputs	Goals, Current Capabilities, Needed Capabilities, Organizational Data Analysis, External Data Analysis
Outputs	Partnering Actions
Entrance Criteria	
Exit Criteria	Needed Capabilities NOT Obtainable by the Organization Implies Partnering Actions Identified
Comments	This process may be used at the strategic level, where Goals are organizational, or at the project level, where Goals are the goals of the project. Partnering Actions are those needed to acquired the Needed Capabilities.

Name	Align Plans
ID	AF-0086
Purpose	To review organizational plans to ensure alignment from organizational directions down to implementation of processes to meet customer requirements.
Correlates to	3.2.a, 4.1.b
Agents	Senior Leaders, Workers
Inputs	Organizational Plans, Customer Requirements, Organizational Directions, Organizational Goals, Key Performance Drivers, Key Performance Objectives
Outputs	Alignment Actions
Entrance Criteria	
Exit Criteria	
Comments	This is a requirement for a review cycle in addition to a day-to-day focus. This requirement addresses alignment of Supplier plans also, QAF 3.2.a. Organizational Plans include any plan to include Training Plans, Improvement Plans, Project Plans, Quality Assurance Plans, Measurement Plans, etc.

Name	Reinforce Training
ID	AF-0087
Purpose	To ensure training and education members receive are understood and practiced.
Correlates to	4.3.b
Agents	Workers
Inputs	Members, Training Concerns
Outputs	Capabilities
Entrance Criteria	
Exit Criteria	
Comments	The are a variety of ways to accomplish this, including written tests, performance tests, refresher sessions, etc.

Name	Plan Training Delivery
ID	AF-0088
Purpose	To plan what training and education to accomplish and when, where, and how to accomplish it.
Correlates to	4.3.b, PF.Ac6, TP.Ac1, TP.Ac2
Agents	Trainers, Workers
Inputs	Course, Training Plans, Training Needs
Outputs	Delivery Plans
Entrance Criteria	
Exit Criteria	
Comments	This is essentially implementation planning.

Name	Identify Training Needs
ID	AF-0089
Purpose	To identify training and education needs based on job actions, human resource, plans, and current capabilities.
Correlates to	4.3.b, TP.Ac1
Agents	Workers
Inputs	Job Actions, Human Resource Plans, Workforce Capabilities
Outputs	Training Needs
Entrance Criteria	
Exit Criteria	
Comments	

Name	Assess Workforce Satisfaction
ID	AF-0090
Purpose	To determine the overall satisfaction of the workforce in the organization.
Correlates to	4.1.b, 4.4.c
Agents	Workers
Inputs	Members, Organizational Environments, Human Resource Information
Outputs	Workforce Satisfaction Data, Workforce Satisfaction Information
Entrance Criteria	
Exit Criteria	
Comments	

Name	Assess Workforce Motivation
ID	AF-0091
Purpose	To determine the overall motivation of the workforce in the organization.
Correlates to	4.1.b, 4.4.c
Agents	Workers
Inputs	Members, Organizational Environments, Human Resource Information
Outputs	Workforce Motivation Data, Workforce Motivation Information
Entrance Criteria	
Exit Criteria	
Comments	

Name	Evaluate Product Implementation
ID	AF-0092
Purpose	To evaluate a product after implementation to ensure it meets design requirements and performance objectives spelled out in the implementation plan.
Correlates to	5.1.c
Agents	Workers
Inputs	Product, Implementation Plans, Performance Objectives, Product Requirements, Product Data Analysis
Outputs	Product Actions
Entrance Criteria	
Exit Criteria	Performance Objectives NOT Achieved OR Product Requirements NOT Met Implies Product Actions Identified
Comments	Performance Objectives should be in Implementation Plans, and based on design requirements, Key Performance Objectives, and Key Performance Drivers.

Name	Evaluate Service Implementation
ID	AF-0093
Purpose	To evaluate a Service after implementation to ensure it meets design requirements and performance objectives spelled out in the implementation plan
Correlates to	5.1.c
Agents	Workers
Inputs	Service, Implementation Plans, Performance Objectives, Service Requirements, Service Data Analysis
Outputs	Service Actions
Entrance Criteria	
Exit Criteria	Performance Objectives NOT Achieved OR Service Requirements NOT Met Implies Service Actions Identified
Comments	Performance Objectives should be in Implementation Plans, and based on design requirements, Key Performance Objectives, and Key Performance Drivers.

Name	Do Research
ID	AF-0094
Purpose	To research information related to a product, process, or service in order to improve it or contribute to alternatives for corrective or improvement actions.
Correlates to	5.2.b, 5.3.c
Agents	Workers
Inputs	Item Concern
Outputs	Research Information
Entrance Criteria	
Exit Criteria	
Comments	The research may be conducted within the organization, in other organizations, at the library, on the internet, at a conference, etc.

Name	Communicate Supplier Requirements
ID	AF-0095
Purpose	For process owners to communicate requirements to their suppliers, whether internal or external to the organization.
Correlates to	5.4.a, SM.Ac3, IC.Ac3
Agents	Process Owners, Suppliers
Inputs	Supplier Requirements
Outputs	Supplier Requirements
Entrance Criteria	
Exit Criteria	Suppliers Informed
Comments	

Name	Determine Key Supplier Requirements
ID	AF-0096
Purpose	To determine the key requirements for the supplier of this process.
Correlates to	5.4.a, SM.Ac1, IC.Ac4
Agents	Workers, Suppliers
Inputs	Key Performance Drivers, Key Performance Objectives
Outputs	Supplier Requirements
Entrance Criteria	
Exit Criteria	
Comments	Suppliers may be empty for Software Subcontracting Activities.

Name	Communicate Information
ID	AF-0097
Purpose	For one group to communicate information about their activities, products, or performance to other groups, or to provide feedback on another groups activities, products, or performance.
Correlates to	5.4.a, 7.2.a, QA.Ac2, QA.Ac6, QA.Ac8, CM.Ac2, CM.Ac9, PF.Ac7, QP.Ac2, QP.Ac6, DP.Ac8, TC.Ac3, PC.Ac4, PC.Ac10
Agents	Providers
Inputs	Receivers, Information, Plans
Outputs	Information
Entrance Criteria	
Exit Criteria	Receivers Informed
Comments	This requires a process for disseminating information about any topic. Information may include reports on activities, performance, products, etc. Most likely there would be several varieties of this process.

Name	Gather Internal Data
ID	AF-0098
Purpose	To gather data from across the organization.
Correlates to	2.3.a, 6.1.a, 6.2.a, PP.Ac15, PD.Ac5
Agents	Workers
Inputs	Sources, Data
Outputs	Internal Data
Entrance Criteria	
Exit Criteria	
Comments	This is a requirement to report data up the chain to organizational leadership.

Name	Determine Customer Groups
ID	AF-0099
Purpose	To determine groups or segments of customers with the goal of providing products, services, or information to better serve a particular group or segment.
Correlates to	7.1.a, 7.3.a
Agents	Workers, Customers
Inputs	Customer Requirement Sets, Customer Data Analysis Sets
Outputs	Customer Groups
Entrance Criteria	
Exit Criteria	
Comments	

Name	Select Group
ID	AF-0100
Purpose	To select a group as a supplier or customer for a specific purpose.
Correlates to	7.1.a, SM.Ac2
Agents	Workers
Inputs	Groups, Selection Criteria
Outputs	Selected Groups
Entrance Criteria	
Exit Criteria	
Comments	

Name	Gather Customer Information
ID	AF-0101
Purpose	To gather, and put into a usable form, various information on the customer, including customer feedback, which may be useful in understand the customer, therefore the customer's requirements, better.
Correlates to	7.1.a, 7.2.b
Agents	Workers
Inputs	Customers, Customer Goals, Customer Expectations, Customer Values, Customer Organization, Customer Requirements, Customer Data, Customer Feedback
Outputs	Customer Information
Entrance Criteria	
Exit Criteria	
Comments	

Name	Provide Customer Access
ID	AF-0102
Purpose	To provide the customer with access to information, complaint, or feedback channels related to their relationship with the organization.
Correlates to	7.2.a
Agents	Workers, Customers
Inputs	Customers, Access Processes
Outputs	Customer Access
Entrance Criteria	
Exit Criteria	
Comments	Customers are considered as Agents in this process as well as Inputs. It may be the same people or different ones.

Name	Maintain Service Standards
ID	AF-0103
Purpose	To maintain standard levels of service provided to the customer.
Correlates to	7.2.a
Agents	Workers
Inputs	Service Standards, Customer Data Analysis, Customer Information
Outputs	Service Actions
Entrance Criteria	
Exit Criteria	Service Standards NOT Met Implies Service Actions Identified
Comments	

Name	Maintain Product Standards
ID	AF-0104
Purpose	To maintain product standards for products provided to the customer.
Correlates to	7.2.a
Agents	Workers
Inputs	Product Standards, Customer Data Analysis, Customer Information
Outputs	Product Actions
Entrance Criteria	
Exit Criteria	Product Standards NOT Met Implies Product Actions Identified
Comments	

Name	Gather Customer Feedback Data
ID	AF-0105
Purpose	To gather and record feedback data from the customer concerning any of the organization's services, products, processes, standards, etc.
Correlates to	7.2.a
Agents	Workers
Inputs	Customers, Indicators
Outputs	Feedback Data, Customer Information
Entrance Criteria	
Exit Criteria	
Comments	

Name	Record Customer Complaint
ID	AF-0106
Purpose	To record customer complaints as accurately as possible.
Correlates to	7.2.b
Agents	Workers, Customers
Inputs	Customers, Customer Requirements, Information, Data Analysis
Outputs	Complaints, Complaint Data
Entrance Criteria	
Exit Criteria	
Comments	

Name	Evaluate Customer Complaint
ID	AF-0107
Purpose	To determine possible course of action to resolve customer complaints.
Correlates to	7.2.b
Agents	Workers, Customers
Inputs	Complaints, Customer Requirements, Standards, Data Analysis, Information
Outputs	Complaint Actions
Entrance Criteria	
Exit Criteria	
Comments	

Name	Review Product
ID	AF-0108
Purpose	To review work products and identify actions necessary to remedy problems.
Correlates to	5.1.b, SM.Ac4, QA.Ac2, QA.Ac5, QA.Ac7, IC.Ac5, PR.Ac2, PR.Ac3
Agents	Auditors
Inputs	Work Products, Work Product Criteria, Plan
Outputs	Deviations, Report
Entrance Criteria	
Exit Criteria	Work Product Criteria NOT Met Implies Deviations Identified AND Documented
Comments	Deviations are of type Action. Reviews can be done on an event-driven basis (for which Plan would be empty), but some should be planned. The process may be used in a variety of manners, e.g., to review subcontractors SDP, a supplier (internal or external) delivery, or a co-worker's efforts.

Name	Review Project Event-Driven
ID	AF-0109
Purpose	To provide leaders with awareness of events that impact the project's activities.
Correlates to	1.2.c, IM.Ac11, Ve
Agents	Leaders, Reviewers
Inputs	Activities, Plans, Data Analysis, Status, Events
Outputs	Corrective Actions, Report
Entrance Criteria	
Exit Criteria	Plan NOT Followed OR Status Bad Implies Corrective Actions Identified AND Documented
Comments	Leaders are the decision makers, whether a project manager for a project review, or a Senior Leader in an organization-level review. Ve - used as verification for any organization activity.

Name	Measure Activity
ID	AF-0110
Purpose	To collect the data associated with the indicators identified for the input activity.
Correlates to	Me, PT.Ac11
Agents	Workers
Inputs	Activities, Indicators, Plan
Outputs	Activity Data
Entrance Criteria	
Exit Criteria	Activity Data Documented in Process Database
Comments	Essentially the same as Measure Process, but may be used for atomic operations. At ML2, Process Database may not be formalized.

Name	Maintain Software Process Database
ID	AF-0111
Purpose	To establish and maintain the organization's software process database.
Correlates to	PF.Co2, PF.Co3, PF.Ac4, PD.Ac5
Agents	SEPG, Senior Leaders, SW Engineering Group
Inputs	Software Process Database, Process Data, Project Data, Organization Data
Outputs	Software Process Database
Entrance Criteria	
Exit Criteria	Software LifeCycle Descriptions Documented (Reviewed AND Approved) by (Senior Leaders AND SEPG)
Comments	Senior Leaders are input to meet the Organization Process Focus Commitment 2 & 3. These state that senior leaders sponsor and oversee the organization's activities for software process development and improvement. Establish Process Database is NOT included as a separate process requirement since it is a one-time operation. The criteria to "establish" is implicitly met by having a database to maintain. Process Data refers to organizational data collected on the process by ALL projects. Project Data refers to project-specific data that may or may not correlate to other projects. Organization Data refers to other relevant data such as HR data, financial data, or customer data.

Name	Develop Software Requirements
ID	AF-0112
Purpose	To develop software requirements based on the system requirements allocated to software.
Correlates to	RM.Ac2
Agents	SW Engineering Group
Inputs	Allocated Requirements
Outputs	Software Requirements
Entrance Criteria	Allocated Requirements Documented AND Managed & Controlled
Exit Criteria	Software Requirements Documented AND Managed & Controlled AND Traceable
Comments	

Name	Change Supplier Commitment
ID	AF-0113
Purpose	To revise the commitment with the supplier.
Correlates to	5.4.b, PT.Ac4, SM.Ac6
Agents	Senior Leaders, Representatives, Supplier Representatives
Inputs	Supplier Commitment, Supplier Requirements, Suggested Changes
Outputs	New Supplier Commitment
Entrance Criteria	Supplier Requirements Documented
Exit Criteria	New Supplier Commitments Documented
	New Supplier Commitments (Reviewed AND Approved) by Senior Leaders
	New Supplier Commitments (Communicated OR Agreed To)
Comments	If Supplier is internal, Senior Leaders may not be involved.

Name	Project Planning
ID	AF-0114
Purpose	To perform planning for the entire project, to include action planning, defect prevention, quantitative process management, etc.
Correlates to	5.1.a, 5.2.a, 5.3.b, PP.Ac2, PP.Ac3, PP.Ac5, PP.Ac6, PP.Ac7, PP.Ac14, PT.Ac1, PT.Ac2, QA.Ac1, QA.Ac3, CM.Ac1, TP.Ac1, IM.Ac3, IM.Ac4, IM.Ac5, IC.Ac3, IC.Ac4, QP.Ac1, SQ.Ac1, DP.Ac1
Agents	Project Managers, Affected Groups
Inputs	Goals, Objectives, SOW, System Requirements, PDSP, Standards, Commitments
Outputs	Project Plans
Entrance Criteria	SOW (Documented AND Approved) AND Software LifeCycle Identified
Exit Criteria	Project Plans (Documented AND Reviewed AND Approved)
Comments	This is a generic planning process that encompasses all the planning for a project. Even though there are a variety of plans to develop, the process is essentially the same for each one. Also includes revising the plan, i.e., replanning.
	Not all output plans are necessarily formal plans.
	For software project planning, Affected Groups must include QA Group.
	At ML2, PDSP may not be formalized.

Name	Make Commitment
ID	AF-0115
Purpose	To make a commitment with a supplier.
Correlates to	RM.Ac1, RM.Ac3, PP.Ac4, PT.Ac3, SM.Ac3
Agents	Senior Leaders, SW Engineering Group, Suppliers
Inputs	Supplier Requirements, Project Requirements
Outputs	New Supplier Commitments
Entrance Criteria	Supplier Requirements Documented
Exit Criteria	Supplier Commitments (Reviewed AND Approved) by Senior Leaders
	Supplier Commitments (Documented AND Agreed To)
Comments	Suppliers may be Other Affected Groups in the organization. Project Requirements may be needed as the basis for negotiation, as Supplier Requirements are what the are proposed by the SW Engineering Group. If Supplier is internal, Senior Leaders may not be involved. For external commitments with other groups, AF-0111 is for internal.

Name	Take Corrective Actions
ID	AF-0116
Purpose	To take corrective actions based on problems in the project.
Correlates to	5.2.a, 5.3.b, PT.Ac5, PT.Ac6, PT.Ac7, PT.Ac8, PT.Ac9, PT.Ac10, Ve
Agents	Project Manager, Project Team, Affected Groups
Inputs	Corrective Actions, Priorities, Plan
Outputs	Actions
Entrance Criteria	Corrective Actions Documented AND Approved
Exit Criteria	Corrective Actions (Performed AND Closed)
Comments	Although in the CMM vernacular taking corrective actions implies reaction at ML2, as opposed to "pro"-action at (ML3. However, corrective action as stated here is more general. It applies to any actions taken, including proactive steps. This requirement is applicable to actions taken as a result of an evaluation, audit, or review. Therefore, Ve is included in Correlates to.

Name	Track Technical Activities
ID	AF-0117
Purpose	To track the technical activities of the software development effort and identify corrective actions if there are problems.
Correlates to	PT.Ac9, IC.Ac2
Agents	SW Engineering Group, Affected Groups
Inputs	Software Development Plan, Technical Activities
Outputs	Corrective Actions, Technical Activities Status
Entrance Criteria	
Exit Criteria	Software Development Plan NOT Followed Implies Corrective Actions Identified
Comments	

Name	Measure Product
ID	AF-0118
Purpose	To collect product data associated with the indicators identified for the product.
Correlates to	5.4.a, 6.1.a, 6.3.a, PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, SQ.Ac2, SQ.Ac4, DP.Ac5
Agents	Workers
Inputs	Products, Indicators, Plans
Outputs	Product Data
Entrance Criteria	
Exit Criteria	Data (Documented in Process Database)
Comments	At ML2, Process Database may not be formalized. At ML3 and higher, methods for using the Process Database are coordinated at the organization level. Most Me measurements in the CMM address measuring activities or process, PE.Me1 addresses products. May also be used for supplier products.

Name	Plan Supplier Work
ID	AF-0119
Purpose	To plan the work the supplier will do.
Correlates to	5.4.b, SM.Ac1
Agents	Senior Leaders, Project Managers, Supplier Managers
Inputs	SOW, Allocated Software Requirements, Software Development Plan, Software Standards, Supplier Procedures
Outputs	Supplier SOW, Supplier Plans
Entrance Criteria	
Exit Criteria	Supplier Plans Reviewed
Comments	May apply internally. Applied Externally, Senior Leaders should review plans.

Name	Review Activity
ID	AF-0120
Purpose	To independently verify a group is regularly performing activities as planned.
Correlates to	SM.Ac5, SM.Ac8, SM.Ac10, SM.Ac11, QA.Ac2, QA.Ac4, QA.Ac8, IC.Ac7
Agents	Reviewers
Inputs	Workers, Plan, Activities, Status, Review Criteria
Outputs	Action Items, Report
Entrance Criteria	
Exit Criteria	Review Criteria NOT Met Implies Action Items Identified
Comments	For an Independent Review, ensure no Workers are in Reviewers.

Name	Audit Baseline
ID	AF-0121
Purpose	To perform an audit on a software baseline.
Correlates to	CM.Ac2, CM.Ac10, CM.Ve3
Agents	CM Group, Project Software Manager
Inputs	CM Plan, Software Baseline, CM LIbrary, Baseline Criteria
Outputs	Action Items
Entrance Criteria	
Exit Criteria	Baseline Criteria NOT Met Implies Action Items Identified
Comments	Baseline Criteria give requirements and standards for the baseline configuration.

Name	Maintain Training Records
ID	AF-0122
Purpose	To maintain the training records of organization personnel.
Correlates to	TP.Ac6
Agents	Training Group,
Inputs	Members, Training Records
Outputs	Updated Records
Entrance Criteria	
Exit Criteria	
Comments	Although not specifically addressed, this requirement relates to QAF 4.3.b.

Name	Maintain Software Process Library
ID	AF-0123
Purpose	To establish and maintain the organization's software process library.
Correlates to	PD.Ac6
Agents	Senior Leaders, SEPG, SW Engineering Group
Inputs	Software Process Library, Process Information, Project Information
Outputs	Software Process Library
Entrance Criteria	
Exit Criteria	
Comments	Establish is not included as a separate process requirement; the criteria to establish is implicitly met by having a database to maintain.

Name	Perform Training
ID	AF-0124
Purpose	To perform training in accordance with the organization's or project's training plan.
Correlates to	4.3.b, TP.Ac3
Agents	Trainers
Inputs	Participants, Course Materials, Training Plan
Outputs	Course, Capabilities
Entrance Criteria	
Exit Criteria	
Comments	

Name	Develop Training Course
ID	AF-0125
Purpose	To develop a training course that meets the needs identified in the project or organization training plan.
Correlates to	4.3.b, TP.Ac4
Agents	Developers, Training Group
Inputs	Organization Training Plan, Training Needs
Outputs	Training Course
Entrance Criteria	
Exit Criteria	Training Course Meets Training Needs
Comments	

Name	Maintain Training Course
ID	AF-0126
Purpose	To update courses to ensure they are current, relevant, and meet training needs
Correlates to	TP.Ac4
Agents	Developers, Training Group, Reviewers
Inputs	Training Course, Change Actions, Organization Training Plan, Training Needs
Outputs	Training Course
Entrance Criteria	
Exit Criteria	Training Course Meets Training Needs
Comments	

Name	Conduct Training Waiver Procedure
ID	AF-0127
Purpose	To determine if members meet the waiver criteria for a course.
Correlates to	TP.Ac5
Agents	Training Group
Inputs	Members, Training Course, Waiver Criteria
Outputs	Trained Participants
Entrance Criteria	
Exit Criteria	Waiver Criteria Met Implies Course Waived
Comments	

Name	Measure Training Quality
ID	AF-0128
Purpose	To measure the quality of training offered in and by the organization.
Correlates to	4.3.a, 4.3.b, TP.Me2
Agents	Training Participants, Software Managers, Training Group
Inputs	Training Course, Training Needs, Capabilities
Outputs	Training Quality Data
Entrance Criteria	
Exit Criteria	
Comments	Training Quality should be partly based on the effectiveness of the training to meet Training Needs and build Capabilities.

Name	Independent Training Evaluation
ID	AF-0129
Purpose	To independently evaluate the training program and its effectiveness.
Correlates to	4.3.a, 4.3.b, TP.Ve2
Agents	Evaluators
Inputs	Training Group, Training Plans, Training Activities, Training Courses, Capabilities, Training Needs, Training Records, Training Standards, Training Quality Data
Outputs	Training Actions, Training Analysis
Entrance Criteria	
Exit Criteria	
Comments	This requirement is separate from AF-0120 Activity Review because of the special nature of the training program; however, similar methods may be used. This evaluation should include how the training program contributes to the organizational capabilities that satisfy mission requirements.

Name	Develop PDSP
ID	AF-0130
Purpose	To develop the project's defined software process based on the organization's standard software process and tailoring guidelines.
Correlates to	QA.Ac3, PF.Ac3, IM.Ac1, PE.Ac1
Agents	Developers, Senior Leaders, SEPG, QA Group
Inputs	Software LifeCycle, OSSP, Tailoring Guidelines, Software Engineering Tasks, Software Methods, Software Tools, Selection Criteria
Outputs	PDSP, Process Waivers
Entrance Criteria	Development Activities Coordinated at Organization Level
Exit Criteria	PDSP Reviewed by (SEPG AND QA Group) AND Approved by Senior Leaders PDSP (Reviewed AND Approved) by Senior Leaders Managed & Controlled
Comments	IM Activity 1 relates to developing the PDSP from the OSSP. PE Activity 1 requires the input and consideration of software engineering activities, methods, and tools, as well as the criteria for choosing them. The idea is to integrate these into the PDSP.

Name	Revise PDSP
ID	AF-0131
Purpose	To revise the project's defined software process based on the input changes and the organization's standard software process and tailoring guidelines .
Correlates to	QA.Ac3, PF.Ac3, IM.Ac2, PE.Ac1, DP.Ac7, TC.Ac8
Agents	Developers, Senior Leaders, SEPG, QA Group
Inputs	PDSP, Change Actions, Software LifeCycle, OSSP, Tailoring Guidelines, Software Engineering Tasks, Software Methods, Software Tools, Selection Criteria
Outputs	PDSP, Process Waivers
Entrance Criteria	
Exit Criteria	PDSP Reviewed by (SEPG AND QA Group) AND Approved by Senior Leaders PDSP (Reviewed AND Approved) by Senior Leaders Managed & Controlled
Comments	Change Actions include inputs from AF-0043, Determine Root Cause and AF-0179, Analyze OSSP.

Name	Identify Software Work Products
ID	AF-0132
Purpose	To identify software work products necessary to support the development effort.
Correlates to	PP.Ac8, IM.Ac4
Agents	SW Engineering Group, Affected Groups
Inputs	SOW, PDSP, Allocated Requirements, Software LifeCycle, Standards, Software LifeCycle
Outputs	Software Work Products
Entrance Criteria	SOW (Documented AND Approved)
Exit Criteria	Software Work Products Designated (Managed & Controlled OR In CM)
Comments	At ML2, PDSP may not be formalized. This requirement is to identify all software work products that will be needed for the project. AF-0067, Identify Software Configuration Items, identifies a subset of these which will be placed under configuration management.

Name	Estimate Size
ID	AF-0133
Purpose	To estimate size of software work products or changes to software work products.
Correlates to	PP.Ac9, PP.Ac15, PF.Ac4, IM.Ac4, IM.Ac5, IM.Ac6
Agents	Workers, Reviewers
Inputs	PDSP, Software Requirements, Software Work Products, Process Database
Outputs	Size Estimates, Size Thresholds
Entrance Criteria	
Exit Criteria	Size Estimates (Reviewed AND Approved) AND (Documented AND Managed & Controlled)
Comments	Reviewers may include Project Manager, Software Project Manager, and Managers of other affected groups. At ML2, PDSP and Process Database may not be formalized, and Thresholds not required outputs. At ML3 and higher, the methods for using the Process Database are coordinated at the organization level.

Name	Estimate Effort
ID	AF-0134
Purpose	To estimate the effort of the software work products or changes to the software work products.
Correlates to	PP.Ac10, PP.Ac15, PF.Ac4, IM.Ac4, IM.Ac5, IM.Ac7
Agents	Workers, Reviewers
Inputs	PDSP, Software Requirements, Software Work Products, Process Database
Outputs	Effort Estimates, Effort Thresholds
Entrance Criteria	
Exit Criteria	Effort Estimates (Reviewed AND Approved) AND (Documented AND Managed & Controlled)
Comments	Reviewers may include Project Manager, Software Project Manager, and Managers of other affected groups. At ML2, PDSP and Process Database may not be formalized, and Thresholds not required outputs. At ML3 and higher, the methods for using the Process Database are coordinated at the organization level.

Name	Estimate Cost
ID	AF-0135
Purpose	To estimate the cost of the software work products or changes to the software work products.
Correlates to	PP.Ac10, PP.Ac15, PF.Ac4, IM.Ac4, IM.Ac5, IM.Ac7
Agents	Workers, Reviewers
Inputs	PDSP, Software Requirements, Software Work Products, Process Database
Outputs	Cost Estimates, Cost Thresholds
Entrance Criteria	
Exit Criteria	Cost Estimates (Reviewed AND Approved) AND (Documented AND Managed & Controlled)
Comments	Reviewers may include Project Manager, Software Project Manager, and Managers of other affected groups. At ML2, PDSP and Process Database may not be formalized, and Thresholds not required outputs. At ML3 and higher, the methods for using the Process Database are coordinated at the organization level.

Name	Estimate Critical Computer Resources
ID	AF-0136
Purpose	To estimate the critical computer resources necessary to support the project.
Correlates to	PP.Ac11, PP.Ac15, PF.Ac4, IM.Ac4, IM.Ac5, IM.Ac8
Agents	Workers, Reviewers
Inputs	PDSP, Software Requirements, Software Work Products, Process Database
Outputs	Critical Computer Resource Estimates, Critical Computer Resource Thresholds
Entrance Criteria	
Exit Criteria	Critical Computer Resource Estimates (Reviewed AND Approved) AND (Documented AND Managed & Controlled)
Comments	Reviewers may include Project Manager, Software Project Manager, and Managers of other affected groups. At ML2, PDSP and Process Database may not be formalized, and Thresholds not required outputs. At ML3 and higher, the methods for using the Process Database are coordinated at the organization level.

Name	Derive Schedule
ID	AF-0137
Purpose	To derive the schedule for the software development effort.
Correlates to	PP.Ac12, PP.Ac15, PF.Ac4, IM.Ac4, IM.Ac5, IM.Ac9
Agents	Workers, Reviewers
Inputs	PDSP, Software Requirements, Software Work Products, Process Database
Outputs	Schedule Estimates, Schedule Thresholds
Entrance Criteria	
Exit Criteria	Schedule Estimates (Reviewed AND Approved) AND (Documented AND Managed & Controlled)
Comments	Reviewers may include Project Manager, Software Project Manager, and Managers of other affected groups. At ML2, PDSP and Process Database may not be formalized, and Thresholds required outputs. At ML3 and higher, the methods for using the Process Database are coordinated at the organization level.

Name	Identify Risks
ID	AF-0138
Purpose	To identify potential risks for the software development effort.
Correlates to	PP.Ac13, PP.Ac15, IM.Ac4, IM.Ac5, IM.Ac10
Agents	SW Engineering Group
Inputs	PDSP, Software Requirements, Software Work Products, Software Estimates, Software Thresholds, Process Database
Outputs	Software Risks
Entrance Criteria	
Exit Criteria	Software Risks Documented AND Managed & Controlled
Comments	At ML2, PDSP and Process Database may not be formalized, and Thresholds may not be produced. At ML3 and higher, the methods for using the Process Database are coordinated at the organization level.

Name	Analyze Risks
ID	AF-0139
Purpose	To assess the impact of the risks to the software development effort.
Correlates to	PP.Ac13, IM.Ac4, IM.Ac5, IM.Ac10
Agents	SW Engineering Group
Inputs	PDSP, Software Requirements, Software Work Products, Software Estimates, Process Database, Software Risks
Outputs	Risk Analysis
Entrance Criteria	
Exit Criteria	
Comments	At ML2, PDSP and Process Database may not be formalized, and Thresholds may not be produced. At ML3 and higher, the methods for using the Process Database are coordinated at the organization level.

Name	Prioritize Risks
ID	AF-0140
Purpose	To prioritize the risks based on risk analysis.
Correlates to	PP.Ac13, IM.Ac4, IM.Ac5, IM.Ac10
Agents	SW Engineering Group
Inputs	PDSP, Software Requirements, Software Work Products, Software Estimates, Process Database, Software Risks, Risk Analysis
Outputs	Prioritized Risks
Entrance Criteria	
Exit Criteria	Prioritized Risks Documented AND Managed & Controlled
Comments	At ML2, PDSP and Process Database may not be formalized, and Thresholds may not be produced. At ML3 and higher, the methods for using the Process Database are coordinated at the organization level.

Name	Manage Size
ID	AF-0141
Purpose	To manage the size of software work products and identify corrective actions if the actual size data exceeds thresholds.
Correlates to	PT.Ac5, IM.Ac6
Agents	SW Engineering Group
Inputs	Software Development Plan, Size Estimates, Size Thresholds, Size Data
Outputs	Corrective Actions
Entrance Criteria	
Exit Criteria	Size Thresholds Exceeded Implies Corrective Actions Identified
Comments	At ML2, Thresholds may not be produced; Size is "tracked". The PDSP is used in planning and estimating, but the S DP, which embodies the PDSP at ML3 and higher, is used for tracking or managing.

Name	Manage Effort
ID	AF-0142
Purpose	To manage the effort of software work products and identify corrective actions if the actual effort data exceeds thresholds.
Correlates to	PT.Ac6, IM.Ac7
Agents	SW Engineering Group
Inputs	Software Development Plan, Effort Estimates, Effort Thresholds, Effort Data
Outputs	Corrective Actions
Entrance Criteria	
Exit Criteria	Effort Thresholds Exceeded Implies Corrective Actions Identified
Comments	At ML2, Thresholds may not be produced; Effort is "tracked". The PDSP is used in planning and estimating, but the S DP, which embodies the PDSP at (ML3, is used for tracking or managing.

Name	Manage Cost
ID	AF-0143
Purpose	To manage the cost of software work products and identify corrective actions if the actual cost data exceeds thresholds.
Correlates to	PT.Ac6, IM.Ac7
Agents	SW Engineering Group
Inputs	Software Development Plan, Cost Estimates, Cost Thresholds, Cost Data
Outputs	Corrective Actions
Entrance Criteria	
Exit Criteria	Cost Thresholds Exceeded Implies Corrective Actions Identified
Comments	At ML2, Thresholds may not be produced; Cost is "tracked". The PDSP is used in planning and estimating, but the S DP, which embodies the PDSP at (ML3, is used for tracking or managing.

Name	Manage Critical Computer Resources
ID	AF-0144
Purpose	To manage the critical computer resources of software project and identify corrective actions if the actual critical computer resource data exceeds thresholds.
Correlates to	PT.Ac7, IM.Ac8
Agents	SW Engineering Group
Inputs	Software Development Plan, Critical Computer Resource Estimates, Critical Computer Resource Thresholds, Critical Computer Resource Data
Outputs	Corrective Actions
Entrance Criteria	
Exit Criteria	Critical Computer Resource Thresholds Exceeded Implies Corrective Actions Identified
Comments	At ML2, Thresholds may not be produced; Critical Computer Resources are "tracked". The PDSP is used in planning and estimating, but the S DP, which embodies the PDSP at (ML3, is used for tracking or managing.

Name	Manage Critical Paths
ID	AF-0145
Purpose	To manage the critical paths of the project based on the software development plan, estimates, and thresholds.
Correlates to	IM.Ac4, IM.Ac5, IM.Ac9, IC.Ac4
Agents	Software Manager
Inputs	Software Development Plan, Software Estimates, Software Thresholds
Outputs	Corrective Actions
Entrance Criteria	
Exit Criteria	Thresholds Exceeded Implies Corrective Actions Identified
Comments	At ML2, Thresholds may not be produced; Critical paths may be "tracked". The PDSP is used in planning and estimating, but the S DP, which embodies the PDSP at (ML3, is used for tracking or managing. The S DP incorporates the schedule and identifies critical paths.

Name	Develop Software Risk Management Plan
ID	AF-0146
Purpose	To develop a comprehensive plan for managing the risks associated with the software development effort and identify contingencies and alternative corrective actions to take should the risk occur or reach a probability threshold of occurring.
Correlates to	IM.Ac10
Agents	SW Engineering Group, Software Managers
Inputs	Software Development Plan, Software Risks, Software Estimates, Software Thresholds, Risk Analysis, Risk Data
Outputs	Software Risk Management Plan
Entrance Criteria	
Exit Criteria	Software Risk Management Plan Managed & Controlled
Comments	This plan is part of the S DP; Corrective Actions identified in managing the project may come from this plan.

Name	Manage Risks
ID	AF-0147
Purpose	To manage the risks associated with the software development effort and identify corrective actions to take based on the risk management plan..
Correlates to	PT.Ac10, IM.Ac10
Agents	SW Engineering Group
Inputs	Software Development Plan, Software Risk Management Plan, Software Risks, Software Thresholds, Risk Analysis, Risk Data
Outputs	Corrective Actions
Entrance Criteria	
Exit Criteria	Software Risks Occur OR Thresholds Exceeded) Implies Corrective Actions Identified
Comments	At ML2, Thresholds may not be produced; Risks may be "tracked". The PDSP is used in planning and estimating, but the S DP, which embodies the PDSP at (ML3, is used for tracking or managing.

Name	Review Project Periodic
ID	AF-0148
Purpose	To determine if actions are needed to bring the project's performance in line with plans, estimates, and business, customer, or end-user needs.
Correlates to	1.2.c, 5.4.a, PP.Ac4, PT.Ac12, PT.Ac13, SM.Ac7, SM.Ac9, IM.Ac11, Ve
Agents	Reviewers
Inputs	Plans, Status, Activities, Estimates, Project Data Analysis, Process Data Analysis, Business Needs, Customer Needs
Outputs	Corrective Actions, Reports
Entrance Criteria	
Exit Criteria	Corrective Actions (Documented AND Assigned AND Reviewed)
Comments	Corrective Actions are closed under AF-0116, Take Corrective Action

Name	Review Allocated Requirements
ID	AF-0149
Purpose	To ensure system requirements allocated to software are feasible, appropriate, testable, clear, and properly stated.
Correlates to	RM.Ac1, RM.Ac3, PE.Ac2
Agents	Reviewers
Inputs	Allocated Requirements, Criteria, PDSP
Outputs	Approved Requirements, Problem Allocated Requirements
Entrance Criteria	Allocated Requirements Documented
Exit Criteria	Criteria NOT Met Implies Problem Allocated Requirements Identified
Comments	At ML2, PDSP may not be formalized.

Name	Correct Allocated Requirements
ID	AF-0150
Purpose	To add missing requirements or correct incomplete or problematic requirements, such as one that are not feasible, appropriate, testable, clear, or properly stated.
Correlates to	RM.Ac1, PE.Ac2
Agents	SW Engineering Group, System Requirements Group
Inputs	Problem Allocated Requirements, System Requirements, PDSP
Outputs	Corrected Allocated Requirements
Entrance Criteria	System Requirements Documented AND (Managed & Controlled OR In CM)
Exit Criteria	Problem Allocated Requirements Corrected
Comments	At ML2, PDSP may not be formalized.

Name	Requirements Analysis
ID	AF-0151
Purpose	To analyze the requirements allocated to software and develop the software requirements for the project.
Correlates to	PE.Ac2
Agents	Analyzers
Inputs	Allocated Requirements, PDSP, Analysis Methods
Outputs	Software Requirements
Entrance Criteria	
Exit Criteria	
Comments	At ML2, PDSP may not be formalized.

Name	Develop Software Requirements Document
ID	AF-0152
Purpose	To develop the software requirements document as the basis for the software component of the project.
Correlates to	PE.Ac2
Agents	Developers
Inputs	Software Requirements, PDSP
Outputs	Software Requirements Document
Entrance Criteria	
Exit Criteria	Requirements Feasible, Testable, Clear, Consistent, Complete Requirements (Verified AND Validated) Software Requirements Document (Reviewed AND Approved) Software Requirements Document Reviewed with Customers Software Requirements Document In CM
Comments	At ML2, PDSP may not be formalized.

Name	Develop Design Criteria
ID	AF-0153
Purpose	To develop criteria applicable to the project.
Correlates to	4.3.b, 5.1.a, 5.3.a, PE.Ac3
Agents	Developers
Inputs	Developers, Software Requirements Document, PDSP
Outputs	Software Design Criteria
Entrance Criteria	
Exit Criteria	Software Design Criteria (Documented AND Reviewed)
Comments	At ML2, PDSP may not be formalized.

Name	Develop Software Architecture Design
ID	AF-0154
Purpose	To develop the high-level architectural design of the software product.
Correlates to	5.1.a, PE.Ac3
Agents	Designers
Inputs	Software Requirements Document, Design Criteria, PDSP
Outputs	Software Architecture Design
Entrance Criteria	
Exit Criteria	Software Architecture Design (Documented AND Peer Reviewed AND In CM)
Comments	At ML2, PDSP may not be formalized.

Name	Develop Software Detail Design
ID	AF-0155
Purpose	To develop the low-level detailed design of the software product.
Correlates to	5.1.a, PE.Ac3
Agents	Designers
Inputs	Software Requirements Document, Design Criteria, PDSP, Software Architecture Design
Outputs	Software Detail Design
Entrance Criteria	
Exit Criteria	Software Detail Design (Documented AND Peer Reviewed AND In CM)
Comments	At ML2, PDSP may not be formalized.

Name	Develop Software Code
ID	AF-0156
Purpose	To develop the software code based on the low-level detailed design and the software requirements of the software product.
Correlates to	PE.Ac4
Agents	Coders
Inputs	Software Requirements Document, Design Criteria, PDSP, Software Detail Design
Outputs	Software Code
Entrance Criteria	
Exit Criteria	Software Code (Documented AND Peer Reviewed AND In CM)
Comments	At ML2, PDSP may not be formalized.

Name	Plan Unit Tests
ID	AF-0157
Purpose	To develop the low level testing strategy to ensure the software code components work and meet software requirements of the software product.
Correlates to	PE.Ac5
Agents	Test Planners
Inputs	Software Requirements Document, Software Development Plan, PDSP
Outputs	Software Test Plans, Software Test Procedures, Software Test Cases
Entrance Criteria	
Exit Criteria	Software Test Plans, Software Test Procedures, Software Test Cases) Managed & Controlled
Comments	At ML2, PDSP may not be formalized.

Name	Perform Unit Tests
ID	AF-0158
Purpose	To test the software using the plans, procedures, and cases developed to ensure the software code components work and meet software requirements of the software product.
Correlates to	PE.Ac5
Agents	Testers
Inputs	Software Code, Software Test Plans, Software Test Procedures, Software Test Cases, PDSP
Outputs	Software Components, Software Test Results, Software Test Data
Entrance Criteria	
Exit Criteria	Regression Testing Performed Software Components Passed Software Testing
Comments	At ML2, PDSP may not be formalized.

Name	Plan Integration Tests
ID	AF-0159
Purpose	To develop the integration testing strategy to ensure the software code components work and meet software requirements of the software product.
Correlates to	PE.Ac6
Agents	Integration Test Planners, Testers
Inputs	Software Requirements Document, Software Development Plan, PDSP
Outputs	Integration Test Plans, Integration Test Procedures, Integration Test Cases
Entrance Criteria	
Exit Criteria	Integration Test Plans, Integration Test Procedures, Integration Test Cases) (Managed & Controlled AND Reviewed by Testers)
Comments	At ML2, PDSP may not be formalized.

Name	Perform Integration Tests
ID	AF-0160
Purpose	To integrate and test the software components using the plans, procedures, and cases developed to ensure the integrated components work and meet software requirements of the software product.
Correlates to	PE.Ac6
Agents	Testers
Inputs	Software Components, Integration Test Plans, Integration Test Procedures, Integration Test Cases, PDSP
Outputs	Integrated Components, Integration Test Results, Integration Test Data
Entrance Criteria	
Exit Criteria	Software Components Passed Software Testing
Comments	At ML2, PDSP may not be formalized.

Name	Plan System Tests
ID	AF-0161
Purpose	To develop a system level testing strategy to ensure software components work together as a system and meet the requirements of the software product.
Correlates to	PE.Ac7
Agents	System Test Planners, Testers, Customers
Inputs	Software Requirements Document, Software Development Plan, PDSP
Outputs	System Test Plans, System Test Procedures, System Test Cases
Entrance Criteria	
Exit Criteria	(System Test Plans, System Test Procedures, System Test Cases) (Managed & Controlled AND Reviewed by (Customers AND Testers))
Comments	At ML2, PDSP may not be formalized.

Name	Perform System Tests
ID	AF-0162
Purpose	To test the system using plans, procedures, and cases developed to ensure components work together as a system and meet the requirements of the product.
Correlates to	PE.Ac7
Agents	Testers, Customers
Inputs	Integrated Components, System Test Plans, System Test Procedures, System Test Cases, PDSP
Outputs	System Test Data, System Test Results
Entrance Criteria	
Exit Criteria	Software Components Passed Software Testing
Comments	At ML2, PDSP may not be formalized.

Name	Develop Software Documentation
ID	AF-0163
Purpose	To develop the documentation used to describe the software system.
Correlates to	PE.Ac8
Agents	Documenters
Inputs	Software Development Plan, Software Requirements Document, Methods, Tools, Software Baselines, PDSP
Outputs	Software Documentation
Entrance Criteria	
Exit Criteria	Software Documentation (Peer Reviewed AND Managed & Controlled) Software Documentation (Reviewed AND Approved) by Customer
Comments	At ML2, PDSP may not be formalized.

Name	Maintain Software Documentation
ID	AF-0164
Purpose	To maintain the documentation used to describe the software system.
Correlates to	PE.Ac8
Agents	Documenters
Inputs	Software Documentation, Change Actions, Software Development Plan, Software Requirements Document, Methods, Tools, Software Baselines, PDSP
Outputs	Software Documentation
Entrance Criteria	
Exit Criteria	Software Documentation (Peer Reviewed AND Managed & Controlled) Software Documentation (Reviewed AND Approved) by Customer
Comments	At ML2, PDSP may not be formalized.

Name	Maintain Consistency
ID	AF-0165
Purpose	To maintain consistency from allocated requirements through software requirements, architectural and detail designs, coding, testing, and documentation.
Correlates to	PE.Ac10
Agents	Workers
Inputs	Software Work Products, Software Documentation
Outputs	Corrective Actions
Entrance Criteria	
Exit Criteria	Software Work Products, Software Documentation NOT Consistent Implies Corrective Actions Identified
Comments	

Name	Establish System Requirements
ID	AF-0166
Purpose	To involve the customer and all affected groups in establishing the requirements for the system.
Correlates to	7.1.a, IC.Ac1
Agents	SW Engineering Group, Customers, Affected Groups
Inputs	SW Engineering Group, Customers, Affected Groups, Customer Information, Customer Data
Outputs	System Requirements, Acceptance Criteria
Entrance Criteria	
Exit Criteria	
Comments	This requirement differs from AF-0046. It is focused on the solution space, i.e., what system is needed. AF-0046 addresses the problem domain, i.e., determining customer needs. Elicitation processes may be used for this, also.

Name	Coordinate Technical Activities
ID	AF-0167
Purpose	To coordinate the activities of the engineering groups with other affected groups.
Correlates to	IC.Ac2
Agents	SW Engineering Group, Affected Groups
Inputs	Inter Group Coordination Plan
Outputs	Technical Activities
Entrance Criteria	
Exit Criteria	
Comments	

Name	Resolve Inter Group Issues
ID	AF-0168
Purpose	To resolve issues between the engineering group and other affected groups.
Correlates to	IC.Ac2, IC.Ac6
Agents	SW Engineering Group, Affected Groups
Inputs	Inter Group Issues, Inter Group Coordination Plan
Outputs	Resolution Actions
Entrance Criteria	
Exit Criteria	
Comments	

Name	Manage Schedule
ID	AF-0169
Purpose	To manage the schedule of the project and identify corrective actions if the schedule exceeds thresholds. Another aspect of this requirement is to manage the critical dependencies between the engineering group and other affected groups.
Correlates to	PT.Ac8, IC.Ac4, IM.Ac9
Agents	SW Engineering Group, Affected Groups
Inputs	Software Development Plan, Inter Group Coordination Plan, Schedule Estimates, Schedule Thresholds, Schedule Data
Outputs	Corrective Actions
Entrance Criteria	
Exit Criteria	Schedule Thresholds Exceeded Implies Corrective Actions Identified
Comments	Inter Group Coordination Plan contains the critical dependencies between the SW Engineering Group and other Affected Groups. At ML2, Thresholds may not be produced; Schedule is "tracked". The PDSP is used in planning and estimating, but the S DP, which embodies the PDSP at (ML3, is used for tracking or managing.

Name	Plan Peer Review
ID	AF-0170
Purpose	To plan a peer review of software work products during the software lifecycle.
Correlates to	PR.Ac1
Agents	Planners
Inputs	Software Development Plan, Software Work Products
Outputs	Peer Review Plan
Entrance Criteria	
Exit Criteria	Software Work Products Identified
Comments	

Name	Develop Measurement Analysis Strategy
ID	AF-0171
Purpose	To develop a strategy for measuring and analyzing process quality data.
Correlates to	QP.Ac3
Agents	Workers
Inputs	PDSP, Identified Software Work Products, Product Indicators
Outputs	Measurement Analysis Strategy
Entrance Criteria	
Exit Criteria	
Comments	

Name	Analyze PDSP
ID	AF-0172
Purpose	To analyze the project's defined software process against expected values to determine if it is within tolerances.
Correlates to	QP.Ac2, QP.Ac5
Agents	Analyzers
Inputs	PDSP, Measurement Data Analysis, Analysis Activities, Expected Values, QPM Plan
Outputs	Corrective Actions, Process Performance Baseline
Entrance Criteria	
Exit Criteria	Measurement Data Analysis NOT within Expected Values Implies Corrective Actions Identified Process Performance Baseline Managed & Controlled
Comments	

Name	Maintain Process Capability Baseline
ID	AF-0173
Purpose	To maintain the baseline for the organizations process performance capability.
Correlates to	QP.Ac2, QP.Ac7
Agents	Maintainers
Inputs	Process Capability Baseline, Process Performance Baselines, QPM Plan
Outputs	New Process Capability Baseline
Entrance Criteria	
Exit Criteria	New Process Capability Baseline (Documented AND Managed & Controlled)
Comments	Establish is not included as a separate requirement, it is assumed.

Name	Manage Quality
ID	AF-0174
Purpose	To manage quality for the project's software products and take corrective action to ensure the goals are met.
Correlates to	SQ.Ac3, SQ.Ac4
Agents	Monitors
Inputs	Software Work Products, Project Quality Goals, Quality Data Analysis, Software Quality Management Plan
Outputs	Corrective Actions, Status
Entrance Criteria	
Exit Criteria	Project Quality Goals Implies Corrective Actions Identified
Comments	Related to QAF 6.1.a

Name	Allocate Quality Goals
ID	AF-0175
Purpose	To allocate quality goals to suppliers developing part of the software system.
Correlates to	SQ.Ac5
Agents	Allocators, Suppliers
Inputs	Project Quality Goals, Software Development Plan, Supplier Work Plan
Outputs	Allocated Quality Goals
Entrance Criteria	
Exit Criteria	Related to AF-0096, Determine Key Supplier Requirements
Comments	

Name	Conduct Task Preparation Meeting
ID	AF-0176
Purpose	To prepare team members for a particular task with the goal of reducing defects.
Correlates to	DP.Ac2
Agents	Team
Inputs	PDSP, Software Development Plan, Quality Goals, Task Methods, Task Tools, Sample Products, Common Defects
Outputs	Defect Prevention Info
Entrance Criteria	
Exit Criteria	
Comments	At ML2, PDSP may not be formalized. Defect Prevention Info is any information, such as explanation of tasks, sample inputs/outputs, or guidance on tools, that may contribute to reducing defects.

Name	Coordinate Prevention Action
ID	AF-0177
Purpose	To coordinate the assignment and implementation of defect prevention actions.
Correlates to	DP.Ac4, DP.Ac6
Agents	DP Team
Inputs	Defects, Software Work Products, Defect Causes, Proposed Actions, Experimental Results
Outputs	OSSP Actions, PDSP Actions, Decision Rationale
Entrance Criteria	
Exit Criteria	Decision Rationale Documented (OSSP Actions AND PDSP Actions) Assigned
Comments	

Name	Identify Technology Change Areas
ID	AF-0178
Purpose	To identify areas to introduce, update, or change the current technology base.
Correlates to	2.2.a, TC.Ac2
Agents	TCM Group, Project Personnel,
Inputs	Organization Current Technologies, Organization Goals, Project Goals, Organization Requirements, Project Requirements, Leading Technologies
Outputs	Technology Change Requests
Entrance Criteria	
Exit Criteria	
Comments	

Name	Analyze OSSP
ID	AF-0179
Purpose	To analyze the organization's standard software process and associated technologies to identify changes that would benefit the organization.
Correlates to	TC.Ac4, TC.Ac7
Agents	TCM Group
Inputs	OSSP, Organization Current Technologies, Technology Change Requests
Outputs	Technology Analysis
Entrance Criteria	
Exit Criteria	Technology Analysis Documented
Comments	Technology Analysis includes proposed changes, expected outcomes, proposed pilots, etc.

Name	Select Technology
ID	AF-0180
Purpose	To select which technology change requests to approve based on the organization's standard software process and technology change plan.
Correlates to	TC.Ac5
Agents	TCM Group, Senior Leaders
Inputs	Technology Change Requests, OSSP, Organization Current Technologies, Selection Criteria, TCM Plan
Outputs	Technology Change Actions, Technology Requirements, Technology Plans
Entrance Criteria	Selection Criteria (Predefined AND Approved)
Exit Criteria	Technology Change Actions, Technology Requirements, Technology Plans) Documented AND (Reviewed AND Approved by Senior Leaders)
Comments	

Name	Acquire Technology
ID	AF-0181
Purpose	To acquire the selected technology based on the actions, requirements and plans.
Correlates to	TC.Ac5
Agents	TCM Group, Senior Leaders
Inputs	Technology Change Actions, Technology Requirements, Technology Plans
Outputs	New Technology
Entrance Criteria	
Exit Criteria	
Comments	

Name	Conduct Technology Pilot
ID	AF-0182
Purpose	To conduct a pilot with a newly acquired technology to evaluate it before implementing it across the organization.
Correlates to	TC.Ac6
Agents	TCM Group, Technology Users
Inputs	New Technology, Pilot Plan
Outputs	Pilot Analysis, Implementation Decision
Entrance Criteria	Pilot Plan (Reviewed AND Approved by Technology Users)
Exit Criteria	Pilot Analysis Documented
Comments	

Name	Coordinate Process Improvement Activities
ID	AF-0183
Purpose	To coordinate process improvement activities across the organization.
Correlates to	PC.Ac2, PC.Ac4
Agents	SEPG, Organization Members, Senior Leaders
Inputs	Process Improvement Plan
Outputs	Process Improvement Activities
Entrance Criteria	
Exit Criteria	
Comments	

Name	Review Process Improvement Proposal
ID	AF-0184
Purpose	To approve/disapprove improvement proposals based on capability baselines and goals, and to identify associated actions to implement them.
Correlates to	PC.Ac2, PC.Ac5
Agents	SEPG, Senior Leaders
Inputs	Improvement Proposal, Process Capability Baseline, Organization Improvement Goals, Review Criteria, Review Procedure
Outputs	Process Improvement Actions, Rationale
Entrance Criteria	
Exit Criteria	
Comments	

Name	Develop Action Plan
ID	AF-0185
Purpose	To develop an action plan based on approved improvement proposals
Correlates to	3.2.a, PF.Ac1, PC.Ac4, PC.Ac6
Agents	Improvement Team, Process Owners,. Senior Leaders
Inputs	Improvement Actions, Software Process Improvement Plan, Improvement Goals
Outputs	Process Improvement Action Plan
Entrance Criteria	
Exit Criteria	
Comments	

Name	Pilot Process Improvement
ID	AF-0186
Purpose	To test new processes in limited use, and evaluate them for transfer to the rest of the organization.
Correlates to	5.1.b, PF.Ac5, PC.Ac4, PC.Ac7
Agents	Evaluators, Process Owners
Inputs	Action Plan, Pilot Process, Acceptance Criteria
Outputs	Approved Process, Actions
Entrance Criteria	
Exit Criteria	
Comments	Actions address updating OSSP & PDSP, in addition to implementation issues.

Name	Implement Process
ID	AF-0187
Purpose	To implement process improvements in the organization.
Correlates to	2.2.a, 5.1.a, 5.2.b, 5.3.b, 5.4.b, PC.Ac4, PC.Ac8
Agents	Implementors, Process Owners
Inputs	Process, Action Plan, Actions
Outputs	Improved Process
Entrance Criteria	
Exit Criteria	
Comments	Closely related to AF-0130 & AF-0131 for PDSP and AF-0191 & AF-0192 for OSSP. This requirement relates to actually using a new process.

Name	Maintain SPI Activity Records
ID	AF-0188
Purpose	To document and maintain records of successful and failed improvement efforts.
Correlates to	PC.Ac4, PC.Ac9
Agents	SEPG
Inputs	Process Improvement Activities, Improvement Results, Improvement Data, Improvement Data Analysis, Improvement Plans
Outputs	Process Improvement Records, Process Improvement Reports
Entrance Criteria	
Exit Criteria	Process Improvement Records, Process Improvement Reports) Available AND Communicated
Comments	

Name	Release Product
ID	AF-0189
Purpose	To build and release a product to the customer.
Correlates to	CM.Ac2, CM.Ac3, CM.Ac7
Agents	CM Group, SCCB, SW Engineering Group
Inputs	CM Plan, Software Baselines
Outputs	Software Product
Entrance Criteria	SCCB Approval
Exit Criteria	Software Product Built Only from Software Baselines
Comments	

Name	Record SCI Status
ID	AF-0190
Purpose	To document and maintain the status of software configuration items.
Correlates to	CM.Ac2, CM.Ac8, CM.Ac9
Agents	CM Group
Inputs	CM Plan, Software Baselines
Outputs	Status Reports
Entrance Criteria	
Exit Criteria	Status Reports Available AND Communicated
Comments	

Name	Develop OSSP
ID	AF-0191
Purpose	To develop the organization standard software process.
Correlates to	5.1.a, PF.Co2, PF.Co3, PF.Ac3, PD.Ac1, PD.Ac2
Agents	SEPG, Senior Leaders, Process Owners
Inputs	Software Policies, Process Standards, Product Standards, Customer Standards, Benchmark Processes, Technology
Outputs	OSSP
Entrance Criteria	
Exit Criteria	OSSP Documented OSSP (Reviewed AND Approved) by (Senior Leaders AND SEPG)
Comments	OSSP - Organization Standard Software Process Senior Leaders are input to meet the Organization Process Focus Commitment 2 & 3. These state that senior leaders sponsor and oversee the organization's activities for software process development and improvement. For an organization that has as OSSP, this requirement may refer to developing new processes for the OSSP and the its use by the organization.

Name	Maintain OSSP
ID	AF-0192
Purpose	To maintain the organization standard software process.
Correlates to	5.1.a, PF.Co2, PF.Co3, PF.Ac3, PD.Ac1, PD.Ac2, DP.Ac6, TC.Ac7
Agents	SEPG, Senior Leaders, Process Owners
Inputs	OSSP Change Actions, Software Policies, Process Standards, Product Standards, Customer Standards, Benchmark Processes, Technology
Outputs	OSSP
Entrance Criteria	
Exit Criteria	OSSP Documented OSSP (Reviewed AND Approved) by (Senior Leaders AND SEPG)
Comments	OSSP - Organization Standard Software Process Senior Leaders are input to meet the Organization Process Focus Commitment 2 & 3. These state that senior leaders sponsor and oversee the organization's activities for software process development and improvement. OSSP Change Actions may come from Defect Prevention Analysis. OSSP Change Actions may come from technology changes associated with the Technology input.

Name	Develop Software LifeCycle Description
ID	AF-0193
Purpose	To develop descriptions of the approved software lifecycles.
Correlates to	PP.Ac5, PF.Co2, PF.Co3, PD.Ac3
Agents	SEPG, Senior Leaders, Process Owners
Inputs	Software Lifecycles, Documentation Standards
Outputs	Software LifeCycle Descriptions
Entrance Criteria	
Exit Criteria	Software LifeCycle Descriptions Documented (Reviewed AND Approved) by (Senior Leaders AND SEPG)
Comments	Senior Leaders are input to meet the Organization Process Focus Commitment 2 & 3. These state that senior leaders sponsor and oversee the organization's activities for software process development and improvement.

Name	Develop Tailoring Guidelines
ID	AF-0194
Purpose	To develop guidelines for tailoring the organization standard software process for use on a project.
Correlates to	PF.Co2, PF.Co3, PD.Ac4
Agents	SEPG, Senior Leaders, Process Owners
Inputs	OSSP, Software LifeCycle Descriptions, Documentation Standards
Outputs	Tailoring Guidelines
Entrance Criteria	
Exit Criteria	Tailoring Guidelines Documented (Reviewed AND Approved) by (Senior Leaders AND SEPG)
Comments	Senior Leaders are input to meet the Organization Process Focus Commitment 2 & 3. These state that senior leaders sponsor and oversee the organization's activities for software process development and improvement.

Name	Maintain Tailoring Guidelines
ID	AF-0195
Purpose	To maintain guidelines for tailoring the organization standard software process for use on a project.
Correlates to	PF.Co2, PF.Co3, PD.Ac4
Agents	SEPG, Senior Leaders, Process Owners
Inputs	Change Actions, OSSP, Software LifeCycle Descriptions, Documentation Standards
Outputs	Tailoring Guidelines
Entrance Criteria	
Exit Criteria	Tailoring Guidelines Documented (Reviewed AND Approved) by (Senior Leaders AND SEPG)
Comments	Senior Leaders are input to meet the Organization Process Focus Commitment 2 & 3. These state that senior leaders sponsor and oversee the organization's activities for software process development and improvement.

Name	Maintain Software LifeCycle Description
ID	AF-0196
Purpose	To maintain descriptions of the approved software lifecycles.
Correlates to	PP.Ac5, PF.Co2, PF.Co3, PD.Ac3
Agents	SEPG, Senior Leaders, Process Owners
Inputs	Software Lifecycles, Change Actions, Documentation Standards
Outputs	Software LifeCycle Descriptions
Entrance Criteria	
Exit Criteria	Software LifeCycle Descriptions Documented (Reviewed AND Approved) by (Senior Leaders AND SEPG)
Comments	Senior Leaders are input to meet the Organization Process Focus Commitment 2 & 3. These state that senior leaders sponsor and oversee the organization's activities for software process development and improvement.

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Appendix B - Capability Maturity Model Relations to Quality Air Force and Integrated

Requirements

1.0 Purpose

The overall purpose of this document is to reference the Capability Maturity Model for Software (CMM) to the Quality Air Force (QAF) criteria by identifying the integrated requirements that relate the two models.

2.0 Overview

This document maps the CMM to the QAF criteria through the integrated requirements that correlate back to each model. Only the CMM practices that have a relationship to QAF areas are included. The document is organized to mirror the maturity levels and key process areas in the CMM. The related area of the QAF criteria is provided along with the name and ID of the integrated requirement that correlates to that CMM practice and the identified QAF areas.

3.0 Guide to Codes

3.1 Capability Maturity Model Codes.

3.1.1 Key Process Areas (KPAs):

RM	Requirements Management
PP	Software Project Planning
PT	Software Project Tracking & Oversight
SM	Software Subcontract Management
QA	Software Quality Assurance
CM	Software Configuration Management
PF	Organization Process Focus
PD	Organization Process Definition
TP	Training Program
IM	Integrated Software Management
PE	Software Product Engineering
IC	InterGroup Coordination
PR	Peer Reviews
QP	Quantitative Process Management
SQ	Software Quality Management
DP	Defect Prevention
TC	Technology Change Management
PC	Process Change Management

3.1.2 Other Common Features (OCFs):

Co	Commitment to Perform
Ab	Ability to Perform
Me	Measurement and Analysis
Ve	Verifying Implementation

3.2 *Quality Air Force Criteria Codes*

1.0 Leadership

    1.1 Senior Executive Leadership

    1.2 Leadership System and Organization

    1.3 Public Responsibility and Citizenship

2.0 Information and Analysis

    2.1 Management of Information and Data

    2.2 Comparisons and Benchmarking

    2.3 Analysis and Use of Organization-Level Data

3.0 Strategic Planning

    3.1 Strategy Development

    3.2 Strategic Deployment

4.0 Human Resource Development and Management

    4.1 Human Resource Planning and Evaluation

    4.2 High Performance Work Systems

    4.3 Member Education, Training, and Development

    4.4 Well Being and Satisfaction

5.0 Process Management

    5.1 Design and Introduction of Products and Services

    5.2 Key Process Management: Product and Service Production and Delivery

    5.3 Process Management: Support Services

    5.4 Supplier Performance Management

6.0 Performance Results

    6.1 Product and Service Quality

    6.2 Operational Performance and Financial Results

    6.3 Supplier Performance Results

7.0 Customer Focus and Customer Satisfaction

    7.1 Customer Knowledge

    7.2 Customer Management

    7.3 Customer Satisfaction Determination

    7.4 Customer Satisfaction Results

    7.5 Customer Satisfaction Comparison

CMM	Related to QAF	Related By	ID
Me	1.1.a, 5.2.a, 5.3.b, 5.4.a, 6.2.a, 6.3.a	Measure Process	AF-0072
Me	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
Ve	1.2.c	Review Project (Event Driven)	AF-0109
Ve	5.2.a, 5.3.b	Take Corrective Actions	AF-0116
Ve	1.2.c, 5.4.a	Review Project (Periodic)	AF-0148
Ve	1.1.b, 2.1.b, 2.2.b, 3.1.c, 4.1.b, 5.1.c, 5.2.b, 5.3.c, 5.4.b, 7.1.c, 7.2.d, 7.3.c	Evaluate Process	AF-0070
PP.Ac2	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
PP.Ac3	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
PP.Ac4	1.2.c, 5.4.a	Project Review	AF-0148
PP.Ac5	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
PP.Ac6	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
PP.Ac7	3.1.b	Set Objectives	AF-0014
PP.Ac7	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
PP.Ac14	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
PP.Ac15	2.3.a, 6.1.a, 6.2.a	Gather Internal Data	AF-0098
PT.Ac1	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
PT.Ac2	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
PT.Ac4	5.4.b	Change Supplier Commitment	AF-0113
PT.Ac5	5.2.a, 5.3.b	Take Corrective Actions	AF-0116
PT.Ac6	5.2.a, 5.3.b	Take Corrective Actions	AF-0116
PT.Ac7	5.2.a, 5.3.b	Take Corrective Actions	AF-0116
PT.Ac8	5.2.a, 5.3.b	Take Corrective Actions	AF-0116
PT.Ac9	5.2.a, 5.3.b	Take Corrective Actions	AF-0116
PT.Ac10	5.2.a, 5.3.b	Take Corrective Actions	AF-0116
PT.Ac11	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
PT.Ac11	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118
PT.Ac12	1.2.c, 5.4.a	Project Review	AF-0148
PT.Ac13	1.2.c, 5.4.a	Project Review	AF-0148

SM.Ac1	5.4.b	Determine Partnering Activities	AF-0085
SM.Ac1	5.4.a	Determine Key Supplier Requirements	AF-0096
SM.Ac1	5.4.b	Plan Supplier Work	AF-0119
SM.Ac2	1.1.a, 1.2.c	Process Assessment	AF-0080
SM.Ac2	7.1.a	Select Group	AF-0100
SM.Ac3	5.4.a	Communicate Supplier Reqs	AF-0095
SM.Ac4	5.1.b	Review Product	AF-0108
SM.Ac6	5.4.b	Change Supplier Commitment	AF-0113
SM.Ac7	1.2.c, 5.4.a	Project Review	AF-0148
SM.Ac9	1.2.c, 5.4.a	Project Review	AF-0148
SM.Ac12	5.4.a	Perform Supplier Acceptance Tests	AF-0064
SM.Ac13	1.1.b, 2.1.b, 2.2.b, 3.1.c, 4.1.b, 5.1.c, 5.2.b, 5.3.c, 5.4.b, 7.1.c, 7.2.d, 7.3.c	Evaluate Process	AF-0070
QA.Ac1	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
QA.Ac2	5.4.a, 7.2.a	Communicate Information	AF-0097
QA.Ac2	5.1.b	Review Product	AF-0108
QA.Ac3	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
QA.Ac5	5.1.b	Review Product	AF-0108
QA.Ac6	5.4.a, 7.2.a	Communicate Information	AF-0097
QA.Ac7	5.1.b	Review Product	AF-0108
QA.Ac8	5.4.a, 7.2.a	Communicate Information	AF-0097
CM.Ac1	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
CM.Ac2	5.4.a, 7.2.a	Communicate Information	AF-0097
CM.Ac9	5.4.a, 7.2.a	Communicate Information	AF-0097
PF.Co2	5.1.a	Develop OSSP	AF-0191
PF.Co2	5.1.a	Maintain OSSP	AF-0192
PF.Co3	5.1.a	Develop OSSP	AF-0191
PF.Co3	5.1.a	Maintain OSSP	AF-0192
PF.Ac1	1.1.a, 1.2.c	Process Assessment	AF-0080
PF.Ac1	3.2.a	Develop Action Plan	AF-0185
PF.Ac2	3.1.a, 4.1.a	Strategic Planning	AF-0075
PF.Ac3	5.1.a	Develop OSSP	AF-0191
PF.Ac3	5.1.a	Maintain OSSP	AF-0192
PF.Ac4	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
PF.Ac4	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118
PF.Ac5	5.1.b	Pilot Process Improvement	AF-0186
PF.Ac6	4.3.b	Plan Training Delivery	AF-0088
PF.Ac7	5.4.a, 7.2.a	Communicate Information	AF-0097

PD.Ac1	5.1.a	Design Process	AF-0038
PD.Ac1	5.1.a	Develop OSSP	AF-0191
PD.Ac1	5.1.a	Maintain OSSP	AF-0192
PD.Ac2	5.1.a	Design Process	AF-0038
PD.Ac2	5.1.a	Develop OSSP	AF-0191
PD.Ac2	5.1.a	Maintain OSSP	AF-0192
PD.Ac5	2.3.a, 6.1.a, 6.2.a	Gather Internal Data	AF-0098
TP.Ac1	4.3.b	Plan Training Delivery	AF-0088
TP.Ac1	4.3.b	Identify Training Needs	AF-0089
TP.Ac1	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
TP.Ac2	3.1.a, 4.1.a	Strategic Planning	AF-0075
TP.Ac2	4.3.b	Plan Training Delivery	AF-0088
TP.Ac3	4.3.b	Perform Training	AF-0124
TP.Ac4	4.3.b	Develop Training Course	AF-0125
TP.Me2	4.3.a, 4.3.b	Measure Training Quality	AF-0128
TP.Ve2	4.3.a, 4.3.b	Independent Training Evaluation	AF-0129
TP.Ve3	4.3.a, 4.3.b	Evaluate Training	AF-0018
IM.Ac3	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
IM.Ac4	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
IM.Ac4	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
IM.Ac4	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118
IM.Ac5	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
IM.Ac5	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
IM.Ac5	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118
IM.Ac11	1.2.c	Review Project (Event Driven)	AF-0109
IM.Ac11	1.1.b, 2.1.b, 2.2.b, 3.1.c, 4.1.b, 5.1.c, 5.2.b, 5.3.c, 5.4.b, 7.1.c, 7.2.d, 7.3.c	Evaluate Process	AF-0070
IM.Ac11	1.2.c, 5.4.a	Project Review	AF-0148
PE.Ac3	4.3.b, 5.1.a, 5.3.a	Develop Design Criteria	AF-0153
PE.Ac3	5.1.a	Develop Software Arch Design	AF-0154
PE.Ac3	5.1.a	Develop Software Detail Design	AF-0155
PE.Ac9	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
PE.Ac9	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118
PE.Me1	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
PE.Me1	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118

IC.Ac1	7.1.a	Establish System Requirements	AF-0166
IC.Ac3	5.4.a	Communicate Supplier Requirements	AF-0095
IC.Ac3	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
IC.Ac4	5.4.a	Determine Key Supplier Requirements	AF-0096
IC.Ac4	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
IC.Ac5	5.1.b	Review Product	AF-0108
PR.Ac2	5.1.b	Review Product	AF-0108
PR.Ac3	5.1.b	Review Product	AF-0108
QP.Ac1	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
QP.Ac1	2.2.a	Set Performance Objectives	AF-0074
QP.Ac2	2.2.a	Set Performance Objectives	AF-0074
QP.Ac2	1.1.a, 5.2.a, 5.3.b, 5.4.a, 6.2.a, 6.3.a	Measure Process	AF-0072
QP.Ac2	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
QP.Ac2	5.4.a, 7.2.a	Communicate Information	AF-0097
QP.Ac3	2.1.a, 2.2.a, 5.4.a, 7.1.a	Determine Indicators	AF-0071
QP.Ac4	2.1.a, 2.2.a, 5.4.a, 7.1.a	Determine Indicators	AF-0071
QP.Ac4	1.1.a, 5.2.a, 5.3.b, 5.4.a, 6.2.a, 6.3.a	Measure Process	AF-0072
QP.Ac4	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
QP.Ac4	2.2.a	Set Performance Objectives	AF-0074
QP.Ac6	5.4.a, 7.2.a	Communicate Information	AF-0097
SQ.Ac1	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
SQ.Ac2	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
SQ.Ac2	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118
SQ.Ac3	2.2.a	Set Performance Objectives	AF-0074
SQ.Ac4	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
SQ.Ac4	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118
DP.Ac1	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
DP.Ac3	5.2.a, 5.3.b	Determine Root Cause	AF-0043
DP.Ac5	5.2.a, 5.3.b	Determine Root Cause	AF-0043
DP.Ac5	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
DP.Ac5	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118
DP.Ac6	5.1.a	Maintain OSSP	AF-0192
DP.Ac8	5.4.a, 7.2.a	Communicate Information	AF-0097

TC.Ac1	3.1.a, 4.1.a	Strategic Planning	AF-0075
TC.Ac2	2.2.a	Identify Technology Change Areas	AF-0178
TC.Ac3	5.4.a, 7.2.a	Communicate Information	AF-0097
TC.Ac7	5.1.a	Maintain OSSP	AF-0192
PC.Ac2	1.1.a	Set Goals	AF-0019
PC.Ac3	3.1.a, 4.1.a	Strategic Planning	AF-0075
PC.Ac4	1.1.a, 5.2.a, 5.3.b, 5.4.a, 6.2.a, 6.3.a	Measure Process	AF-0072
PC.Ac4	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
PC.Ac4	1.1.a	Set Goals	AF-0019
PC.Ac4	5.4.a, 7.2.a	Communicate Information	AF-0097
PC.Ac4	3.2.a	Develop Action Plan	AF-0185
PC.Ac4	5.1.b	Pilot Process Improvement	AF-0186
PC.Ac4	2.2.a, 5.1.a, 5.2.b, 5.3.b, 5.4.b	Implement Process	AF-0187
PC.Ac6	3.2.a	Develop Action Plan	AF-0185
PC.Ac7	5.1.b	Pilot Process Improvement	AF-0186
PC.Ac8	1.1.a, 5.2.a, 5.3.b, 5.4.a, 6.2.a, 6.3.a	Measure Process	AF-0072
PC.Ac8	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
PC.Ac8	2.2.a, 5.1.a, 5.2.b, 5.3.b, 5.4.b	Implement Process	AF-0187
PC.Ac10	5.4.a, 7.2.a	Communicate Information	AF-0097
PC.Me1	1.1.a, 5.2.a, 5.3.b, 5.4.a, 6.2.a, 6.3.a	Measure Process	AF-0072
PC.Me1	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073

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Appendix C - Quality Air Force Relations to Capability Maturity Model and Integrated

Requirements

1.0 Purpose

The overall purpose of this document is to reference the Quality Air Force (QAF) criteria to the Capability Maturity Model for Software (CMM) by identifying the integrated requirements that relate the two models.

2.0 Overview

This document maps the QAF criteria to the CMM through the integrated requirements that correlate back to each model. Only the QAF criteria areas that have a relationship to CMM practices are included. The document is organized to mirror the categories, areas to address, and items in the QAF criteria. The related area of the CMM is provided along with the name and ID of the integrated requirement that correlates to that QAF area and the identified CMM practices.

3.0 Guide to Codes

3.1 Capability Maturity Model Codes.

3.1.1 Key Process Areas (KPAs):

RM	Requirements Management
PP	Software Project Planning
PT	Software Project Tracking & Oversight
SM	Software Subcontract Management
QA	Software Quality Assurance
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PD	Organization Process Definition
TP	Training Program
IM	Integrated Software Management
PE	Software Product Engineering
IC	InterGroup Coordination
PR	Peer Reviews
QP	Quantitative Process Management
SQ	Software Quality Management
DP	Defect Prevention
TC	Technology Change Management
PC	Process Change Management

3.1.2 Other Common Features (OCFs):

Co	Commitment to Perform
Ab	Ability to Perform
Me	Measurement and Analysis
Ve	Verifying Implementation

3.2 Quality Air Force Criteria Codes

1.0 Leadership

    1.1 Senior Executive Leadership

    1.2 Leadership System and Organization

    1.3 Public Responsibility and Citizenship

2.0 Information and Analysis

    2.1 Management of Information and Data

    2.2 Comparisons and Benchmarking

    2.3 Analysis and Use of Organization-Level Data

3.0 Strategic Planning

    3.1 Strategy Development

    3.2 Strategic Deployment

4.0 Human Resource Development and Management

    4.1 Human Resource Planning and Evaluation

    4.2 High Performance Work Systems

    4.3 Member Education, Training, and Development

    4.4 Well Being and Satisfaction

5.0 Process Management

    5.1 Design and Introduction of Products and Services

    5.2 Key Process Management: Product and Service Production
        and Delivery

    5.3 Process Management: Support Services

    5.4 Supplier Performance Management

6.0 Performance Results

    6.1 Product and Service Quality

    6.2 Operational Performance and Financial Results

    6.3 Supplier Performance Results

7.0 Customer Focus and Customer Satisfaction

  7.1 Customer Knowledge

  7.2 Customer Management

  7.3 Customer Satisfaction Determination

  7.4 Customer Satisfaction Results

  7.5 Customer Satisfaction Comparison

QAF	Related to CMM	Related By	ID
1.1.a	PC.Ac2, PC.Ac4	Set Goals	AF-0019
1.1.a	QP.Ac2, QP.Ac4, PC.Ac8, PC.Me1, Me	Measure Process	AF-0072
1.1.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
1.1.a	SM.Ac2, PF.Ac1	Process Assessment	AF-0080
1.1.b	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
1.2.c	SM.Ac2, PF.Ac1	Process Assessment	AF-0080
1.2.c	IM.Ac11, Ve	Review Project (Event Driven)	AF-0109
1.2.c	PP.Ac4, PT.Ac12, PT.Ac13, SM.Ac7, SM.Ac9, IM.Ac11, Ve	Review Project (Periodic)	AF-0148
2.1.a	QP.Ac3, QP.Ac4	Determine Indicators	AF-0071
2.1.b	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
2.2.a	QP.Ac3, QP.Ac4	Determine Indicators	AF-0071
2.2.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
2.2.a	SQ.Ac3, QP.Ac1, QP.Ac2, QP.Ac4	Set Performance Objectives	AF-0074
2.2.a	TC.Ac2	Identify Technology Change Areas	AF-0178
2.2.a	PC.Ac4, PC.Ac8	Implement Process	AF-0187
2.2.b	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
2.3.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
2.3.a	PP.Ac15, PD.Ac5	Gather Internal Data	AF-0098
3.1.a	PF.Ac2, TP.Ac2, TC.Ac1, PC.Ac3	Strategic Planning	AF-0075
3.1.b	PP.Ac7	Set Objectives	AF-0014
3.1.c	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
3.2.a	PF.Ac1, PC.Ac4, PC.Ac6	Develop Action Plan	AF-0185
3.2.b	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
4.1.a	PF.Ac2, TP.Ac2, TC.Ac1, PC.Ac3	Strategic Planning	AF-0075
4.1.b	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070

4.3.a	TP.Ve3	Evaluate Training	AF-0018
4.3.a	TP.Me2	Measure Training Quality	AF-0128
4.3.a	TP.Ve2	Independent Training Evaluation	AF-0129
4.3.b	TP.Ve3	Evaluate Training	AF-0018
4.3.b	PF.Ac6, TP.Ac1, TP.Ac2	Plan Training Delivery	AF-0088
4.3.b	TP.Ac1	Identify Training Needs	AF-0089
4.3.b	TP.Ac3	Perform Training	AF-0124
4.3.b	TP.Ac4	Develop Training Course	AF-0125
4.3.b	TP.Me2	Measure Training Quality	AF-0128
4.3.b	TP.Ve2	Independent Training Evaluation	AF-0129
4.3.b	PE.Ac3	Develop Design Criteria	AF-0153
5.1.a	PD.Ac1, PD.Ac2	Design Process	AF-0038
5.1.a	PP.Ac2, PP.Ac3, PP.Ac5, PP.Ac6, PP.Ac7, PP.Ac14, PT.Ac1, PT.Ac2, QA.Ac1, QA.Ac3, CM.Ac1, TP.Ac1, IM.Ac3, IM.Ac4, IM.Ac5, IC.Ac3, IC.Ac4, QP.Ac1, SQ.Ac1, DP.Ac1	Project Planning	AF-0114
5.1.a	PE.Ac3	Develop Design Criteria	AF-0153
5.1.a	PE.Ac3	Develop Software Architecture Design	AF-0154
5.1.a	PE.Ac3	Develop Software Detail Design	AF-0155
5.1.a	PC.Ac4, PC.Ac8	Implement Process	AF-0187
5.1.a	PF.Co2, PF.Co3, PF.Ac3, PD.Ac1, PD.Ac2	Develop OSSP	AF-0191
5.1.a	PF.Co2, PF.Co3, PF.Ac3, PD.Ac1, PD.Ac2, DP.Ac6, TC.Ac7	Maintain OSSP	AF-0192
5.1.b	SM.Ac4, QA.Ac2, QA.Ac5, QA.Ac7, IC.Ac5, PR.Ac2, PR.Ac3	Review Product	AF-0108
5.1.b	PF.Ac5, PC.Ac4, PC.Ac7	Pilot Process Improvement	AF-0186
5.1.c	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
5.2.a	DP.Ac3, DP.Ac5	Determine Root Cause	AF-0043
5.2.a	QP.Ac2, QP.Ac4, PC.Ac8, PC.Me1, Me	Measure Process	AF-0072
5.2.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
5.2.a	PP.Ac2, PP.Ac3, PP.Ac5, PP.Ac6, PP.Ac7, PP.Ac14, PT.Ac1, PT.Ac2, QA.Ac1, QA.Ac3, CM.Ac1, TP.Ac1, IM.Ac3, IM.Ac4, IM.Ac5, IC.Ac3, IC.Ac4, QP.Ac1, SQ.Ac1, DP.Ac1	Project Planning	AF-0114
5.2.a	PT.Ac5, PT.Ac6, PT.Ac7, PT.Ac8, PT.Ac9, PT.Ac10, Ve	Take Corrective Actions	AF-0116

5.2.b	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
5.2.b	PC.Ac4, PC.Ac8	Implement Process	AF-0187
5.3.a	PE.Ac3	Develop Design Criteria	AF-0153
5.3.b	DP.Ac3, DP.Ac5	Determine Root Cause	AF-0043
5.3.b	QP.Ac2, QP.Ac4, PC.Ac8, PC.Me1, Me	Measure Process	AF-0072
5.3.b	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
5.3.b	PP.Ac2, PP.Ac3, PP.Ac5, PP.Ac6, PP.Ac7, PP.Ac14, PT.Ac1, PT.Ac2, QA.Ac1, QA.Ac3, CM.Ac1, TP.Ac1, IM.Ac3, IM.Ac4, IM.Ac5, IC.Ac3, IC.Ac4, QP.Ac1, SQ.Ac1, DP.Ac1	Project Planning	AF-0114
5.3.b	PT.Ac5, PT.Ac6, PT.Ac7, PT.Ac8, PT.Ac9, PT.Ac10, Ve	Take Corrective Actions	AF-0116
5.3.b	PC.Ac4, PC.Ac8	Implement Process	AF-0187
5.3.c	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
5.4.a	SM.Ac12	Perform Supplier Acceptance Test	AF-0064
5.4.a	QP.Ac3, QP.Ac4	Determine Indicators	AF-0071
5.4.a	QP.Ac2, QP.Ac4, PC.Ac8, PC.Me1, Me	Measure Process	AF-0072
5.4.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
5.4.a	SM.Ac3, IC.Ac3	Communicate Supplier Requirements	AF-0095
5.4.a	SM.Ac1, IC.Ac4	Determine Key Supplier Requirements	AF-0096
5.4.a	QA.Ac2, QA.Ac6, QA.Ac8, CM.Ac2, CM.Ac9, PF.Ac7, QP.Ac2, QP.Ac6, DP.Ac8, TC.Ac3, PC.Ac4, PC.Ac10	Communicate Information	AF-0097
5.4.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, SQ.Ac2, SQ.Ac4, DP.Ac5	Measure Product	AF-0118
5.4.a	PP.Ac4, PT.Ac12, PT.Ac13, SM.Ac7, SM.Ac9, IM.Ac11, Ve	Review Project (Periodic)	AF-0148

5.4.b	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
5.4.b	SM.Ac1	Determine Partnering Activities	AF-0085
5.4.b	PT.Ac4, SM.Ac6	Change Supplier Commitment	AF-0113
5.4.b	SM.Ac1	Plan Supplier Work	AF-0119
5.4.b	PC.Ac4, PC.Ac8	Implement Process	AF-0187
6.1.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
6.1.a	PP.Ac15, PD.Ac5	Gather Internal Data	AF-0098
6.1.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, SQ.Ac2, SQ.Ac4, DP.Ac5	Measure Product	AF-0118
6.2.a	QP.Ac2, QP.Ac4, PC.Ac8, PC.Me1, Me	Measure Process	AF-0072
6.2.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
6.2.a	PP.Ac15, PD.Ac5	Gather Internal Data	AF-0098
6.3.a	QP.Ac2, QP.Ac4, PC.Ac8, PC.Me1, Me	Measure Process	AF-0072
6.3.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
6.3.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, SQ.Ac2, SQ.Ac4, DP.Ac5	Measure Product	AF-0118
7.1.a	QP.Ac3, QP.Ac4	Determine Indicators	AF-0071
7.1.a	SM.Ac2	Select Group	AF-0100
7.1.a	IC.Ac1	Establish System Requirements	AF-0166
7.1.c	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
7.2.a	QA.Ac2, QA.Ac6, QA.Ac8, CM.Ac2, CM.Ac9, PF.Ac7, QP.Ac2, QP.Ac6, DP.Ac8, TC.Ac3, PC.Ac4, PC.Ac10	Communicate Information	AF-0097
7.2.b	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
7.2.c	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
7.2.d	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070

7.3.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
7.3.b	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
7.3.c	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
7.4.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
7.4.b	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
7.5.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
7.5.b	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073

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Appendix D - Capability Maturity Model Map to Integrated Requirements

1.0 Purpose

The overall purpose of this document is to reference the Capability Maturity Model for Software (CMM) to the integrated requirements.

2.0 Overview

This document maps the CMM to the integrated requirements. All CMM practices are included. The document is organized to mirror the maturity levels and key process areas of the CMM.

3.0 Guide to Codes

3.1 Key Process Areas (KPAs):

RM	Requirements Management
PP	Software Project Planning
PT	Software Project Tracking & Oversight
SM	Software Subcontract Management
QA	Software Quality Assurance
CM	Software Configuration Management
PF	Organization Process Focus
PD	Organization Process Definition
TP	Training Program
IM	Integrated Software Management
PE	Software Product Engineering
IC	InterGroup Coordination
PR	Peer Reviews
QP	Quantitative Process Management
SQ	Software Quality Management
DP	Defect Prevention
TC	Technology Change Management
PC	Process Change Management

3.2 Other Common Features (OCFs):

Co Commitment to Perform
Ab Ability to Perform
Me Measurement and Analysis
Ve Verifying Implementation

Activity	Name	ID
	Other Common Features	
Ab	Adequate Resources	AF-0055
	Adequate Funding	AF-0056
	Adequate Training	AF-0057
Co	Follows Policy	AF-0054
	Follows Procedure	AF-0058
Me	Determine Status	AF-0059
	Measure Process	AF-0072
	Analyze Data	AF-0073
	Measure Activity	AF-0110
Ve	Evaluate Process	AF-0070
	Event Driven Review	AF-0109
	Take Corrective Actions	AF-0116
	Project Review	AF-0148
	Requirements Management	
RM.Ab1	Allocate Requirements	AF-0060
RM.Ab2	Allocate Requirements	AF-0060
RM.Ac1	Negotiate Commitments	AF-0111
	Review Allocated Requirements	AF-0149
	Correct Allocated Requirements	AF-0150
RM.Ac2	Develop Software Requirements	AF-0112
RM.Ac3	Assess Requirements Change	AF-0061
	Make Commitment	AF-0115
	Review Allocated Requirements	AF-0149
	Software Project Planning	
PP.Ac1	Develop Project Proposal	AF-0063
PP.Ac2	Project Planning	AF-0114
PP.Ac3	Project Planning	AF-0114
PP.Ac4	Make Commitment	AF-0115
	Project Review	AF-0148
PP.Ac5	Project Planning	AF-0114
	Develop Software LifeCycle Descriptions	AF-0193
	Maintain Software LifeCycle Descriptions	AF-0196
PP.Ac6	Project Planning	AF-0114
PP.Ac7	Set Objectives	AF-0014
	Project Planning	AF-0114
PP.Ac8	Identify Software Work Products	AF-0132
PP.Ac9	Estimate Size	AF-0133
PP.Ac10	Estimate Effort	AF-0134
	Estimate Cost	AF-0135
PP.Ac11	Estimate Critical Computer Resources	AF-0136
PP.Ac12	Derive Schedule	AF-0137

PP.Ac13	Risk Identification	AF-0138
	Risk Analysis	AF-0139
	Risk Prioritization	AF-0140
PP.Ac14	Project Planning	AF-0114
PP.Ac15	Gather Internal Data	AF-0098
	Estimate Size	AF-0133
	Estimate Effort	AF-0134
	Estimate Cost	AF-0135
	Estimate Critical Computer Resources	AF-0136
	Derive Schedule	AF-0137
	Risk Identification	AF-0138
	Software Project Tracking & Oversight	
PT.Ac1	Project Planning	AF-0114
PT.Ac2	Project Planning	AF-0114
PT.Ac3	Make Commitment	AF-0115
PT.Ac4	Change Supplier Commitment	AF-0113
PT.Ac5	Take Corrective Actions	AF-0116
	Manage Size	AF-0141
PT.Ac6	Take Corrective Actions	AF-0116
	Manage Effort	AF-0142
	Manage Cost	AF-0143
PT.Ac7	Take Corrective Actions	AF-0116
	Manage Critical Computer Resources	AF-0144
PT.Ac8	Take Corrective Actions	AF-0116
	Manage Schedule	AF-0169
PT.Ac9	Take Corrective Actions	AF-0116
	Track Technical Activities	AF-0117
PT.Ac10	Take Corrective Actions	AF-0116
	Manage Risks	AF-0147
PT.Ac11	Analyze Data	AF-0073
	Measure Product	AF-0118
	Measure Activity	AF-0110
PT.Ac12	Project Review	AF-0148
PT.Ac13	Project Review	AF-0148
	Software Subcontract Management	
SM.Ac1	Determine Partnering Activities	AF-0085
	Determine Key Supplier Requirements	AF-0096
	Plan Supplier Work	AF-0119
SM.Ac2	Process Assessment	AF-0080
	Select Group	AF-0100
SM.Ac3	Make Contractual Agreement	AF-0062
	Communicate Supplier Requirements	AF-0095
SM.Ac4	Review Product	AF-0108
SM.Ac5	Activity Review	AF-0120
SM.Ac6	Change Supplier Commitment	AF-0113

SM.Ac7	Project Review	AF-0148
SM.Ac8	Activity Review	AF-0120
SM.Ac9	Project Review	AF-0148
SM.Ac10	Activity Review	AF-0120
SM.Ac11	Activity Review	AF-0120
SM.Ac12	Perform Supplier Acceptance Tests	AF-0064
SM.Ac13	Evaluate Process	AF-0070
	Software Quality Assurance	
QA.Ac1	Project Planning	AF-0114
QA.Ac2	Activity Review	AF-0120
	Communicate Information	AF-0097
	Handle Deviations	AF-0065
	Review Product	AF-0108
QA.Ac3	Project Planning	AF-0114
	Develop PDSP	AF-0130
	Revise PDSP	AF-0131
QA.Ac4	Activity Review	AF-0120
QA.Ac5	Review Product	AF-0108
QA.Ac6	Communicate Information	AF-0097
QA.Ac7	Handle Deviations	AF-0065
	Review Product	AF-0108
QA.Ac8	Communicate Information	AF-0097
	Software Configuration Management	
CM.Ac1	Project Planning	AF-0114
CM.Ac2	Establish CM Library System	AF-0066
	Identify Software Configuration Items	AF-0067
	Identify Software Work Products	AF-0132
	Handle Change Requests	AF-0068
	Change Baseline	AF-0069
	Communicate Information	AF-0097
	Record SCI Status	AF-0190
	Audit Baseline	AF-0121
	Release Product	AF-0189
CM.Ac3	Release Product	AF-0189
	Establish CM Library System	AF-0066
CM.Ac4	Identify Software Configuration Items	AF-0067
	Identify Software Work Products	AF-0132
CM.Ac5	Handle Change Requests	AF-0068
CM.Ac6	Change Baseline	AF-0069
CM.Ac7	Release Product	AF-0189
CM.Ac8	Record SCI Status	AF-0190
CM.Ac9	Record SCI Status	AF-0190
	Communicate Information	AF-0097
CM.Ac10	Audit Baseline	AF-0121
CM.Ve3	Audit Baseline	AF-0121

	Organization Process Focus	
PF.Co2	Develop Software LifeCycle Descriptions	AF-0193
	Maintain Software LifeCycle Descriptions	AF-0196
	Develop Tailoring Guidelines	AF-0194
	Maintain Tailoring Guidelines	AF-0195
PF.Co3	Develop Software LifeCycle Descriptions	AF-0193
	Maintain Software LifeCycle Descriptions	AF-0196
	Develop Tailoring Guidelines	AF-0194
	Maintain Tailoring Guidelines	AF-0195
PF.Ac1	Process Assessment	AF-0080
	Develop Action Plan	AF-0185
PF.Ac2	Strategic Planning	AF-0075
PF.Ac3	Develop PDSP	AF-0130
	Revise PDSP	AF-0131
PF.Ac4	Analyze Data	AF-0073
	Estimate Size	AF-0133
	Estimate Effort	AF-0134
	Estimate Cost	AF-0135
	Estimate Critical Computer Resources	AF-0136
	Derive Schedule	AF-0137
	Maintain Software Process Database	AF-0111
	Measure Product	AF-0118
PF.Ac5	Pilot Process Improvement	AF-0186
PF.Ac6	Plan Training Delivery	AF-0088
PF.Ac7	Communicate Information	AF-0097
	Organization Process Definition	
PD.Ac1	Maintain OSSP	AF-0192
	Develop OSSP	AF-0191
	Design Process	AF-0038
PD.Ac2	Maintain OSSP	AF-0192
	Develop OSSP	AF-0191
	Design Process	AF-0038
PD.Ac3	Develop Software LifeCycle Descriptions	AF-0193
	Maintain Software LifeCycle Descriptions	AF-0196
PD.Ac4	Develop Tailoring Guidelines	AF-0194
	Maintain Tailoring Guidelines	AF-0195
PD.Ac5	Gather Internal Data	AF-0098
	Maintain Software Process Database	AF-0111
PD.Ac6	Maintain Software Process Library	AF-0123
	Training Program	
TP.Ac1	Plan Training Delivery	AF-0088
	Identify Training Needs	AF-0089
	Project Planning	AF-0114
TP.Ac2	Strategic Planning	AF-0075
	Plan Training Delivery	AF-0088

TP.Ac3	Perform Training	AF-0124
TP.Ac4	Develop Training Course	AF-0125
	Maintain Training Course	AF-0126
TP.Ac5	Conduct Training Waiver Procedure	AF-0127
TP.Ac6	Maintain Training Records	AF-0122
TP.Me2	Measure Training Quality	AF-0128
TP.Ve2	Independent Training Evaluation	AF-0129
TP.Ve3	Evaluate Training	AF-0018
	Integrated Software Management	
IM.Ac1	Develop PDSP	AF-0130
IM.Ac2	Revise PDSP	AF-0131
IM.Ac3	Project Planning	AF-0114
IM.Ac4	Analyze Data	AF-0073
	Measure Product	AF-0118
	Project Planning	AF-0114
	Identify Software Work Products	AF-0132
	Estimate Size	AF-0133
	Estimate Effort	AF-0134
	Estimate Cost	AF-0135
	Estimate Critical Computer Resources	AF-0136
	Derive Schedule	AF-0137
	Risk Identification	AF-0138
	Risk Analysis	AF-0139
	Risk Prioritization	AF-0140
	Manage Critical Paths	AF-0145
IM.Ac5	Analyze Data	AF-0073
	Project Planning	AF-0114
	Measure Product	AF-0118
	Estimate Size	AF-0133
	Estimate Effort	AF-0134
	Estimate Cost	AF-0135
	Estimate Critical Computer Resources	AF-0136
	Derive Schedule	AF-0137
	Risk Identification	AF-0138
	Risk Analysis	AF-0139
	Risk Prioritization	AF-0140
	Manage Critical Paths	AF-0145
IM.Ac6	Estimate Size	AF-0133
	Manage Size	AF-0141
IM.Ac7	Estimate Effort	AF-0134
	Estimate Cost	AF-0135
	Manage Effort	AF-0142
	Manage Cost	AF-0143
IM.Ac8	Estimate Critical Computer Resources	AF-0136
	Manage Critical Computer Resources	AF-0144

IM.Ac9	Derive Schedule	AF-0137
	Manage Critical Paths	AF-0145
	Manage Schedule	AF-0169
IM.Ac10	Risk Identification	AF-0138
	Risk Analysis	AF-0139
	Risk Prioritization	AF-0140
	Develop Software Risk Management Plan	AF-0146
	Manage Risks	AF-0147
IM.Ac11	Event Driven Review	AF-0109
	Evaluate Process	AF-0070
	Project Review	AF-0148
	Software Product Engineering	
PE.Ac1	Develop PDSP	AF-0130
PE.Ac2	Review Allocated Requirements	AF-0149
	Correct Allocated Requirements	AF-0150
	Requirements Analysis	AF-0151
	Develop Software Requirements Document	AF-0152
PE.Ac3	Develop Design Criteria	AF-0153
	Develop Software Architecture Design	AF-0154
	Develop Software Detail Design	AF-0155
PE.Ac4	Develop Software Code	AF-0156
PE.Ac5	Plan Unit Tests	AF-0157
	Perform Unit Tests	AF-0158
PE.Ac6	Plan Integration Tests	AF-0159
	Perform Integration Tests	AF-0160
PE.Ac7	Plan System Tests	AF-0161
	Perform System Tests	AF-0162
PE.Ac8	Develop Software Documentation	AF-0163
	Maintain Software Documentation	AF-0164
PE.Ac9	Analyze Data	AF-0073
	Measure Product	AF-0118
PE.Ac10	Maintain Consistency	AF-0165
PE.Me1	Analyze Data	AF-0073
PE.Me1	Measure Product	AF-0118
	InterGroup Coordination	
IC.Ac1	Establish System Requirements	AF-0166
IC.Ac2	Track Technical Activities	AF-0117
	Coordinate Technical Activities	AF-0167
	Resolve InterGroup Issues	AF-0168
IC.Ac3	Communicate Supplier Requirements	AF-0095
	Project Planning	AF-0114
IC.Ac4	Determine Key Supplier Requirements	AF-0096
	Project Planning	AF-0114
	Manage Critical Paths	AF-0145
	Manage Schedule	AF-0169

IC.Ac5	Review Product	AF-0108
IC.Ac6	Resolve InterGroup Issues	AF-0168
IC.Ac7	Activity Review	AF-0120
	Peer Reviews	
PR.Ac1	Plan Peer Review	AF-0170
PR.Ac2	Review Product	AF-0108
PR.Ac3	Review Product	AF-0108
	Quantitative Process Management	
QP.Ac1	Project Planning	AF-0114
	Set Performance Objectives	AF-0074
QP.Ac2	Set Performance Objectives	AF-0074
	Measure Process	AF-0072
	Analyze Data	AF-0073
	Analyze PDSP	AF-0172
	Communicate Information	AF-0097
	Maintain Process Capability Baseline	AF-0173
QP.Ac3	Determine Indicators	AF-0071
	Develop Measurement Analysis Strategy	AF-0171
QP.Ac4	Determine Indicators	AF-0071
	Set Performance Objectives	AF-0074
	Measure Process	AF-0072
	Analyze Data	AF-0073
QP.Ac5	Analyze PDSP	AF-0172
QP.Ac6	Communicate Information	AF-0097
QP.Ac7	Maintain Process Capability Baseline	AF-0173
	Software Quality Management	
SQ.Ac1	Project Planning	AF-0114
SQ.Ac2	Analyze Data	AF-0073
	Measure Product	AF-0118
SQ.Ac3	Set Performance Objectives	AF-0074
	Manage Quality	AF-0174
SQ.Ac4	Analyze Data	AF-0073
	Measure Product	AF-0118
	Manage Quality	AF-0174
SQ.Ac5	Allocate Quality Goals	AF-0175
	Defect Prevention	
DP.Ac1	Project Planning	AF-0114
DP.Ac2	Conduct Task Preparation Meeting	AF-0176
DP.Ac3	Determine Root Cause	AF-0043
DP.Ac4	Coordinate Prevention Action	AF-0177
DP.Ac5	Analyze Data	AF-0073
	Measure Product	AF-0118
	Determine Root Cause	AF-0043
DP.Ac6	Coordinate Prevention Action	AF-0177
	Maintain OSSP	AF-0192

DP.Ac7	Revise PDSP	AF-0131
DP.Ac8	Communicate Information	AF-0097
	Technology Change Management	
TC.Ac1	Strategic Planning	AF-0075
TC.Ac2	Identify Technology Change Areas	AF-0178
TC.Ac3	Communicate Information	AF-0097
TC.Ac4	Analyze OSSP	AF-0179
TC.Ac5	Select Technology	AF-0180
	Acquire Technology	AF-0181
TC.Ac6	Conduct Technology Pilot	AF-0182
TC.Ac7	Analyze OSSP	AF-0179
	Maintain OSSP	AF-0192
TC.Ac8	Revise PDSP	AF-0131
	Process Change Management	
PC.Ac1	Maintain Improvement Program	AF-0040
PC.Ac2	Set Goals	AF-0019
	Coordinate Process Improvement Activities	AF-0183
	Review Process Improvement Proposal	AF-0184
PC.Ac3	Strategic Planning	AF-0075
PC.Ac4	Set Goals	AF-0019
	Coordinate Process Improvement Activities	AF-0183
	Review Process Improvement Proposal	AF-0184
	Develop Action Plan	AF-0185
	Communicate Information	AF-0097
	Pilot Process Improvement	AF-0186
	Measure Process	AF-0072
	Analyze Data	AF-0073
	Implement Process	AF-0187
	Maintain SPI Activity Records	AF-0188
PC.Ac5	Review Process Improvement Proposal	AF-0184
PC.Ac6	Develop Action Plan	AF-0185
PC.Ac7	Pilot Process Improvement	AF-0186
PC.Ac8	Measure Process	AF-0072
	Analyze Data	AF-0073
	Implement Process	AF-0187
PC.Ac9	Maintain SPI Activity Records	AF-0188
PC.Ac10	Communicate Information	AF-0097
PC.Me	Measure Process	AF-0072
PC.Me	Analyze Data	AF-0073

Appendix E - Quality Air Force Criteria Map to Integrated Requirements

1.0 Purpose

The overall purpose of this document is to reference the Quality Air Force (QAF) criteria to the integrated requirements.

2.0 Overview

This document maps the QAF to the integrated requirements. All QAF areas and items are included. The document is organized to mirror the categories, areas to address, and items in the QAF criteria.

3.0 Guide to Codes

1.0 Leadership
    1.1 Senior Executive Leadership
    1.2 Leadership System and Organization
    1.3 Public Responsibility and Citizenship

2.0 Information and Analysis
    2.1 Management of Information and Data
    2.2 Comparisons and Benchmarking
    2.3 Analysis and Use of Organization-Level Data

3.0 Strategic Planning
    3.1 Strategy Development
    3.2 Strategic Deployment

4.0 Human Resource Development and Management
    4.1 Human Resource Planning and Evaluation
    4.2 High Performance Work Systems
    4.3 Member Education, Training, and Development
    4.4 Well Being and Satisfaction

5.0 Process Management
   5.1 Design and Introduction of Products and Services
   5.2 Key Process Management: Product and Service Production
       and Delivery
   5.3 Process Management: Support Services
   5.4 Supplier Performance Management

6.0 Performance Results
   6.1 Product and Service Quality
   6.2 Operational Performance and Financial Results
   6.3 Supplier Performance Results

7.0 Customer Focus and Customer Satisfaction
   7.1 Customer Knowledge
   7.2 Customer Management
   7.3 Customer Satisfaction Determination
   7.4 Customer Satisfaction Results
   7.5 Customer Satisfaction Comparison

Area	Name	ID
	Leadership	
1.1.a	Develop Organizational Values	AF-0001
	Set Directions	AF-0002
	Set Expectations	AF-0003
	Build Organizational Capabilities	AF-0011
	Set Goals	AF-0019
	Recognize Member	AF-0027
	Measure Process	AF-0072
	Analyze Data	AF-0073
	Reinforce Organizational Values	AF-0078
	Process Assessment	AF-0080
1.1.b	Review Organizational Structure	AF-0005
	Improve Leadership System	AF-0012
	Improve Organization Structure	AF-0013
	Evaluate Process	AF-0070
1.2.b	Communicate Leadership Information	AF-0079
1.2.c	Review Organizational Performance	AF-0004
	Process Assessment	AF-0080
	Event Driven Review	AF-0109
	Project Review	AF-0148
1.3.a	Set Citizenship Goals	AF-0081
	Assess Community Impact	AF-0082
	Improve Community Involvement	AF-0021
	Plan Community Involvement	AF-0083
	Information & Analysis	
2.1.a	Determine Customer Data Requirements	AF-0006
	Determine Indicators	AF-0071
2.1.b	Evaluate Process	AF-0070
2.2.a	Determine Benchmarking Requirements	AF-0007
	Set Benchmarking Priorities	AF-0008
	Determine Benchmarking Data Criteria	AF-0009
	Develop Breakthrough Approach	AF-0022
	Determine Indicators	AF-0071
	Analyze Data	AF-0073
	Set Performance Objectives	AF-0074
	Gather External Data	AF-0084
	Identify Technology Change Areas	AF-0178
	Implement Process	AF-0187
2.2.b	Evaluate Process	AF-0070
2.3.a	Aggregate Data	AF-0010
	Analyze Data	AF-0073
	Gather Internal Data	AF-0098

	Strategic Planning	
3.1.a	Strategic Planning	AF-0075
3.1.b	Set Objectives	AF-0014
	Determine Key Performance Drivers	AF-0015
	Determine Partnering Activities	AF-0085
3.1.c	Evaluate Process	AF-0070
3.2.a	Align Plans	AF-0086
	Develop Action Plan	AF-0185
3.2.b	Project Key Indicator Data	AF-0016
	Determine Benefits	AF-0017
	Analyze Data	AF-0073
	Human Resource Development and Management	
4.1.a	Strategic Planning	AF-0075
4.1.b	Assess Member Well-Being	AF-0023
	Assess Member Development	AF-0024
	Evaluate Process	AF-0070
	Align Plans	AF-0086
	Assess Workforce Satisfaction	AF-0090
	Assess Workforce Motivation	AF-0091
4.2.a	Improve Work Organization	AF-0025
	Improve Job Design	AF-0026
	Evaluate Job Design	AF-0076
	Evaluate Work Organization	AF-0077
4.2.b	Recognize Member	AF-0027
	Compensate Member	AF-0028
	Evaluate Member	AF-0029
4.3.b	Evaluate Training	AF-0018
	Assess Member Development	AF-0024
	Improve Training	AF-0030
	Evaluate Job Design	AF-0076
	Reinforce Training	AF-0087
	Plan Training Delivery	AF-0088
	Identify Training Needs	AF-0089
	Perform Training	AF-0124
	Develop Training Course	AF-0125
	Measure Training Quality	AF-0128
	Independent Training Evaluation	AF-0129
	Develop Design Criteria	AF-0153
4.4.a	Review Work Environment	AF-0031
	Improve Work Environment	AF-0032

4.4.b	Build Workforce Well-Being	AF-0033
	Build Workforce Satisfaction	AF-0034
	Assess Member Services	AF-0035
	Assess Member Facilities	AF-0036
	Assess Member Activities	AF-0037
4.4.c	Assess Member Well-Being	AF-0023
	Assess Workforce Satisfaction	AF-0090
	Assess Workforce Motivation	AF-0091
	Process Management	
5.1.a	Design Process	AF-0038
	Design Service	AF-0039
	Implement Process	AF-0040
	Project Planning	AF-0114
	Develop Design Criteria	AF-0153
	Develop Software Architecture Design	AF-0154
	Develop Software Detail Design	AF-0155
5.1.b	Test Product	AF-0041
	Test Service	AF-0042
	Review Product	AF-0108
	Pilot Process Improvement	AF-0186
5.1.c	Evaluate Process	AF-0070
	Evaluate Product	AF-0092
	Evaluate Service	AF-0093
5.2.a	Measure Process	AF-0072
	Determine Root Cause	AF-0043
	Analyze Data	AF-0073
	Project Planning	AF-0114
	Take Corrective Actions	AF-0116
5.2.b	Evaluate Alternatives	AF-0044
	Evaluate Process	AF-0070
	Do Research	AF-0094
	Implement Process	AF-0187
5.3.a	Develop Design Criteria	AF-0153
5.3.b	Determine Root Cause	AF-0043
	Measure Process	AF-0072
	Analyze Data	AF-0073
	Project Planning	AF-0114
	Take Corrective Actions	AF-0116
	Implement Process	AF-0187
5.3.c	Evaluate Alternatives	AF-0044
	Evaluate Process	AF-0070
	Do Research	AF-0094

5.4.a	Determine Indicators	AF-0071
	Measure Process	AF-0072
	Analyze Data	AF-0073
	Communicate Supplier Requirements	AF-0095
	Determine Key Supplier Requirements	AF-0096
	Communicate Information	AF-0097
	Measure Product	AF-0118
	Project Review	AF-0148
5.4.b	Build Supplier Relationship	AF-0045
	Evaluate Process	AF-0070
	Change Supplier Commitment	AF-0113
	Plan Supplier Work	AF-0119
	Implement Process	AF-0187
	Performance Results	
6.1.a	Analyze Data	AF-0073
	Gather Internal Data	AF-0098
	Measure Product	AF-0118
6.2.a	Measure Process	AF-0072
	Analyze Data	AF-0073
	Gather Internal Data	AF-0098
6.3.a	Measure Process	AF-0072
	Analyze Data	AF-0073
	Measure Product	AF-0118
	Customer Focus and Customer Satisfaction	
7.1.a	Determine Customer Requirements	AF-0046
	Determine Customer Expectations	AF-0047
	Determine Indicators	AF-0071
	Determine Customer Groups	AF-0099
	Select Group	AF-0100
	Gather Customer Information	AF-0101
7.1.b	Determine Future Customer Requirements	AF-0048
	Determine Future Customer Expectations	AF-0049
	Develop Listening Strategies	AF-0050
7.1.c	Evaluate Process	AF-0070
7.2.a	Communicate Information	AF-0097
	Provide Customer Access	AF-0102
	Maintain Service Standards	AF-0103
	Maintain Product Standards	AF-0104
	Gather Customer Feedback Data	AF-0105
7.2.b	Analyze Data	AF-0073
	Gather Customer Information	AF-0101
	Record Customer Complaint	AF-0106
	Evaluate Customer Complaint	AF-0107

7.2.c	Evaluate Mission Effectiveness	AF-0051
	Analyze Data	AF-0073
7.2.d	Evaluate Process	AF-0070
7.3.a	Evaluate Mission Effectiveness	AF-0051
	Analyze Data	AF-0073
	Determine Customer Groups	AF-0099
7.3.c	Evaluate Measurement Scale	AF-0052
	Improve Measurement Scale	AF-0053
	Evaluate Process	AF-0070
7.4.b	Analyze Data	AF-0073
7.5.a	Analyze Data	AF-0073
7.5.b	Analyze Data	AF-0073

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13. ABSTRACT (Maximum 200 words)

As defense budgets decrease and it is required to do more with less, the Air Force has chosen to use the Malcolm Baldrige National Quality Award (MBNQA) as the basis for implementing quality principles. The Air Force program is known as Quality Air Force (QAF), and the criteria are referred to as the QAF criteria [DEPA95b]. At about the same time the Department of the Air Force implemented QAF, the software leaders in the Air Force adopted the Capability Maturity Model for Software (CMM) as the internal standard for Air Force software organizations [MOSE91]. Software organizations strapped with both sets of requirements struggle with how to implement both models. Many organizations implement redundant programs in an effort to satisfy both. This research uses signature and specification matching techniques gleaned from the software reuse domain to integrate the CMM and QAF criteria into a single set of requirements that correlate to both models.

14. SUBJECT TERMS
Software Engineering; Capability Maturity Model; CMM; Quality Air Force Criteria; QAF; QAFA; Malcolm Baldrige; Specification Matching; Signature Matching; Process; Process Requirements; Requirements Integration; Quality; Models; Matching

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