Departmental Information Systems Engineering (DISE)

Volume 1
Information Systems Engineering Lifecycle

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Title Page

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The concepts and processes in this document are aligned with the DOE Information Management (IM) Strategic Plan Mission and Goals.

The Information Management Mission is:

To provide DOE employees and contractors with the capability to readily acquire, share, protect, disseminate, and store the information needed to successfully accomplish their jobs.

The IM Strategic Goals are:

1. Increase customers' trust by involving them in the information management process.
2. Improve understanding of DOE missions and processes in order to provide effective information management support.
3. Partner with our customers in planning and implementing corporate systems.
4. Develop, in concert with our customers, DOE-wide data administration to ensure data availability and access.
5. Provide customers with the technology to access and share information easily and seamlessly from any location.
6. Improve cooperation and collaboration of information management community to cost-effectively meet the information management needs of DOE.

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Preface

The development of the Departmental Information Systems Engineering (DISE) series was initiated as part of the continuing effort of the Office of the Chief Information Officer (CIO) to improve the quality, performance and productivity of Departmental information systems and their architecture. The development of the DISE series is sponsored by the Departmentwide Systems Engineering Process Group (DSEPG) under the auspices of the Departmental Software Quality and Systems Engineering program. Many Departmental and contractor personnel were involved in the development of the document as contributors or reviewers.

The purpose of the DISE series is to describe information systems engineering practices that will move the Department towards achieving higher levels of capability, maturity, and quality in information systems solutions and foster the institutionalization of these practices. The DISE series is aimed at improving the Department's information systems engineering practices by advocating a "total systems approach" aligned with site and Departmental architectures.

DISE Abstracts:

The topics for the volumes of the DISE series will focus on meeting the needs of the Department in improving information systems engineering capability. Volumes addressing project management, process management, Commercial-Off-The-Shelf (COTS) integration, and metrics and assessments are being considered at this time.

Volume 1, Information Systems Engineering Lifecycle – includes an overview of information systems engineering (ISE), project initiation and strategic planning activities, resources, and quality management. It includes a discussion on drivers, roles, concerns, capital planning, acquisition, and Information Architecture as they relate to information systems projects.

Volume 2, Project Management – includes best practices, project planning and control, tracking and oversight, estimating, and uses of project plans and work breakdown structures.

Volume 3, Process Management – includes adopted and/or recognized best practices for developing individual, team, and organizational processes; techniques for definition, mapping, analysis, and improvement of existing processes; and guidance on implementation of configuration management, requirements management, risk management, and quality management processes.

Volume 4, Off-the-Shelf and In-House Programming – includes Departmental practices for COTS integration and quality assurance techniques for system development.

Volume 5, Metrics and Assessments – includes techniques and tools for tracking metrics, assessing solution provider capability, and the benefits and techniques for Post-Implementation Reviews (PIRs) and Information Systems Reviews (ISRs)

The DISE series will be reviewed on a regular basis and modified as needed to keep pace with the changing needs of the Departmental information systems engineering environment and the continuing technical advances in the information systems industry. Questions or comments should be referred to the document owner, listed on the title page.

1.0 Introduction

The Department of Energy provides critical products and services in national security, environmental quality, science, energy resources, and corporate management. State-of-the-art information systems (IS) solutions are needed to support these vital mission and business processes and provide the information needs of the Department for effective decision-making and tracking.

Legislative and regulatory mandates have tasked the Department with ensuring that information technology (IT) initiatives are implemented at acceptable costs within reasonable and expected time frames. The Clinger-Cohen Act imposed requirements on Government agencies to ensure that investments in information technology are fully justified and aligned with agency missions and business needs. As a result, the Department of Energy has implemented Information Architecture (IA), and the IT Capital Planning and Investment Control (CPIC) processes.

The Departmental Information Systems Engineering (DISE) series will identify best practices for implementing and managing Departmental information systems solutions. The DISE series is intended to complement and synergize Departmental information management programs and initiatives such as IA, IA Standards, Information Security, Strategic Information Management (SIM) process, capital planning, and acquisition strategies. Also, this series is intended to be consistent with other methodologies used in the Government and private industry.

1.1 Applicability

The DISE series provides guidance for maturing DOE's capability in providing quality IS solutions and, therefore, is applicable to all IS development and maintenance for the Department of Energy. According to the Clinger-Cohen Act, an "information system" is defined as a combination of data information, computer resources, telecommunications resources, other information technology resources, and personnel resources and procedures which collect, record, process, store, communicate, retrieve, and display information.

The DISE series is intended to be used by individuals, project teams, and managers who are responsible for developing new information systems, making changes to existing systems, and managing the architectural environment and systems infrastructure. It is applicable to all DOE scientific, technical and business ISs, including customized solutions involving Commercial-Off-The Shelf (COTS) products. However, it is recognized that while some scientific systems, e.g., systems of a research and development or experimental nature, may require a lesser degree of rigor of systems engineering practices, a disciplined approach is still needed and the IS engineering standards and practices provided in the DISE series should be adapted for use. At the same time, other systems, such as weapons or defense-oriented systems may require a higher degree of rigor to eliminate defects and meet higher quality standards. These systems may need to implement additional systems engineering practices beyond those recommended in the DISE series.

Also, while the DISE series does not intend to specifically exclude or be interpreted to exclude any IS or Program area from using the concepts and practices identified in this series, additional security or other Program requirements may take precedence or dictate additional activities to the principles outlined in this series.

1.2 Purpose

DISE, Volume 1, Information Systems Engineering Lifecycle, is intended to provide high-level guidance to foster more consistent and mature IS engineering practices. Inconsistent systems engineering practices within and across organizations limit the Department's capability to deliver quality ISs and corporate systems applications in accordance with predictable costs and schedules. In addition, without well defined, repeatable processes to improve, it is impossible to systemically improve product delivery.

Consistent, mature IS engineering practices are necessary at DOE. The DOE systems and software engineering environment is large, decentralized, and extremely complex. There are several thousand programmers and systems specialists supporting a multi-billion dollar IT investment. The Department's architecture encompasses a variety of platforms, from desktops to supercomputers, operating over a variety of networks, representing diverse IS structures, from mainframe-based to 2- and 3-tier client server, to Web-based, supporting a variety of IS applications, from business functions to research and development.

1.3 Document Overview

Departmental Information Systems Engineering (DISE), Volume 1, Information Systems Engineering Lifecycle, consists of 5 chapters and 2 appendices, as follows.

Chapter 1, Introduction, provides the purpose for the DISE series and its applicability, and the purpose of Volume 1.

Chapter 2, Overview of Information Systems Engineering, provides a definition and lifecycle model for IS engineering at the Department of Energy. It also describes the supporting roles associated with IS engineering and identifies management concerns.

Chapter 3, The IS Engineering Lifecycle and Project Initiation, discusses the CIO cooperative processes described in the Clinger-Cohen Act and how they are being applied on Departmentwide corporate and non-corporate projects. Topics of discussion include project initiation in the DOE environment, formulation of a business case (feasibility analysis), acquisition strategy, IA principles, strategic planning, the SIM process, capital planning, high-level scoping of the project, and identification of high-level project objectives and requirements.

Chapter 4, Systems Engineering Organizations and Standards, discusses DOE standards usage and identifies DOE and industry resources for IS engineering.

Chapter 5, Quality Management, discusses the importance of quality reviews, metrics and analysis, assessments, and improvements.

Appendix A, IS Engineering Resources, provides statutes, directives, and other applicable references. Additionally, directives and guidance documents that establish the justification or rationale for, and directly relate to, the engineering of DOE IS are also provided. These references and guidelines apply to DOE Federal and contractor IT activities and Department entities developing and maintaining ISs.

Appendix B, Glossary and Acronyms, provides definitions for selected terms and defines acronyms.

1.4 Guidance Reference

References for additional information are documented throughout, as applicable to the section.

2.0 Overview of Information Systems Engineering

At DOE, information systems (IE) engineering refers to the practice of managing the IS lifecycle as depicted in Figure 2.1, DOE Systems Engineering Lifecycle for Information Systems Solutions. It is a problem-solving process used to translate customer (user) wants and needs into requirements and then transforms those requirements into system products and processes. This transformation may occur through the development of a new, or enhancements to an existing, IS and/or the infrastructure that supports it. IS engineering takes a total systems approach to software engineering to include all factors such as environment (including hardware and infrastructure), operations (including response times, back-up and recovery), safety and security. This concept is in agreement with systems engineering definitions developed by the International Council on Systems Engineering (INCOSE) and the Electronic Industries Alliance (EIA).

Systems engineering as defined by the INCOSE, “What is Systems Engineering?” - 1996, is the discipline of developing systems products or processes based on a total systems perspective and utilizing a systems engineering approach. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and systems validation while considering the complete problem: operations, performance, test, manufacturing, cost and schedule, training and support, and disposal. Systems engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Systems engineering considers both the business and technical needs of all customers with the goal of providing a quality product that meets user needs.

Systems engineering as defined by the EIA Std. IS-632-1994, is an interdisciplinary approach encompassing the entire technical effort to evolve and verify an integrated and lifecycle balanced set of systems, people, product, and process solutions that satisfy customer needs. Systems engineering encompasses:

- the technical efforts related to the development, manufacturing, verification, deployment, operations, support, disposal of, and user training for, system products and processes
- the definition and management of the system configuration
- the translation of the system definition into work breakdown structures
- development of information for management decision-making

🕮 For more information on DOE IS Engineering: http://cio.doe.gov/sqse/sse.htm
🕮 For more information on INCOSE: http://www.incose.org
🕮 For more information on the EIA: http://www.eia.org

2.1 The DOE Information Systems Engineering Lifecycle

The DOE IS engineering lifecycle illustrated in Figure 2.1 shows where software and systems engineering practices fit within the overall DOE IT framework. This lifecycle also applies to the technical infrastructure of ISs.

Within the DOE environment, there are many drivers that identify needs for the implementation of new, or changes to existing, IS and the technical infrastructure surrounding these systems. Through various planning processes that include activities such as functional analysis, conceptualization, feasibility study, and business case analysis, these needs are translated into high-level requirements and projects are initiated. The requirements are assimilated, and allocated to projects that are managed through solution development and into operation and maintenance.

Once funding is provided, a project proceeds into solution development. Whether the focus is on software or infrastructure, a similar development path is followed and the development stages are typically arranged to suit the project. In all projects there is an integration of software and systems because a change in one can cause a change in the other. Once a development or maintenance project has been completed, the product goes into operation and maintenance. Throughout this lifecycle, all development and enhancement project staffs must coordinate with staff from capital planning, IA, IA standards, information security, safety, configuration management, risk management, quality management, and assurance.

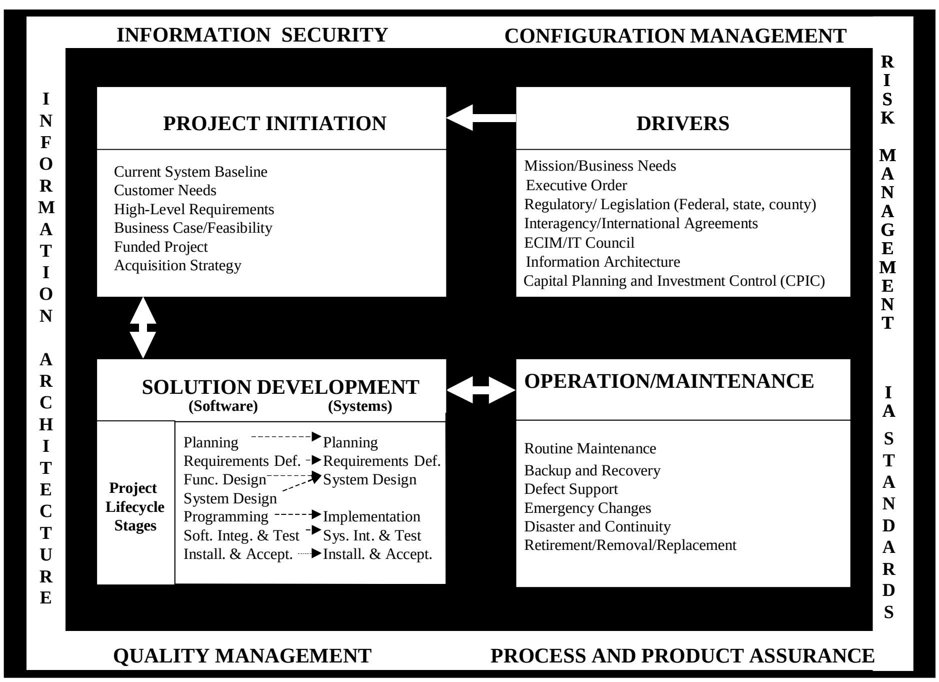

Figure 2.1 DOE System Engineering Lifecycle for Information Systems Solutions

2.1.1 Drivers

There are numerous drivers that determine the need for an IS solution. These drivers include:

Mission/Business Needs. These include needs as defined by (1) the mission statements and charters of DOE organization, (2) systems engineering activities that result in the integration of disparate DOE systems, (3) systems engineering activities to take advantage of new technology to improve the way the DOE mission and business processes are executed, and (4) programmatic and management and administrative staffs seeking improved productivity in their assigned tasks and the results of business process reengineering activities.

Executive Order.   Mandates or decisions imposed by the President of the United States, the Vice President, and other Federal officials can cause new developments or enhancements to an IS or technical infrastructure.

Regulatory/Legislation. A need for IS solutions may arise from a Federal, state, or county government legislation and from actions taken by other regulatory bodies and agencies.

Interagency/International Agreements. Agreements reached between agencies of the US government and agencies of other foreign governments or of the United Nations, such as international agreements on nuclear non-proliferation, can cause not only changes in US IS solutions but also new, or enhancements to, a cooperative international IS solution.

Executive Committee for Information Management/Information Technology Council. These bodies are comprised of representatives from numerous organizations across the DOE. Collectively, these two bodies propose and approve Departmental information management needs, which result in requirements for new, or changes to, existing information systems solutions.

Departmental Information Architecture. The DOE IA program has been developed in a series of four volumes and the Corporate Systems Information Architecture (CSIA) document. Processes and initiatives are being implemented as a necessary foundation for ensuring quality information, supporting strategic alignment objectives, and providing for linkages from the mission/business processes to the architectural infrastructures of the Department. IA serves not only as a driver but also as a control against which development occurs.

Capital Planning and Investment Control (CPIC). The implementation of an effective, efficient, and repeatable IT CPIC process is required by law and is essential to ensure sound IT investment decisions. The *CPIC Guide* details the approach the Department of Energy (DOE) uses to identify, prioritize, justify, fund, and manage IT investment opportunities. The process applies to the selection, control, and evaluation of the Department’s business and administrative and infrastructure-related IT initiatives.

2.1.2 Project Initiation

Various drivers identify needs for new or improved IS solutions that are aligned with DOE mission and business goals and objectives. Through activities such as conceptualization, functional analysis, feasibility study, business case analysis, and design synthesis, these needs are translated into high-level requirements that become input to the solution development process. High-level requirements are strategically mapped against the current system baseline and functional gaps are identified. A decision may be made to either develop the solution "in-house" by DOE Federal or contractor personnel or acquire it via a DOE acquisition vehicle from industry vendors that are expert in a particular solution development. Once these activities have been conducted; i.e., the project has been initiated, it is ready to move forward to solution development. Not all of the above activities result in projects that move beyond this point and into development of an IS solution. Projects need to be approved and funded.

2.1.3 Solution Development

IS engineering solutions include new development and enhancements to existing systems. IS engineering activities are those typically associated with executing the project lifecycle such as, detailed requirements definition, project management, product design, programming, testing, and installation. The resulting system may contain components that are developed in-house, a COTS solution that is implemented as-is or customized, or a combination of both.

Projects involve the disciplines of project management, software/systems engineering, and quality assurance. A methodology for managing the project and resulting product (system) should be instituted at the inception of the project and throughout the product lifecycle. The methodology should incorporate these three disciplines.

The DOE Software Engineering Methodology (SEM) is DOE's lifecycle methodology standard. Either the SEM or a comparable or more rigorous lifecycle methodology should be followed when planning and managing IS engineering projects.

📖 For more information on the SEM: http://cio.doe.gov/sqse/sem_main.htm

2.1.4 Operation/Maintenance

Once the new system, or modification to existing system, has been completed and implemented, Operation/Maintenance is entered. In Operation/Maintenance, business and technical requirements of a routine maintenance nature are addressed. Requirements for changes or enhancements will be generated by the "drivers" discussed above, as well as the users of the system. The processes and products conducted or developed during Solution Development will be continued or evolved in Operation/Maintenance. A maintenance plan should be developed as the guiding document. The SEM includes a chapter that discusses maintenance.

📖 For information on the maintenance plan and other resources: http://cio.doe.gov/sqse.

2.2 Information Systems Engineering Roles

There are many individuals involved in the inception, development, deployment, and maintenance of IS solutions. Those in Drivers and Project Initiation (Figure 2.1) are in a supportive and oversight role, while those in Solution Development and Operations/Maintenance deal with the day-to-day activities of the project and resulting product.

2.2.1 Drivers and Project Initiation Roles

With regard to IS engineering, the roles of the individuals involved with the Drivers mentioned in section 2.1.1 are generally as recipients to status/progress reporting. Their main interest is that projects are completed in a timely and cost-effective manner that supports business and mission needs.

The roles of the individuals involved with Project Initiation are to complete the high-level planning, review and analysis. They are responsible lead-time activities including developing the business case, feasibility analysis, high-level requirements and information management plans. They typically report status to the "drivers" and management during the project initiation processes and at various other times during the project's lifecycle. They include capital planners and analysts, information architects, strategic planners, and procurement specialists.

2.2.2 Solution Development and Operation/Maintenance Roles

Staffs from various functional areas are involved in a Solution Development. Many of these same individuals are also found in Operations/Maintenance. They can be classified into two major categories: customer and solution provider. Figure 2.2, Customer and Solution Provider Interaction, shows the relationship between the customers and solution providers, and the establishment of performance measures.

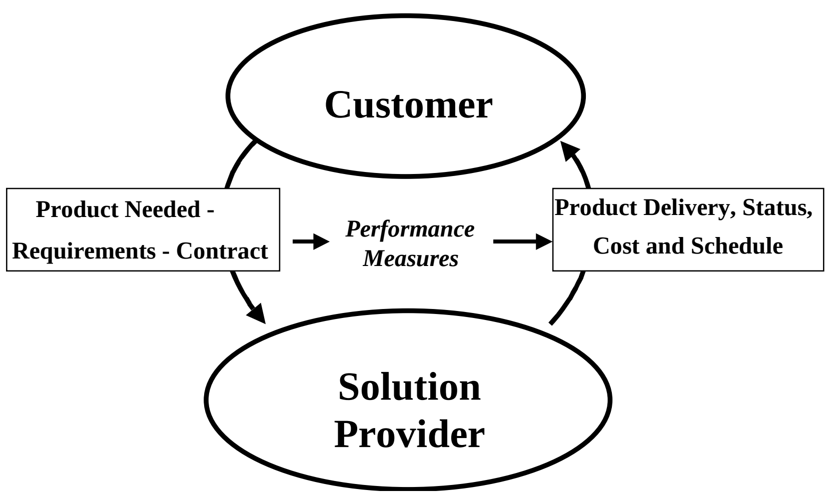

Figure 2.2 – Customer and Solution Provider Interaction

Most DOE projects are initiated as a result of a need identified by staff performing DOE's mission and business functions. These individuals make up the Customer and typically are

Federal employees. The customers identify needs as either business objectives of the users or customers of a system, or as technology objectives of the IA or other technical groups. This information is input to the process of developing contracting agreements with solution providers.

The staff responsible for delivering or maintaining the resulting product (system) are the solution providers, who can be Federal and contractor staff. These individuals form the technical expertise to define project feasibility, manage the project lifecycle, and provide or maintain the solution. They are responsible for product delivery, status, cost, and schedule.

As project constraints and risks are identified along with requirements, performance measures are established for both the project (status, cost, and schedule) and the resulting product (delivery). Some are established at contract award and some are established during planning. Both the customer and solution provider monitor performance measures throughout the project and product lifecycle.

2.2.3 Project Roles

Some of the key project roles are:

- project manager
- program manager
- information systems engineer
- information architect
- quality assurance representative
- security specialist

For any given IS engineering project there may be many additional participants. For example, specialists in standards, security, and safety may be needed to ensure compliance in those areas. Other business and systems analysts and programmers may be needed for systems and process analysis, programming, testing, and migration of the resulting product.

2.2.3.1 Project Manager

The Project Manager is the person who is responsible for daily planning, tracking, reporting, and coordinating of project activities. Some of these activities include the performance or oversight of configuration management, requirements management, risk management, and quality management. The project manager is also typically responsible for personnel actions and issue resolution. Other common titles for the project manager's role includes project coordinator, project leader, project officer and systems integrator.

The project manager’s role may be full or part-time. The project manager may be a Federal or contractor employee. It may be common for a contract project manager to report to a contractor manager from an organizational perspective, but receive functional direction from the Federal program manager.

📖 For more information on project management:
DOE Software and Systems Engineering: http://cio.doe.gov/sqse
The Project Management Institute: http://www.pmi.org

2.2.3.2 Program Manager

Although the technical expertise of individuals that comprise the Solution Provider space will drive the system that is developed and typically provide the project manager role, the program manager should be identified within the Customer space. The program manager should ensure performance indicators are established, met, and appropriate transition to operations and maintenance occurs.

This role is generally assigned to a Federal employee who is responsible for the oversight of a program that is supported by a team of people that may include or be exclusively comprised of contractors. The program manager is the product sponsor and a key stakeholder. The program may include one or more systems engineering projects to develop new, or make changes to existing, ISs. Program manager responsibilities include:

- ensure justification of expenditures and investment in systems engineering activities
- coordinate activities to obtain funding
- review and approve project plans
- review and approve project deliverables throughout the IS engineering lifecycle
- ensure processes are applied that will foster delivery of quality products and systems
- coordinate issue resolution and escalations to higher management
- ensure acceptance testing and acceptance is completed by the customer or system owner

2.2.3.3 Information Systems Engineering Manager

The information systems engineering manager (ISEM) is not a separate role within DOE. Within DOE, the project manager often performs this role for an IS project. The ISEM is responsible for coordinating the systems engineering tasks for a project. The ISEM may be a Federal or contractor employee. The ISEM is responsible for coordinating the efforts of a project manager and other key players to ensure the resulting system meets the requirements of the Department's IA, standardized networks, and other guidance and standards while utilizing the IS engineering practices and methodologies.

2.2.3.4 Information Architect

Every IS organization should include or have access to, at a minimum, one full or part-time staff member who is responsible for architecture activities and can provide architecture expertise to a team. Depending on organization size, an architecture group may be appropriate. The architecture function (person) typically performs activities that include:

- maintain system design information in a repository and ensure it is updated as it evolves
- provide guidance and consulting to the development and maintenance teams
- facilitate the flow of information between organizations

- recommend standards (hardware and software) for information transfer
- ensure that the solution design is consistent with DOE architecture philosophy, guidelines, and target business and technical architectures

The IA person should be experienced in developing system architectures and be well versed in DOE architecture principles, guidance, assessment, and the target or vision environment.

2.2.3.5 Quality Assurance Representative

To promote independence, the person performing the Quality Assurance (QA) role should, as a general rule, report to a separate organization such as an oversight or process group. The QA person typically performs activities as an independent participant that include:

- be the process expert (e.g., lifecycle process, QA process, improvement process)
- provide assistance to the project team on process matters
- assist the project team in developing project plans and deliverables
- review project plans and deliverables and assess for adherence to organizational processes
- conduct independent project and process assessments
- provide independent view of project health and well being
- provide guidance on software verification and validation

2.2.3.6 Security Specialist

Security guidelines for system development and system access are necessary for all information systems. Guidance in IS security issues needs to be provided to the project team throughout the project lifecycle. Activities requiring expertise as part of the project team, or available within the organization, include:

- early involvement and guidance on developing the project plan
- the development of the security plan
- review and approval of lifecycle deliverables
- guidance on user access control techniques

📖 For more information on security:
DOE Unclassified Security Program: http://cio.doe.gov/ucsp
DOE Headquarters Classified and Unclassified Computer Security Program:
http://cio.doe.gov/compsec

2.2.3.7 Additional Project Functions

Standards. Every IS engineering project should be staffed with, or have access to, a person who is familiar with the standards established for that organization, as well as DOE IA Standards. This person should be familiar with standards development techniques and should be able to develop standards specifically for a given project, program or organization.

🕮 For more information on the DOE standards program:
DOE IA Standards Program: http://cio.doe.gov/standards/index.html
DOE Standards: http://tis.eh.doe.gov/techstds/

Safety. Every IS engineering project should be staffed with, or have access to, a person who is familiar with the safety standards and regulations for DOE and the DOE Program sponsoring the project. The safety specialist will ensure that applicable safety requirements are included in the project planning, requirements gathering and systems testing and implementation.

Programmers, testers, network specialist, etc. 🕮 For more information on additional project functions and participants: DOE Software and Systems Engineering, http://cio.doe.gov/sqse

2.3 Management and Customer Concerns

There may be both organizational (external) and project (internal) factors and risks that affect an IS project. Management and customers need to be aware of these factors and risks and provide adequate funding, contingencies and planning to minimize negative effects on the project. Some of the common concerns for DOE IS projects are discussed below.

Lifecycle principles apply, regardless of size. As DOE organizations are increasingly asked to do more with less, it is even more important to apply the fundamental project management principles and best practices to all projects, regardless of size. For smaller projects, stages may be combined and deliverables reduced in scope as appropriate. The key is to tailor the lifecycle methodology to the particular project, and to document actions taken, demonstrating why risk was not unduly increased. It is not appropriate to "bypass" or ignore practices because a project is "too small" or is not the most visible in the organization.

Deliverables for scientific projects meet or exceed those for business projects. Scientific projects, such as weapons or defense-oriented systems, may require more deliverables than business projects. They may need more rigorous processes to track the progress and quality of the project, minimize risk and plan for contingencies. Management should ensure that initial project planning includes documentation of those additional deliverables and processes, and track the projects status accordingly to eliminate defects and meet higher quality standards.

Duration and level of funding. The duration and level of funding can directly affect the project's viability and outcome. If a project's duration spans several fiscal years, the project can be in jeopardy of budget cuts, or a change in business or mission goals, or a victim of inadequate funding. A project's level of funding may require additional management controls and reporting based on the sources of funding. As a result it is essential that fundamental project management principles and best practices are applied to ensure feasibility and project justification are managed throughout the project's lifecycle.

Mission/Business continuity. As programs within the Department are realigned, projects may be impacted based on changes to mission and business needs. Strong IS engineering practices are necessary to minimize the impact of these changes and provide appropriate levels of communication regardless of the disruption.

Strategic and Migration Planning. Initial project planning must incorporate strategic and migration planning for addressing the parallel operations and subsequent retiring of prior stovepipe systems. In some cases, existing systems may be more robust than the initial new IS solutions. Strategic plans should include these issues and management agreements should be established in the initial planning stages of the IS solution.

These concerns are particularly true for Departmental corporate systems. When developing corporate systems, requirements from across the Department must be incorporated and managed based on a documented process. While the Departmental corporate system is being developed, senior DOE management face the challenge of ensuring duplicate or rogue systems development does not occur within limited areas of DOE that do not meet the needs of the enterprise.

3.0 Project Initiation

The Clinger-Cohen Act, also known as the Information Technology Management Reform Act, directs U.S. Government departments and agencies to better manage technology investments. As a result of the Clinger-Cohen Act and internal DOE process improvement objectives, the Department of Energy has implemented processes for corporate project initiation to ensure the resulting IS solution meets business and mission needs, and is feasible both from a cost and technological standpoint. The Solution Development and Operation/Maintenance activities of the project and product lifecycle are fully defined in the DOE G 200.1-1A Software Engineering Methodology (SEM).

3.1 Project Initiation Process Model

The Project Initiation Process Model in Figure 3.1 outlines the Department of Energy processes for initiation of corporate and non-corporate systems. As was previously illustrated in Figure 2.1, internal and external Drivers are the source, or point of beginning, for most IS engineering projects. All proposed projects participate in the process of forming and evolving the Vision (target) IA, described later in this chapter. Projects must be strategically planned through the capital planning process such that they will be part of a harmonious migration from the current to the proposed DOE architecture; i.e., in line with the documented IA migration plans and objectives.

The Capital Planning process, described later in this chapter, enables the IA migration process through cooperative planning efforts with the IA staff to develop both the technical strategies and budgets to achieve the Vision IA. The results of these planning efforts are potential projects that should undergo a feasibility analysis to determine if they should be funded.

Projects involving the development of corporate systems should be evaluated to determine if their participation in the Strategic Information Management (SIM) process is appropriate. The SIM process is a robust set of activities resulting in a full-blown business case and feasibility study, with alternatives and recommendations for systems and business process reengineering. Evaluation of non-corporate systems is less intensive and may include a feasibility study and an analysis of benefits and costs (ABC), which are generally conducted in Solution Development. Sections 3.2 and 3.3 further discuss differences in the flow of initiation activities conducted for corporate and non-corporate projects.

Once a project obtains management support, approvals, and funding, it moves into Solution Development and ultimately into Operation/Maintenance. Many of the SIM activities such as conducting a feasibility study, developing high-level requirements, and conducting an ABC, are prescribed as part of the SEM process. Therefore, they would not be repeated if a SIM-initiated project moves forward into Solution Development. Throughout Solution Development, and Operation and Maintenance, data and information are fed back to information architects, strategic planners, and capital planners for their project analyses, reviews, trend analyses, and process improvement.

📖 For more information on the SIM process: http://cio.doe.gov/sim

📖 For more information on the SEM: http://cio.doe.gov/sqse/sem_main.htm

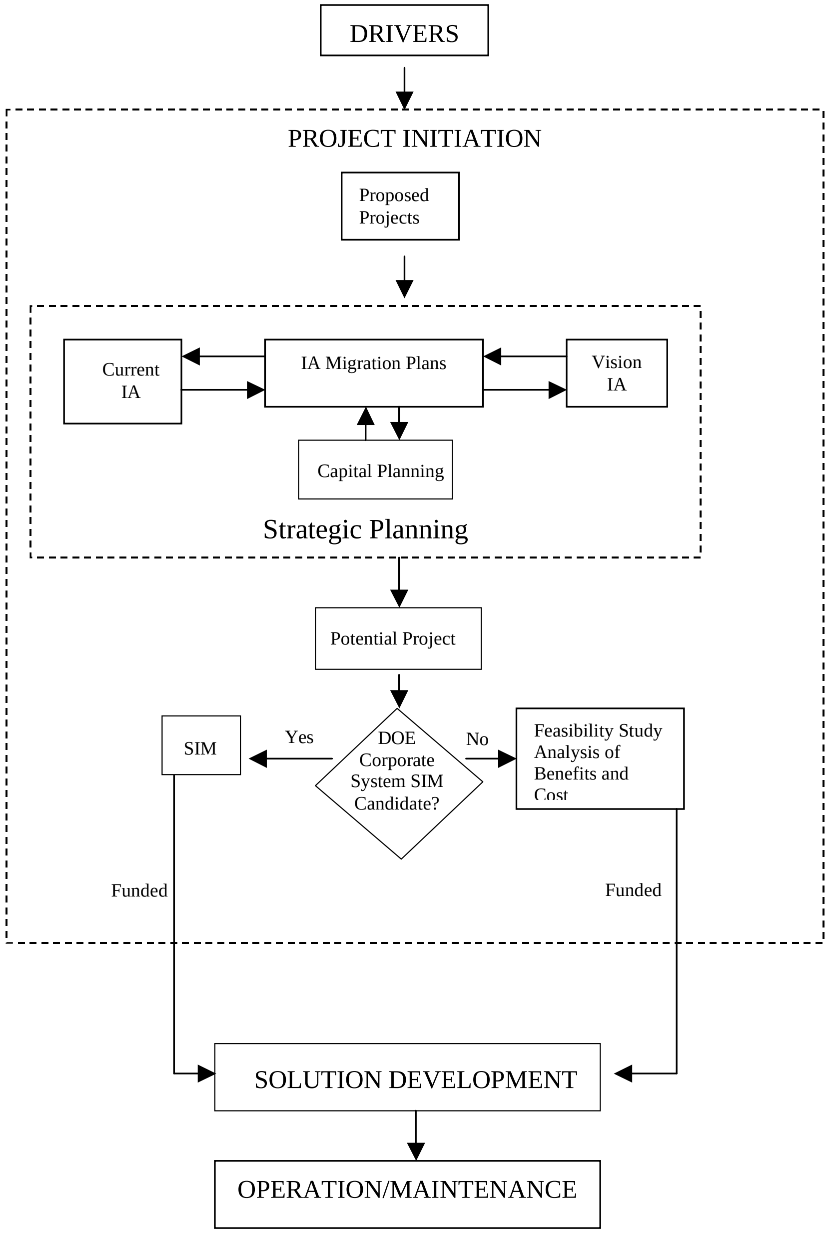

Figure 3.1 – Project Initiation Process Model

3.2 Corporate Systems

As defined in *Information Architecture, Volume III, Guidance*, a corporate system is a design and implementation to satisfy a subset of the enterprise's total business/mission (and information) needs. Such systems can be partitioned across separate business (or mission) areas, organizations, or processes to integrate both functional processes and technological capabilities. Corporate systems support business/mission functions that meet the following criteria:

- support business/mission functions that exist in the majority of DOE organizations
- are required by laws, regulations, or generally recognized sound management practices
- are considered vitally important by DOE top-level executive management and support accomplishment of the business/mission functions for which they are responsible
- are highly institutionalized and operate continuously and routinely

A system is determined to be a corporate system when the project would add benefit to DOE if implemented across programs and facilities and has a high-dollar funding expectation. When a project is identified as a corporate or potential corporate system, the Strategic Information Management (SIM) process may be applied in order to bring together cross-functional views to develop the business case and high-level requirements. More rigorous IS engineering practices should be employed for corporate projects due to the complexities, cost, scope of impact, and distributed nature of corporate projects. Some corporate systems have other initiation sources, such as program offices. However, regardless of the source, it is important that all projects be coordinated and synchronized with IA strategies and plans, especially wherever an organization has already developed a programmatic or site architecture plan.

The Corporate System Project Initiation Process is a dynamic process. Figure 3.2, Corporate System Project Initiation Process, illustrates one view of the internal management process for corporate projects; other processes are possible. Figure 3.2 shows how projects are recommended for funding, receive funding, and are reviewed. Once a project is identified through proposal a business case may be developed through the SIM process. The project is then reviewed by an approval body. In the past, the approval body has been the DOE CIO Council. The approval body then recommends the project for funding. Next, the Senior Management Executive Review Board, e.g., Deputy Secretaries or in the past, the Executive Committee for Information Management (ECIM), approves the funding. Funding can be provided from any source, such as the normal budget allocation or the Corporate Management Information Program (CMIP), which provides funding for, and oversight of, efforts to modernize major, outdated DOE corporate systems. A rigorous quarterly program oversight/review process was established by the CIO to ensure projects are selected, planned, managed and funded to provide the greatest potential for success and customer satisfaction.

📖 For more information on the CIO Quarterly Review Process:
http://cio.doe.gov/sqse/pm_trck.htm

📖 For more information on the Corporate Systems Information Architecture:
http://cio.doe.gov/iap/publications/csia/csia_home.htm

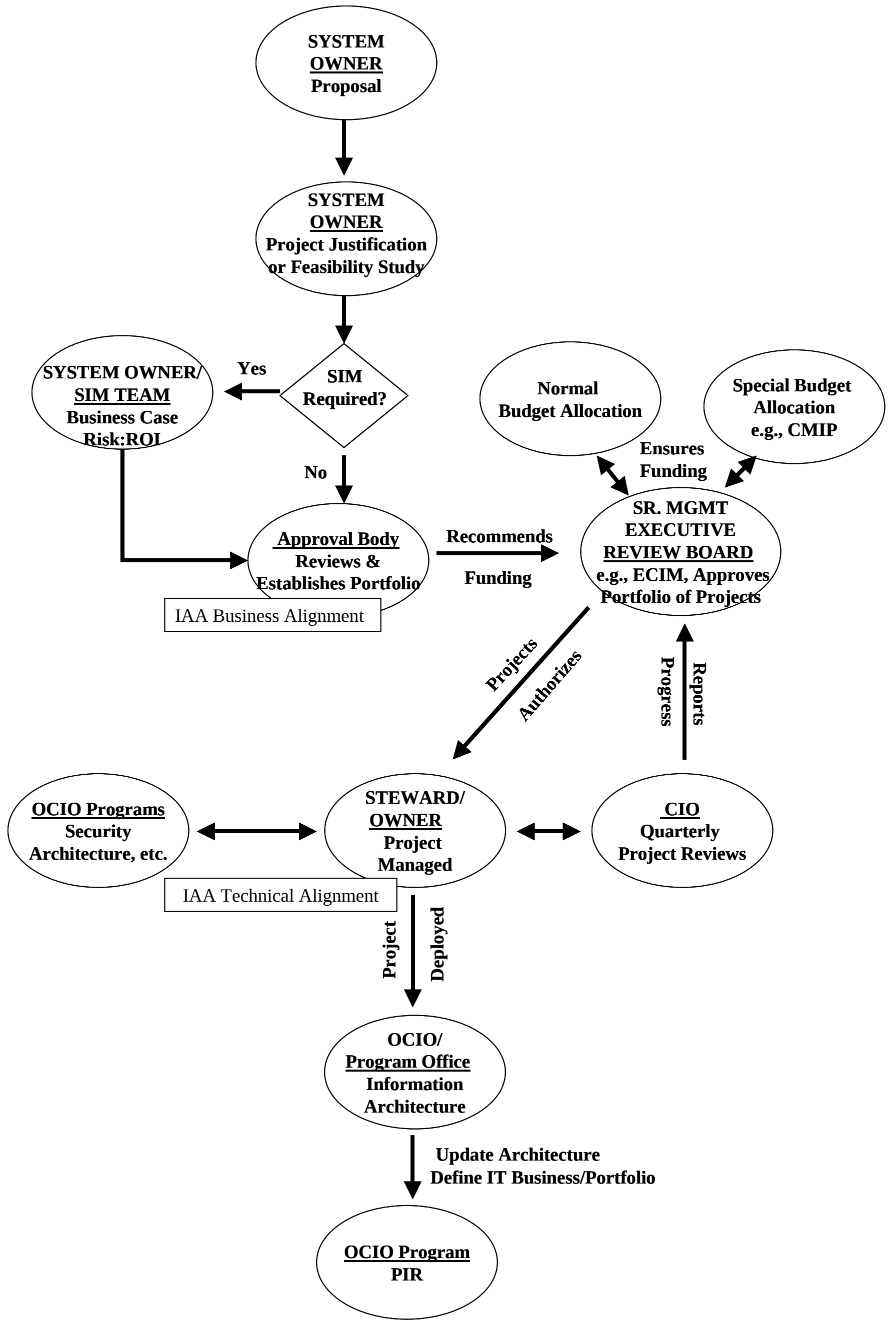

Figure 3.2 – Corporate System Project Initiation Process

3.2.1 Information Architecture - Current and Vision

Much progress has been made in the Departmental IA program in the last several years, from developing the guiding documentation for the IA program (1995) to the current coordinated Department-wide implementation efforts, such as the Departmental IA Project (DIAP) conducted in FY 2000. The Corporate Systems Information Architecture document, which was the outcome of the DIAP, was developed as a vision and DOE target. It is being formulated and implemented as a necessary foundation for ensuring quality information while helping DOE maximize the utilization of resources that each year become increasingly scarce. Using a process-oriented approach, Departmental elements and sites worked diligently to define architectures for their respective areas that nest into the overall Departmental IA, while meeting individual information needs. Additionally, groups that span across DOE elements have been formed to deal with issues of common concern, and ensure that common directions are pursued and allowances made to achieve compatibility and interoperability when directions diverge.

Implementation of the Departmental IA supports strategic alignment objectives and provides for linkages from the business/mission processes to the technology infrastructures that serve the information needs of the Department. It provides a common foundation for technology resource planning in the DOE's distributed decision-making environment. The result is improved coordination and communication between Headquarters, the field, laboratories, site/facilities management contractors (formerly called M&O) and other contractors.

The foundation of the Departmental IA is the DOE IA Model. The Model provides a framework to interconnect the business/mission unit or programmatic defacto IAs to better support the Department's strategic plan and mission goals. It is based on a five-tiered framework, which allows for organizing, planning, and building an integrated set of information and IT architectures. Each tier, labeled as a subarchitecture (also known as a layer), is defined separately but each is interrelated and interwoven with the other sub-architectures.

Some sites are using the Zachman Framework[1] to implement the Departmental IA. The tiers with their description and comparison to Zachman are described in the following chart.

[1] For more information visit the Zachman Institute for Framework Advancement web site at http://www.zifa.com

Information Architecture			
Departmental Information Architecture Subarchitectures (layers)		Zachman Framework	
Type	Description	Type	Description
Business	Defines the core business procedures and processes of the enterprise.	Scope (Contextual)	Defines the enterprises direction and business purpose
		Enterprise Model (Conceptual)	Identifies in business terms the nature of the business, including structure, functions, organization, and so forth.
Information	Identifies all relevant information necessary to support the enterprise's business, procedures, and processes.		
Applications	Translates the requirements for information into an automated set of systems and/or applications.	System Model (Logical)	Describes the Enterprise Model in terms of transformation of data.
Data	Identifies the structure, definitions, and storage needs of the entities; allows for processing data into useable information.	Technology Model (Physical)	Describes how technology might be used to address the needs identified in the Enterprise and System Models
Technology	Describes the physical layer of the infrastructure that is required to support the processing of data into useable information.	Detailed Representations	Describes the physical layer of infrastructure to support the technology model, e.g., a particular language is chosen, and database specifications, networks, etc. are produced.

As shown in the chart, the DOE IA layers are similar in nature to the Zachman Framework for Enterprise Architecture. The Zachman Framework also represents business scope and rules, with underlying technology and implementation at its lowest levels. However, the DOE subarchitectures do not address the implementation details at the same level as the Zachman Framework.

The DOE IA is founded on principles that are high-level visions of DOE philosophy expressed in terms of objectives and goals intended to endure, and provide the foundation for standards and policy. These principles (stated in Volume 1, *Foundations*) are expanded in Volume III, *Guidance*, of the Departmental IA series.

- DOE information products and services are user-centric and customer-driven.
- The DOE IA is based on modular components.
- IA is based on an open systems approach.
- Security is designed into all architectural elements, balancing accessibility and ease of use with protection of data.
- Information is not only a Departmental asset, but also a national asset for which DOE staff is the steward.

- DOE-wide access to information is the rule rather than the exception.
- The IA incorporates a robust interface that optimizes the nature, efficiency, and effectiveness of the human operator.
- DOE will have an IT infrastructure that links offices, programs, facilities, and field locations together seamlessly.

Several groups work closely with the Departmental IA team to implement the goals and principles of the IA program within the Department. These include the DOE IA Standards Program, the CIO Council, site CIOs, and other senior level approval bodies.

📖For additional information on the DOE IA Program: http://cio.doe.gov/iap

- DOE/HR-0141 Information Architecture, Volume I, The Foundations
- DOE/HR-0171 Information Architecture, Volume II, Baseline Analysis Summary
- DOE/HR-0178 Information Architecture, Volume III, Guidance
- DOE/HR-0190 Information Architecture, Volume IV, Vision
- Corporate Systems Information Architecture

3.2.2 Strategic Information Management (SIM) Process/Business Case

When a corporate project is initially proposed, the project scope is established in order to limit the project size to a manageable cost target and implementation time frame. The high-level objectives and initial high-level requirements are identified based on the scope of the project and documented as part of the initial project planning. The high-level scope, objectives and requirements are often identified or affirmed when developing the business case for a corporate system. The business case is generated as part of the SIM process.

Strategic Information Management (SIM) Process. The purpose of the DOE SIM process is to provide the conceptual framework and process that recommends the best solution to a business or mission need. The objectives of the DOE SIM process are to create a business case and high-level requirements for a corporate project for a new, or major enhancements to, a corporate system. It essentially is a DOE-wide feasibility study that typically occurs before Solution Development. The SIM process goals are to:

- effect efficiencies in operation
- eliminate redundant information systems
- improve processes and information flow
- provide information needed for management to make sound decisions
- align with the IT capital planning and investment process

The SIM process dovetails into the IS engineering lifecycle by identifying business or mission needs, high-level requirements, and project feasibility. Further, the SIM process includes process-reengineering initiatives that stimulate, analyze, and communicate customer needs and expectations to obtain a better understanding of what will satisfy the customer. Such initiatives may include or lead to process diagrams, and the definition of business and technical objectives or rules. Thus, the SIM process complements the IS engineering initiative.

Business Case. A business case is a structured proposal for business improvement that functions as a decision package for organizational decision-makers and planners. A business case includes an analysis of business process performance and associated needs or problems, proposed alternative solutions, assumptions, constraints, and a risk-adjusted cost-benefit analysis. It:

- defines required functionality and shows where the current system/processes are not meeting those needs
- provides the rationale for quantifying benefits and costs and shows expected cash flow over a project lifecycle for considered alternatives
- describes the process improvements needed to implement the technology or to improve the business function information flow
- states the financial, technical, cultural and political consequences of the alternatives considered
- recommends the alternative considered by the participants to be the best solution
- justifies capital investments for major IS and infrastructure components

The business case should be reviewed and updated regularly during Solution Development to determine if it is still valid and the cost and benefit objectives are being realized.

3.3 Non-Corporate Systems

IS engineering projects that are not identified as corporate systems still follow many of the same initiation processes as the corporate system. They may be the result of the same drivers or result from a business process reengineering initiative; however, the processes are applied by individual Programs or organizations within DOE and are less structured than the corporate processes. In some cases, the non-corporate project is initiated by a bottoms-up request, where a business/mission need is identified based on individual input. Coordination with and alignment to the IA strategic plan and vision are required of all projects.

3.3.1 Information Architecture and System Baselines

For projects not evolved through corporate processes, it is essential that system baselines be maintained and verified against organizational IAs. These architectures should be communicating with and aligned to the Departmental IA to ensure that the environment is evolved along with the current project. To secure approval for funding, a concept of operations or other document describing the system, the need, and its expected implementation may need to be provided to the capital planners, information architects, or management staff.

3.3.2 Analysis of Benefits and Costs (ABC) and Feasibility Study

Unlike the development of a business case and SIM process for a corporate system, an analysis of benefits and costs and feasibility study are conducted after initial project funding has been granted. It is an activity conducted in Solution Development, and its execution is dependent upon the project size and complexity.

Analysis of Benefits and Costs. An ABC is typically performed as part of the feasibility study. An ABC is used to identify and compare the benefits and costs associated with all of the hardware and/or software alternatives considered in the development of an IS solution. The results of the ABC should indicate the most cost-effective alternative.

During planning, the results of an ABC help to determine the feasibility of a project and the return on investment. For example, an ABC can be conducted to determine (1) if changing the users' current business processes or computing environment will improve efficiency or reduce overhead expenditures enough to justify the cost of the project, and (2) the expectation, in terms of time and money, for realizing return on the investment. An ABC can be a useful tool in any stage of the IS engineering lifecycle and should be reviewed and updated regularly to determine if it is still valid and the cost and benefit objectives are being realized.

🕮 For additional information on the ABC process:
Analysis of Benefits and Costs (ABC) Guideline: Volume 1, A Manager's Guide to Analysis of Benefits and Costs, and Volume 2, An Analyst's Handbook for Analysis of Benefits and Costs: http://cio.doe.gov/sqse/pm_abc.htm
Office of Management and Budget Guideline: Evaluating Information Technology Investments: http://www.whitehouse.gov/OMB/sitemap.html

Feasibility Study. When a project is faced with decisions or issues that require a more detailed investigation than is possible with a traditional feasibility analysis, a formal feasibility study should be performed to obtain the necessary information for making an informed decision about project feasibility. The following are examples of cases when a feasibility study should be performed:

- there is uncertainty or disagreement on the boundaries of the project
- there is uncertainty over the cost justification or technical feasibility of a project
- there is a lack of agreement about the goals or approach for building the product
- the proposed size or complexity of the product indicates a high degree of risk
- the product will implement functions that currently are not being performed either automatically or manually

Sometimes a feasibility study for a similar project has already been conducted. An existing feasibility study can be used if the information is current, relevant to the new project, and technically correct. The results of the feasibility study should be documented with a description of the process that was used to determine feasibility, the alternatives that were considered, and the results of the ABC.

🕮 For more information on performing a feasibility study:
http://cio.doe.gov/sqse/sem_main.htm

3.4 Capital Planning and Investment Control

The implementation of an effective, efficient, and repeatable capital planning and investment control (CPIC) process is required by the Clinger-Cohen Act, and is essential to ensure sound IT investment decisions. DOE uses a documented and established approach to identify, prioritize, justify, fund, and manage corporate IT investment opportunities. The process describes the selection, control, and evaluation of the Department's corporate and infrastructure-related IT initiatives. The process includes guidelines for Program-level IT CPIC processes, as well as current Program models.

The Department's approach is based on legislative requirements, direction provided by the Office of Management and Budget (OMB), recommendations of the General Accounting Office (GAO), Federal Chief Information Officer (CIO) Council, and best business practices. The DOE *Guide to IT Capital Planning and Investment*, describes how techniques for IT investment selection and management could be applied within the Department to ensure that individual IT investments, as well as programmatic IT CPIC processes perform as expected.

All projects, corporate and non-corporate, should participate in a CPIC process where they are funded, tracked, and analyzed to ensure sufficient resources are provided for successful completion.

🕮 For additional information on the DOE Capital Planning and Investment Control Process:
Capital Planning and IT Investments: http://cio.doe.gov/CapitalPlanning/
Information Management Planning: http://www-it.hr.doe.gov/implan/
FY 1999 DOE IM Operational/Action Plan: http://www-it.hr.doe.gov/implan/FY99imop.htm

3.5 Acquisition

After a project has been funded, a decision needs to be made as to who the solution provider will be; i.e., in-house or contracted out. If in-house, the acquisition of services may be the issuance of a Statement of Work and the receipt of a Management Plan for the accomplishment of the task. If the project is contracted out, then an acquisition strategy will need to be developed. As can be seen in Figure 3.1, the conduct of the acquisition strategy usually overlaps or is a part of Solution Development.

3.5.1 Project Planning Questionnaire

Completion of the DOE Project Planning Questionnaire is very useful to prospective IS solution providers and would be a valuable input to the acquisition strategy process. The purpose of the Project Planning Questionnaire is to enable project teams (immediate and extended) to be cognizant of the disparate planning activities, which can affect project outcome. In addition, it can be a very effective tool for providing (1) early notification to the stakeholders that a new project may involve their area, and (2) information to help plan resource estimates and identify risks. Topic areas covered in the questionnaire include general project information, infrastructure, processes, technical environment, and project management factors.

The Project Planning Questionnaire can be downloaded from:
http://cio.doe.gov/sqse/pm_plan.htm

3.5.2 Acquisition Strategy

Federal acquisition is governed and regulated by numerous laws, statutes, and Departmental regulations. Laws and regulations include Common Law, Administrative Law, the Federal

Acquisition Regulation (FAR), the DOE Acquisition Regulation (DEAR), and the DOE Assistance Regulation. Statutes include the Federal Property and Administrative Services Act, the Armed Services Procurement Act, the Small Business Act, the Office of Federal Procurement Policy Act, and the Federal Grant and Cooperative Agreement Act.

Additionally, there are a number of organizations that play critical roles in defining and accomplishing the Department's acquisition strategy objectives. These include the Congress, the General Accounting Office, the President, the Office of Federal Procurement Policy, and other regulatory agencies, such as the FAR Council. The FAR Council issues and maintains the FAR, which is implemented by the Department as the DEAR.

The Secretary of Energy has delegated acquisition and strategy authority to the Procurement Executive, who can delegate this authority to the heads of field activities. These officials can further delegate specific written acquisition and strategy authority to contracting officers. Contracting officers are responsible for ensuring that requirements of law and regulation are met, funds are available for obligation, contractors receive fair and equitable treatment, and both Federal and contractor parties comply with the terms of the contract. Contracting officers often request advice and counsel from specialists in other fields. These include contract specialists and other contracting officer representatives, program and project managers, attorneys, competition advocates, small business advocates, and auditors and accountants.

Contract Categories. There are several methods for obtaining products and services for meeting IS solution needs depending on the dollar threshold. Basically, contracts fall into two categories: large (over $100,000) or simplified procurement (under $100,000). The following charts and accompanying explanations summarize the acquisition strategies for these two categories. There may be other acquisition vehicles not listed; the procurement specialist can provide additional information on what is available.

Large Procurements (over $100,000)			
Strategy	**No. of Offerors**	**Length to Award**	**Type**
GWAC	As Qualified	Typically 60 days or less	Usually Fixed Price
GSA Schedule	Only need 3 offerors	Typically 45-60 days or less	Fixed Price
Invitation for Bid (IFB)	As Qualified	More than 60 days	Fixed Price
Request for Proposal (RFP)	As Qualified	More than 60 days	Cost or Time and Material

Government-wide Acquisition Contracts (GWAC) are awards made by another agency that other agencies can use. The GWAC is becoming a preferred acquisition strategy because it is a vehicle that provides a very economical and streamlined method for obtaining IS solution needs. General Services Administration (GSA) Schedules offer a variety of services. They also are becoming preferred because of their short time to award.

Invitations for Bid (IFB) and Requests for Proposals (RFP) involve sealed bids and award based on evaluation criteria. Length of time to award depends upon the size and complexity of the acquisition. IFBs are conducted without discussions for products and services. RFPs may require discussions, oral presentations, etc. Both can include various types of incentives.

Simplified Procurements (under $100,000)			
Category	**No. of Offerors**	**Length to Award**	**Type**
Micro-purchase (Under $2,500; $2,000 for construction)	No limitation	Generally less than 2 days	Fixed price
Purchase Cards (Under $25,000)	Three or more or valid justification	Generally less than 2 days	Fixed price
Simplified (Under $100,000)	Three or more or valid justification	Typically 30-45 days	Fixed price

Simplified procurements are set aside for small and disadvantaged businesses. Micro-purchases may be awarded without any competition, advertisement, or pricing support. Any purchase over $2,500 (or $2,000 for construction) needs to have a minimum of three offerors or a valid justification for a noncompetitive action. The length to award for simplified procurements is dependent upon the workload of the procurement office and other factors.

Contract Preparations. Preparations for the letting of an award are made based on the award method selected. The preparations for a large contractual agreement are more involved than a simplified procurement, however, regardless of their size and complexity, procurements follow a similar path.

Pre-solicitation (or Pre-award) Phase. In this phase the groundwork is laid for soliciting offers and awarding a contract. Activities include identifying the need for products and services, preparing a statement of work, determining and/or committing funds, preparing purchase requests, and researching the market. Tasks may include issuing program regulation, defining program objectives, identifying who is eligible to participate, developing evaluation criteria, and soliciting and evaluating applications.

Solicitation and Evaluation (or Award) Phase. In this phase, tasks include determining the extent of competition, determining the method of acquisition, drafting the solicitation and terms and conditions of the award, evaluating bids or proposals, discussing proposals with offerors, awarding the contract and responding to protests. For some awards, it may be necessary to provide notification to Congress.

Contract Administration (or Post-Award) Phase. In this phase, tasks include orienting the contractor, monitoring performance and compliance with the terms of the contract, inspecting and accepting contract deliverables, assessing problems, administrating payments to contractors, reviewing financial status and audit reports, modifying or terminating the contract, and closing the contract.

📖 For more information on acquisition:

- DOE-Wide Information Management Acquisition/Procurement Consolidation Program: http://cio.doe.gov/dimap/dimap.htm
- DOE Office of Procurement and Assistance Management: http://www.pr.doe.gov
- Federal Acquisition Jumpstation: http://nais.nasa.gov/fedproc/home.html
- GAO Guide for Assessing Acquisition Risk: http://www.gao.gov/policy/guidance.htm

- Office of Federal Procurement Policy: http://www.arnet.gov

3.5.3 Supplier Technical Effort

The term supplier refers to an organization that develops, manufactures, tests, supports, etc., a system or component of the system. Within DOE, suppliers generally take the form of vendors, contractors, or subcontractors. When the Department determines there is a need to obtain portions of the systems work product from a supplier (e.g., COTS to be integrated, additional bandwidth, new hardware, etc.), the supplier technical effort must be integrated into the activities of the overall project plan and acquisition strategy. Once a supplier(s) has been chosen, the business/mission needs, expectations and performance measures should be communicated to the supplier to ensure effective integration of the effort into the overall system being developed. For supplier technical efforts performed by subcontractors refer to the next section for additional requirements.

3.5.4 Subcontractor Management

The purpose of subcontractor management is to select qualified subcontractors and manage them effectively. A subcontractor is an individual, partnership, corporation or association that contracts with an organization (i.e., the prime contractor) to design and/or develop the system or one or more system components. The following guidance should not be construed as an interpretation of a DOE contract, but generally accepted industry practices for subcontractor management. These practices keep the doors of communication open and are conducive to the delivery of the expected product.

DOE Federal managers typically administer the prime contract with the expectation that the prime contractor will manage and coordinate the efforts of their subcontractor. When a project requires a subcontractor, the prime contractor project manager is responsible for ensuring that the subcontractors are held to the same standards and guidance as the prime contractor. The prime contractor and the subcontractor should agree and document their commitments and maintain ongoing communications throughout the project.

The contractual agreement between the prime contractor and the subcontractor is used as the basis for managing the subcontract. In some cases a subcontractor may already have a contract with DOE, and work for a specific project may not require a separate contractual agreement per se but some other documented agreement. Changes to the statement of work, subcontractor terms and conditions and other commitments are resolved according to any Departmental, site-specific, or contractor processes.

The work to be subcontracted should be defined and planned, and should follow any Departmental, site-specific, or contractor processes for documenting and planning the effort. This should be contained in the agreement. When selecting the subcontractor, the evaluation should be based on the subcontract bidders' ability to perform the work, according to the Departmental, site-specific, or contractor evaluation and selection processes.

Once awarded, a subcontractor should develop a project plan and work breakdown structure, which includes the methodology and processes to be used. In some cases, the responsibilities of the subcontractor may be included in the prime's project plan and work breakdown structure. If there is a separate project plan, the subcontractor's project plan and work breakdown structure should be reviewed and approved by the prime contractor and the DOE program manager. Once approved, the subcontractor’s project plan is used for tracking the activities and communicating status for that piece of work.

4.0 Systems Engineering Organizations and Standards

Before a project begins, the standards for the project, processes, and product should be clearly defined. Besides DOE directives, the project manager should be aware of the international, national, Federal, and DOE IT standards that affect the project. These standards are usually specified in statements of work and contracts. There are several sources for determining which standards are applicable to a project. The standards discussed in this section are the most common sources used by DOE Federal and contractor staffs. Contractors may have their own specific standards that are used on a project. These should be clearly defined before a project begins and the project manager should ensure they do not conflict with DOE directives.

4.1 DOE Standards

DOE Information Architecture (IA) Standards Program. The DOE IA Standards program has the responsibility to lead, manage, integrate, and coordinate efforts centrally to achieve and implement standards to support the DOE IA. Its purpose is to ensure the wise stewardship of IT resources by promoting a DOE-wide standards program that is participatory and consensus-based. The goal of the IA Standards program is to be flexible, forward thinking, and aligned with technology directions. The DOE IA Standards program applies to all DOE Elements, including contractors and laboratories.

The focus is to establish a framework and best practices that will enable the overall accomplishment of the DOE mission and to avoid any unnecessary structural impediments. The IA Standards program sponsors and maintains a Profile of Adopted Standards and an ongoing IA Standards Adoption and Retirement Process. The Profile consists of processes supported by representatives from the DOE community who are responsible for IA Standards activities. It is developed through consensus, with all of these representatives, thus ensuring that DOE elements have a voice in the process. The Profile is maintained in a repository on the DOE IA Standards Web site.

The project manager should consult the Profile to determine if the proposed project is compatible with the established DOE IA. Recommendations for changes to the Profile are submitted according to the IA Standards Adoption and Retirement Process. The IA Standards program manager can be contacted when and if new standards should be proposed for inclusion.

🕮 For additional information on DOE IA standards and to access the standards repository: http://cio.doe.gov/standards/index.html

DOE Technical Standards Program. The DOE Technical Standards program, which is managed by the Environment, Safety and Health organization (EH) at Headquarters, promotes the use of non-Government standards across the Department. EH also oversees the development of DOE technical standards, including information technology standards.

The project manager should consult the DOE Technical Standards to determine if the proposed project is compatible with the technical standards established by DOE. Recommendations for changes to the DOE Technical Standards Program can be submitted.

📖 For additional information on DOE Technical Standards and to access the Standards repository:
http://tis.eh.doe.gov/techstds/

4.2 DOE IS Engineering Organizations

The Departmentwide Systems Engineering Process Group (DSEPG), Software Quality Assurance Subcommittee (SQAS), and DOE International Council on Systems Engineering (INCOSE) Systems Engineering Practices Interest Group are DOE groups that promote the use of IS engineering standards and practices and the continual improvement of DOE projects based on improvements to DOE IS engineering processes.

4.2.1 Departmentwide Systems Engineering Process Group (DSEPG)

The mission of the DSEPG is to move the Department towards achieving higher levels of capability, maturity, and quality in IS solutions provided to the DOE customer. The DSEPG, which is sponsored by the Office of the Chief Information Officer, supports the development and maintenance of DOE IS and software management programs by providing flexible and adaptable industry standard project management, IS engineering, and quality assurance guidance, procedures and other support.

📖 For more information on the DSEPG: http://cio.doe.gov/sqse/dssepg.htm

4.2.2 Software Quality Assurance Subcommittee (SQAS)

SQAS is sponsored by the DOE Nuclear Weapons Complex (NWC) Quality Managers under the auspices of the Albuquerque Operations Office (now under the National Nuclear Security Administration (NNSA)). The objectives of SQAS are to:

- serve as a technical advisory group to the Quality Managers, DOE Albuquerque Operations Office, and other DOE offices, as appropriate
- promote an understanding and awareness of software quality and its assurance
- identify and share tools, techniques, and methodologies for improving software quality

📖 For more information on SQAS: http://cio.doe.gov/sqas

4.2.3 DOE International Council on Systems Engineering (INCOSE) Systems Engineering Practices Interest Group

The DOE INCOSE Systems Engineering Practices Interest Group is a Technical Committee of INCOSE. The DOE INCOSE mission is to foster the application of good systems engineering practices within the U.S. Department of Energy complex. Their focus is on the waste management and environmental restoration applications.

📖 For general information on INCOSE: http://www.incose.org

4.3 Industry Organizations and Standards

DOE IS engineering practices are based on recommendations from industry organizations and standards for IS engineering, project management, and quality assurance. Organizations include the Software Engineering Institute (SEI), INCOSE, Electronic Industries Alliance (EIA), International Electronics and Electrical Engineering (IEEE), and the International Organization for Standardization (ISO).

4.3.1 Software Engineering Institute (SEI)

The SEI is a Federally funded research and development center established in 1984 by the U.S. Congress, and placed under the management of the Department of Defense. The SEI has a broad charter to address the transition of software engineering technology and to advance the practice of software engineering because quality software that is produced on schedule and within budget is a critical component of U.S. defense systems.

SEI is an integral component of the Carnegie-Mellon University. SEI has developed and published maturity models, technical reports, special reports, and handbooks. They do not issue standards but their products may be adopted by industry standards organizations. The SEI has developed Capability Maturity Models (CMMs) for software, people, software acquisition, systems engineering, and integrated product development. The intent of the CMMs is to assist organizations in maturing their people, processes, and technology assets to long-term business performance.

📖 For more information on SEI: http://www.sei.cmu.edu

4.3.2 International Council on Systems Engineering (INCOSE)

INCOSE is an international organization formed to develop, nurture and enhance the systems engineering approach to multi-disciplinary system product development. The INCOSE mission states that INCOSE shall foster the definition, understanding, and practice of world class systems engineering in industry, academia, and government. They do not issue standards but their products may be adopted by industry standards organizations.

There are several committees sponsored by INCOSE. In particular, the INCOSE Standards Technical Committee (STC) promotes the involvement in and influence on national, international, and other standards, handbooks, and guides. The STC encourages, guides, and assesses INCOSE's participation in standards activities, coordinates INCOSE's review of standards, and disseminates information on standards and standardization activities.

📖 For more information on INCOSE: http://www.incose.org

4.3.3 System Safety Society

The System Safety Society is a professional organization dedicated to the promotion of the System Safety concepts at the local, national and international level.

The objectives and activities of the System Safety Society are:
- To advance the state-of-the-art of System Safety
- To contribute to a meaningful understanding of System Safety
- To disseminate newly developed knowledge to all interested groups and individuals
- To further the development of the professionals engaged in System Safety
- To improve the public understanding of the system safety discipline
- To improve the communication of the System Safety movement and discipline to all levels of management, engineering, and other professional groups

🕮 For more information on the System Safety Society: http://www.system-safety.org

4.3.4 Electronic Industries Alliance (EIA)

The Electronic Industries Alliance (EIA) is a federation of associations and sectors that focuses on the electronics industry. Comprised of over 2,100 members, EIA has representatives from about 80% of the U.S. electronics industry. EIA member and sector associations represent telecommunications, consumer electronics, components, government electronics, semiconductor standards, as well as other vital areas of the U.S. electronics industry.

EIA is committed to promoting business opportunities for its industries. It provides a forum for industry to develop standards and publications in the major technical areas of electronic components, consumer electronics, electronic information, and telecommunications.

🕮 For more information on EIA and EIA standards: http://www.eia.org/

4.3.5 Institute of Electronics and Electrical Engineers (IEEE)

IEEE is a non-profit technical professional association of more than 330,000 individual members in 150 countries. Through its members, the IEEE is a leading authority in technical areas ranging from computer engineering, biomedical technology and telecommunications to electric power, aerospace and consumer electronics, among others.

Through its technical publishing, conferences and consensus-based standards activities, the IEEE produces 30 percent of the world's published literature in electrical engineering, computers and control technology. It holds annually more than 300 major conferences and has more than 800 active standards with 700 under development.

🕮 For more information on IEEE and IEEE standards: http://www.ieee.org

4.3.6 International Organization for Standardization (ISO)

The International Organization for Standardization (ISO) is a worldwide federation of national standards bodies from about 130 countries. ISO is a non-governmental organization established in 1947. The mission of ISO is to promote the global development of standardization and related activities with a view to facilitating the international exchange of goods and services, and to developing cooperation in the spheres of intellectual, scientific, technological and economic activity. ISO's work results in international agreements, which are generated and published as International Standards by the International Electrotechnical Commission (IEC). The ISO 9000 series of standards provides a framework for quality management and quality assurance, as well as other related ISO standards.

🕮 For more information on ISO and ISO standards: http://www.iso.ch/
🕮 For more information on IEC and IEC standards: http://www.iec.ch

4.3.7 Other Organizations and Standards

There are several other well-recognized organizations that create or endorse best practices and standards for quality assurance and project management. The American Society for Quality (ASQ), the Quality Assurance Institute (QAI), and the Project Management Institute (PMI) are a few of these organizations.

🕮 For more information on ASQ: http://www.asq.org/
🕮 For more information on QAI: http://www.qaiusa.com/
🕮 For more information on PMI: http://www.pmi.org/

5.0 Quality Management

Quality management is a significant aspect of IS engineering. It provides the measurements and assurance that the project is managed according to best practices and applicable standards and that the resulting product meets expectations. It also provides insight into areas for improvement.

With today's highly evolutionary nature of IS engineering technology, a high level of product quality and a well-managed project is not only desired by management, it is expected by the customer and user of the product or system. Objectives normally associated with quality management include improving the process of IS engineering , lowering the cost of producing and maintaining software and systems, reducing cycle time, and improving customer satisfaction. Quality management activities should be planned for and performed in a number of areas, throughout the entire project and product lifecycle.

A quality assurance (QA) plan that details the where, when, why, who, and how quality will be addressed, should be developed and approved. The QA plan may include both process and product assurance activities.

5.1 Process and Product Assurance

Process assurance is an integral part of a quality management program aimed at improving the quality of the products being developed and maintained. Process assurance includes the activities carried out while developing a product to ensure that the processes, methods, and techniques used are integrated, consistent, and correctly applied.

Product assurance focuses on the methods used to assure that deliverables, including documentation, meet customer requirements, standards, and good systems engineering practices. Product assurance includes the set of activities carried out to develop a product and ensure its quality and completeness. A set of quality standards should be developed and integrated into the product assurance process.

5.1.1 Testing

The overall goal of testing is to produce a product of high quality that is free of defects. Testing is generally conducted with four basic objectives in mind: to detect errors, to remove errors, to track errors, and to regression test to see if the fix actually removed the error and did not cause any new errors. Testing is generally categorized as unit testing, integration testing, system testing, and acceptance testing. A test plan that details the where, when, why, who, and how about the test effort should be developed and approved.

5.1.2 Verification and Validation

Verification and validation (V&V) activities indicate how well the product meets its stated requirements and performance criteria. V&V also helps in ascertaining the reliability of the product, and is intended to be one step in ensuring the quality of the product. According to the IEEE Standard Glossary of Software Engineering Terminology, verification and validation (V&V) is the process of determining whether the requirements for a system or component are complete and correct, the products of each development phase fulfill the requirements or conditions imposed by the previous phase, and the final system or component complies with specified requirements. A V&V plan that details the where, when, why, who, and how about the V&V effort should be developed and approved.

Verification activities are process-oriented. They include inspections, peer reviews, walkthroughs, audits, and sign-offs. They are conducted throughout the project lifecycle to ensure that at every stage the product is being built according to the standards and processes in place. According to the IEEE Standard Glossary of Software Engineering Terminology, verification is the process of evaluating a system or component to determine whether the products of a given development phase satisfy the conditions imposed at the start of that phase.

Validation activities are oriented towards ensuring that the product has been built according to the documented requirements specifications. They are generally associated with testing. According to the IEEE Standard Glossary of Software Engineering Terminology, validation is the process of evaluating a system or component during or at the end of the development process to determine whether it satisfies specified requirements.

5.2 Metrics and Analysis

Metrics can help organizations better manage projects, deliver mission-aligned products, and improve overall mission or business performance. In addition, measurements can help identify product quality and reliability, and can help determine if the product will meet user expectations. Some (basic) measures that are commonly tracked for systems engineering projects and software products in development include:

- number of defects (failures, unmet expectations, bad documentation)
- level of effort (person hours, planned vs. actual)
- cost (planned vs. actual; earned value)
- schedule (planned vs. actual start and completion dates)
- number of requirements changes (variances from baseline)
- product size (lines of code (LOC), function points)

As indicators of product quality and project status, metrics should be collected throughout the project and product lifecycle.

Additionally, metrics for enhancements and maintenance are provided in the DOE SEM.
📖 For more information on metrics: http://cio.doe.gov/sqse/pm_metric.htm

5.3 Assessments and Improvements

Assessments and process improvement need to be considered an integral part of an organization's plan for improving project and product quality. An organizational culture, which is open and receptive to the need for change will facilitate process improvement. Open communications at all levels detailing the need for improvement, the strategy, and how everyone will be involved and affected will go a long way to ease fear of change. Basic steps involved in process improvement include:

Planning. This includes selecting areas for improvement, developing goals and charters, obtaining a sponsor, selecting team members, and defining roles and responsibilities.

Assess the current process. Includes developing process flow diagrams, and conducting assessments.

Analyze findings. Collect assessment data and baseline (today's) process flows. Identify improvement areas.

Define an ideal process. Develop and document in detail the best possible process that can be conceived. Describe all inputs and outputs, data flows, and who would be involved.

Implement the new process. Develop a plan, which details all of the required implementation activities. Execute the plan.

Measure progress. Develop a measurement plan, which includes some basic metrics, recipients of the data, and the frequency of collection.

Assessments and process improvement activities should be planned in the schedule of a project. Also if applicable, Inspector General (IG), Office of Management and Budget (OMB), and General Accounting Office (GAO) audits and inspections should be included in project and maintenance plans to reduce impact on project schedules.

Appendix A – IS Engineering Resources

Federal

1 Federal Acquisition Jumpstation, http://nais.nasa.gov/fedproc/home.html

2 GAO Guide for Assessing Acquisition Risk, http://www.gao.gov/policy/guidance.htm

3 Office of Management and Budget Circular A-11, provides detailed instructions and guidance on the preparation and submission of agency budget requests and related material for the 1998 budget. Part 2 of the Circular provides specific instructions on the preparation and submission of agency strategic plans required by the Government Performance and Results Act of 1993.

4 Office of Management and Budget, Circular, A-130, Management of Federal Information Resources, provides uniform government-wide information resources management policies as required by the Paperwork Reduction Act of 1980, as amended by the Paperwork Reduction Act of 1995, 44 U.S.C. Chapter 35.

5 Office of Management and Budget Guideline: Evaluating Information Technology Investments

6 Public Law 104-106, Information Technology Management Reform Act (ITMRA) of 1995, authorizes military activities appropriations for fiscal year 1996 and effective August 8, 1996, rescinds the Federal Information Resources Management Regulations (FIRMR) and establishes the Chief Information Officer (CIO) functions.

7 Public Law 103-62, Government Performance and Results Act of 1993, requires agencies develop strategic plans and performance measures. It starts with a series of pilot programs and allows waivers of regulations for some of the pilots.

Department of Energy

1 Analysis of Benefits and Costs (ABC) Guideline: Volume 1, A Manager's Guide to Analysis of Benefits and Costs, and Volume 2, an Analyst's Handbook for Analysis of Benefits and Costs, http://cio.doe.gov/sqse/pm_abc.htm

2 DOE Capital Planning Process, http://cio.doe.gov/capitalplanning/

3 DOE Directives, http://www.directives.doe.gov/

4 DOE HQ Computer Security Program, http://cio.doe.gov/compsec

5 DOE Information Architecture, http//cio.doe.gov/iap

6 DOE IT Standards Program, http://cio.doe.gov/standards/

7 DOE Office of Procurement and Assistance Management, http://www.pr.doe.gov

8 DOE Order 200.1, Information Management

9 DOE Software Engineering Methodology (SEM), Version 2, March 1999, http://cio.doe.gov/sqse/sem_main.htm

10 DOE Software Quality and Systems Engineering programs, http://cio.doe.gov/sqse

11 DOE Standards, http://tis.eh.doe.gov/techstds/

12 DOE Strategic Information Management (SIM) program, http://cio.doe.gov/sim

13 DOE/HR-0175 Information Architecture, Profile of Adopted Standards

14 DOE/HR-0141 Information Architecture, Volume I, The foundations

15 DOE/HR-0171 Information Architecture, Volume II, Baseline Analysis Summary

16 DOE/HR-0178 Information Architecture, Volume III, Guidance

17 DOE/HR-0190 Information Architecture, Volume IV, Vision

18 DOE-wide Information Management Acquisition/Procurement Consolidation Program, http://cio.doe.gov/dimap/dimap.htm

19 DOE-wide Software Engineering Process Group (DSEPG), http://cio.doe.gov/sqse/dssepg.htm

20 DOE-wide Unclassified Computer Security Program, http://cio.doe.gov/ucsp/

21 FY1999 DOE IM Operational/Action Plan, http://www-it.hr.doe.gov/implan/fy99imop.htm

22 Information Management Planning, http://www-it.hr.doe.gov/implan/

23 Information Management Strategic Plan, http://www-it.hr.doe.gov/implan/reference/stratpln.htm

24 Office of Procurement Policy, http://www.arnet.gov

25 Project Planning Questionnaire, http://cio.doe.gov/sqse/pm_plan.htm

26 Software Quality Assurance Sub-Committee (SQAS), http://cio.doe.gov/sqas

Industry

1 American Society for Quality, http://www.asq.org/

2 Controlling Software Projects, Tom DeMarco, Yourdon Press, 1992

3 Cultivating Successful Software Development, Donaldson & Siegel, Prentice Hall, 1997

4 Electronic Industries Association, http://www.eia.org

5 Inroads to Software Quality, Jarvis & Crandall, Prentice Hall, 1997

6 Institute of Electrical and Electronics Engineers, Inc., http://www.ieee.org

7 International Council for Systems Engineering, http://www.incose.org

8 International Organization for Standardization, http://www.iso.ch

9 Managing the System Life Cycle, Edward Yourdon, Prentice Hall, 1988

10 Martin, James N, Systems Engineering Guidebook, A process for Developing Systems and Products, CRC Press, New York, 1996

11 Quality Assurance Institute, http://www.qaiusa.com

12 Software Engineering Institute, http://www.sei.cmu.edu

13 Software Safety Handbook, http://www.nswc.navy.mil/safety/ssshdbk.pdf

14 Systems Safety Society, http://www.system-safety.org

15 The New Project Management, Davidson Frame, Jossy Bass, 1994

16 The Project Management Institute, http://www.pmi.org

Appendix B – Glossary and Acronyms

Glossary

Business Area. As stated in the DOE Strategic Plan, the four core business areas are Energy Resources, National Security, Environmental Quality, and Science.

Information Systems. A combination of information, computer, and telecommunications resources and other information technology and personnel resources that collects, records, processes, stores, communicates, retrieves, and displays information; DOD Directive #7920.1, Life Cycle Management of Automated Information Systems, June 1988.

Information Systems Engineering. A subset of systems engineering. IS engineering is limited to the development of IS products and their environment.

Information Systems Solutions. A solution to a need either through new or enhanced information system or infrastructure component. May include COTS, glue-code, customization of business rules, etc., to implement a business solution.

Information Technology. Any equipment or interconnected system or subsystem of equipment, that is used in the automatic acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information. *Clinger-Cohen Act*, 104th Congress, 1996.

Solution Providers. Solution providers are Federal or contractor staff responsible for delivering or maintaining an Information Systems Solution.

Systems Engineering (SE). The discipline of developing systems products or processes based on a total systems perspective and utilizing a system engineering approach. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and systems validation while considering the complete problem: operations, performance, test, manufacturing, cost and schedule, training and support, and disposal. Systems Engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Systems Engineering considers both the business and technical needs of all customers with the goal of providing a quality product that meets the user needs; INCOSE, "What is Systems Engineering?" - 1996.

Acronyms

***ABC* –** Analysis of Benefits and Costs

***ASQ* –** American Society for Quality

***CIO* –** Chief Information Officer

***CMIP* –** Corporate Management Information Program

***CMM* –** Capability Maturity Model

***COTS* –** Commercial-Off-The-Shelf

***CPIC* –** Capital Planning and Investment Control

***CSIA* –** Corporate Systems Information Architecture

***DEAR* -** DOE Acquisition Regulation

***DIAP* –** Departmental Information Architecture Project

***DISE* –** Departmental Information Systems Engineering

***DOE* –** Department of Energy

***DSEPG* –** Departmentwide Systems Engineering Process Group

***ECIM* –** Executive Committee for Information Management

***EH* –** Environment, Safety and Health organization

***EIA* –** Electronic Industries Alliance

***FAR* –** Federal Acquisition Regulation

***FIRMR* –** Federal Information Resources Management Regulations

***GAO* –** General Accounting Office

***GSA* –** General Services Administration

***GWAC* –** Government-wide Acquisition Contracts

***IA* –** Information Architecture

IEC **–** International Electrotechnical Commission

IEEE **–** Institute of Electronics and Electrical Engineers

IFB **–** Invitations for Bid

IG **–** Inspector General

IM **–** Information Management

INCOSE **–** International Council on Systems Engineering

IS **–** Information Systems

ISEM **–** Information Systems Engineering Manager

ISO **–** International Organization for Standardization

ISR **–** Information Systems Reviews

IT **–** Information Technology

ITMRA **–** Information Technology Management Reform Act

LOC **–** Lines of Code

M&O **–** Management and Operating

NNSA – National Nuclear Security Administration

NWC **–** DOE Nuclear Weapons Complex

OCIO **–** Office of the Chief Information Officer

OMB **–** Office of Management and Budget

PIR **–** Post Implementation Review

PMI **–** Project Management Institute

QA **–** Quality Assurance

QAI **–** Quality Assurance Institute

RFP **–** Requests for Proposals

***SEI* –** Software Engineering Institute

***SEM* –** Systems Engineering Methodology

***SIM* –** Strategic Information Management

***SQA* –** Software Quality Assurance

***SQAS* –** Software Quality Assurance Subcommittee of the Nuclear Weapons Complex

***US* –** United States

***V&V* –** Verification and Validation