RADIOACTIVE WASTE MANAGEMENT: IT'S NOT ALL SCIENCE AND ENGINEERING

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Abstract

Science and engineering provide the necessary answer to the ultimate question in radioactive waste management and disposal: How safe is the management approach and the repository system? The credibility of that answer is founded on underlying processes and systems that demonstrate the reliability of the information used to answer this singularly important question. This technobureaucratic culture is often assumed to be effortless and is taken for granted, and assumptions like this can lead to unacceptable results.

These non-technical processes fall into two broad but related categories; regulatory compliance and information/knowledge management. In addition to specific technical regulatory requirements, in the United States (U.S.), the U.S. Nuclear Regulatory Commission (NRC) requires compliance with several abstract concepts that it views as essential to demonstrating that an organization has the requisite wherewithal to be a licensee, such as Nuclear Safety Culture, Safety Conscious Work Environment, and Quality Assurance. These concepts greatly influence all the technobureaucratic processes and systems that support the science and engineering work.

This paper presents a generic framework for an organization and the functions of the organizational elements necessary to execute a generic radioactive waste repository development effort. These organizational elements reflect a workforce's functional composition and the practices that facilitate meeting all of the NRC's expectations.

Successful implementation of a plan to develop a repository requires an effective organization and infrastructure designed to execute the effort in compliance with regulatory expectations. The discussions in this paper are based on the current U.S. statutory and regulatory framework. Notably, the context in which the organization's work will be conducted differs substantially from that of the typical research, development, and demonstration (RD&D) environment. First, there are work elements that are not customarily included in RD&D work, such as regulatory compliance, a corrective action program, technical configuration controls, and requirements/commitment management. Secondly, the rigor with which organizational assurance and quality assurance functions need to be applied and practiced is greater than necessary in the typical RD&D environment.

One all-too-frequently overlooked component of a compliance-oriented endeavor is the importance of having an outcome-aware management and business organization, technical support, and information management technologies. Successfully accomplishing such an endeavor requires more than world-class science and engineering. It is equally important that the technical team be supported by an experienced and proficient non-technical infrastructure.

1. INTRODUCTION

This paper identifies and summarizes descriptions of the principal elements of an organizational framework for a generic Nuclear Waste Management organization and is independent of type of geologic media, or the location of the disposal facility. It summarizes the roles and responsibilities (functions) for individual organizational elements, described in more substantive detail in a previous report [1].

In the United States, successful implementation of a repository development effort will require an effective organization and infrastructure designed to execute work in compliance with U.S. Department of Energy (DOE) and regulatory expectations. The Nuclear Waste Policy Act (NWPA) supports the use of deep geologic repositories for the safe storage and/or disposal of radioactive waste. [22] The Act provides a timetable of key milestones the federal agencies must meet in carrying out such a program, and stipulates the roles and responsibilities of the DOE, the U.S. Environmental Protection Agency (EPA) and the U.S. Nuclear Regulatory Commission (NRC) in the U.S. national program for the management and disposal of Spent Nuclear Fuel and High-Leve Radioactive Waste (HLW). The effort will be conducted under applicable DOE Orders, standards, and regulations promulgated by the EPA and the NRC. It is assumed that the repository will be licensed by the NRC with the DOE as the applicant (licensee). Work will be conducted in compliance with applicable NRC quality assurance requirements.

Activities and roles described for organizational elements throughout this paper will be essential components of the waste management organizational effort. Additional activities may also be required, and the list of organizational elements and functions presented here should be viewed as a comprehensive, but not necessarily complete set, of the full suite of organizational elements and associated activities.

The scope of responsibility for the organization described in this paper is to site, characterize, design, license, construct and operate a repository for the disposal of high-level waste (HLW) and spent nuclear fuel (SNF). This scope is extensive and will take decades to accomplish. Recognizing that substantial changes will occur over such a long timeframe, this paper focuses on identifying the roles and responsibilities of organizational elements that are needed to stand up the organization (start-up phase) and to initiate the work (initiation phase).

The elements that are the focus of this paper are the Management and Operations elements and do not include scientific and engineering organizational elements. Based on previous experience, the nature of these management, administrative, business, and technical support functions are well enough understood to define with some detail and will need to be firmly established as early as possible in the effort to support other activities.

The organizational elements identified herein reflect a workforce composition and level of practice that facilitates meeting NRC's expectations. It is assumed that the work will be conducted in compliance with NRC quality assurance requirements. A high-quality, regulation-aware, and technically savvy science and engineering team is of course essential; however, it is equally important that the technical team be supported by an experienced, proficient, non-technical infrastructure. Ultimately, this team of professionals provides management with the means to extend policy across the organization, as well as providing the context in which operational decisions are implemented. Technical support, business, and quality processes need to be requirements- and assurance-based, as well as quality assurance-informed.

2. MANAGEMENT

Management provides the vision, the management approach, enterprise policies and identifies procedures for the assembly and overall operation of the organization. The entire organization's activities need to be conducted in accordance with Nuclear Safety Culture (NSC) principles reflected in a Safety Conscious Work Environment (SCWE) and an effective Quality Assurance (QA) program that is consistent with the license applicant's expectations, and those of the regulator.

Because of the regulatory compliance orientation of the organization's work products, the organization's approach will be based on centralization of function and responsibility. The organization's focus will be on conscientious planning, work execution monitoring, work performance evaluation and documentation of results in each of the functional areas listed below. The fulfilment of the organization's mission will require interactions and integration with the license applicant's management and operating contractors, R&D organizations performing the science and engineering work, other waste management organizations and various external review and advisory groups, as well as, state, local and tribal governments and the general public. An integrated management system should provide a single framework for the arrangements and processes necessary to address all the goals of the organization. These goals include safety, health, environmental, security, quality and economic elements and other considerations such as social responsibility [2].

Management activities that will require particular attention in the first year or two of the effort are:

- Completion of a detailed plan, including full description of the strategy (institutional, technical, regulatory) and of the organizational structure;
- Initial staffing of an enterprise management team, and staffing for the initial phase of project execution
- Initial development of the consent-based siting process, and full-scale implementation of the consent-based siting process;
- Development of an enterprise risk management plan;
- Complete development of support functions, including implementation of a QA program;
- Waste inventory evaluation, and finalization of a planned inventory including consideration of options for phased disposal;
- Initiation of generic repository design concepts for multiple geologic media, consistent with phased disposal of the waste inventory;
- Development of a NEPA strategy;
- Initial interactions with the EPA and NRC, including development of a regulatory strategy;
- Performance of a rigorous readiness review mid-to-late in the initiation phase;
- International collaborations.

Development of a repository is an earnest undertaking. NRC takes the licensee management's role very seriously, as underscored by these examples:

— The provisions of 10 CFR Part 21 (Title 10 Code of Federal Regulations Part 21) apply to facilities like the repository proposed for this effort licensed under 10 CFR Part 60. 10 CFR Part 21 concerns reporting of defects, in basic components that could create a substantial safety hazard, and which requires immediate notification the Commission upon the identification of such defects. In this context, basic component means a structure, system, or component, or part thereof, that affects their safety function, that is directly procured by the licensee of a facility or activity subject to the NRC regulations and in which a defect or failure to comply with any applicable regulation or license issued by the NRC could create a substantial safety hazard (10 CFR 21.3(3)). The rule requires identification of a 'Responsible officer,' which means the president, vice-president, or other individual in the organization of a corporation, partnership, or other entity who is vested with executive authority over activities subject to 10 CFR Part 21. Failure to comply can result in criminal penalties imposed on the officer;

— NRC requires information provided to the Commission to be "complete and accurate in all material respects" [3]. The Commission takes this prescription very seriously. Recognizing the importance of this specific kind of constraint is what emphasizes the importance of organizational assurance. Once a compliance document is issued, its contents effectively become commitments, which translate into enterprise requirements.

2.1. Legal Counsel

Legal Counsel provides support to the Senior Manager on the wide variety of legal issues that will inevitably arise. Counsel also provides a direct interface for the effort with the waste management organization's Office of General Counsel, which is essential to support the organization's and the Agency's regulatory roles with respect to the National Environmental Policy Act (NEPA) and repository licensing.

2.2. Quality Assurance

The Quality Assurance Manager (QAM) defines the enterprise level requirements necessary to formulate a high quality and streamlined Quality Assurance program to satisfy the American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance-1 (NQA-1) 2015 Quality Assurance Requirements for Nuclear Facilities Applications, expected to satisfy NRC licensing rules.

In the context of this discussion, it is assumed that DOE adopts the definition of quality assurance (QA) at 10 CFR Part 60.150 [3]: "As used in this part, quality assurance comprises all those planned and systematic actions necessary to provide adequate confidence that the geologic repository and its subsystems or components will perform satisfactorily in service. Quality assurance includes quality control, which comprises those quality assurance actions related to the physical characteristics of a material, structure, component, or system which provide a means to control the quality of the material, structure, component, or system to predetermined requirements."

A QA program must be developed and implemented so that it is consistent with this definition and will meet applicable requirements of the NRC (e.g., 10 CFR Part 60, Subpart G [3]) and applicable DOE Orders (e.g., DOE O 414.1d) [4]. Where NRC and DOE requirements duplicate or conflict, NRC requirements shall take precedence. The QA program will apply to structures, systems and components important to safety, to design and characterization of barriers important to waste isolation, and to related activities, and it will be implemented throughout site characterization, repository design, licensing, construction, and operations. Requirements of the QA program will apply to DOE and DOE contractors, as appropriate. The need for a transparent, pervasive, and effective QA program cannot be understated.

The QAM serves as the focal point for the organization's QA activities, providing coordination with the DOE to ensure quality-affecting activities are conducted according to DOE policies, guidance and objectives, and in compliance with standards and regulations. The QAM is responsible for identifying overall QA requirements and confirming the satisfactory operation of the QA program through audits and surveillances; however, the workforce itself is responsible for the design and implementation of QA processes to enable implementation of the QA program.

To achieve enterprise-wide quality objectives, it is important that non-quality-affecting activities (e.g., business processes) facilitate and are integrated with QA's interests. The converse of this is also true.

2.3. Regulatory/Licensing

This element is responsible for the activities necessary to manage the regulatory support activities conducted by the organization, regardless of the regulator's identity (e.g., NRC, EPA, or state entities). Regulatory activities will include interactions with DOE to formulate direction, mitigate complex issues involving internal and external organizations, present work-related material in upper management forums, approve technical and non-technical products and documents, and allocate resources to the performance of regularly scheduled work and rapid response tasks associated with regulatory matters. The strategic response development for regulatory issues as well as the planning for and preparation of witnesses during the licensing hearing is managed from this element. Working with Management, this element ensures consistency and coordination among other organizational elements for producing regulatory materials and during regulatory proceedings.

The regulatory/licensing element will be responsible for meeting requirements in two broad regulatory regimes: NEPA, and NRC licensing. NEPA will require attention first with NRC licensing following during site characterization. These regimes are inter-related, as an EIS must be submitted with a license application to NRC.

2.4. NEPA Compliance

This element is responsible for the activities necessary to manage the Record of Decision (ROD) compliance with NEPA. DOE is subject to the Council on Environmental Quality regulations that implement NEPA and to its own implementing regulations (10 CFR Part 1021) [5].

2.5. Licensing Strategy

The effort is expected to be subject to NRC licensing under 10 CFR Part 60. The regulatory organizational element will be actively engaged in tracking and understanding NRC's anticipated rulemaking process to align 10 CFR Part 60 with the risk-informed, performance-based approach in 10 CFR Part 63, which will also involve EPA, to ensure the organization's ability to comply. In issuing 10 CFR Part 63, NRC acknowledged that its new more risk-informed, performance-based approach provides a better regulatory framework for geologic disposal of HLW and SNF than the earlier approach in 10 CFR Part 60. NRC stated that the "generic Part 60 requirements will need updating if applied to sites other than Yucca Mountain" (66 FR 55732) [6]. The NRC has not yet begun rulemaking to produce this update [7]. The licensing strategy element will formulate licensing and compliance strategies based on the outcome of this rulemaking, developing strategic responses for regulatory issues, and planning and preparing for license application development and submittal and license defense activities.

2.6. Regulatory Integration and Interactions

This element will be responsible for the two typical functions in the regulatory area: regulatory integration; and regulatory interactions. While the functions apply to both the NEPA and NRC organizations, interactions are most prominent in the latter. Regulatory integration entails coordination of regulatory activities among the enterprise's various organizational elements (e.g., systems engineering, transportation and storage) and with the DOE's regulatory affairs. Both Management and DOE will receive technical and integration recommendations regarding regulatory matters from this source. Regulatory interactions provide the interface with and support for DOE regulatory affairs, in interactions with regulators and responses to regulatory requests. The regulatory interactions lead is also responsible for supporting DOE regulatory affairs, meetings with the NRC, the regulator's onsite representative, and the associated inspection program as it relates to the organization's scope of work. Regulatory interactions are most likely to begin during the Site Characterization phase.

2.7. Regulatory Document Configuration Management

This element addresses development and implementation of the organization's regulatory document configuration management process. Its purpose is to facilitate and maintain rigorous configuration management for formal regulatory document submittals. This is a special case of document development and control. Official documents produced by the organization should be managed and produced through the document development element. For regulatory documents (e.g., EISs, license applications, etc.), meticulous attention must be paid to their composition and configuration. Such documents generally represent precise documentation of the satisfaction of requirements and often contain the explanation of significant numbers of commitments.

3. OPERATIONS MANAGEMENT

Operations Management is the organizational element responsible for the direction, coordination, and oversight of the Business Management, Organizational Assurance, Information Management, and IT Systems elements. Reporting directly to the Program Manager, Operations Management is responsible for the day-to-day functionality of the principal support organizations.

3.1. Business Management

Business Management includes the activities that enable a workforce to accomplish its objectives using established work processes and business management systems. The work force, project management, and financial controls are supplied using prescribed business management processes. It is most likely that the business management practices and systems for the enterprise will be the license applicant's or their contractor's and therefore well established.

Nonetheless, certain aspects of enterprise requirements will influence customary practices. For example, addition of Employee Concerns Program (ECP) elements to customary Human Resources (HR) processes can be complicated. Also, training program requirements and documentation, as well as, procurement processes will need to conform to the QA program, which may result in the development of separate processes or system interfaces with existing parent organization programs. Elements of Business Management include:

- Staffing;
- Financials/Funding;
- Procurement;
- Project Controls;
- Facilities and Safeguards and Security;
- Environmental Safety and Health;
- Employee Concerns Program;
- Differing Professional Opinions;
- Training.

The following elements deserve more elaboration.

3.1.1. Employee Concerns Program (ECP)

The ECP is tied closely to the SCWE program and the broader concept of an NSC, because it provides the means by which Members of the Workforce (MOWs) can express a concern without fear of retaliation. A well implemented SCWE, ECP, and a persistent NSC are essential for NRC's acceptance of the licensee's activities. The ECP will also need to conform to DOE's directive on employee concerns programs in DOE Order 442.1A, Employee Concerns Program [8]. Information maintained by the ECP also requires rigorous protection as it will contain particularly sensitive information related to individuals and their perceptions, perhaps about other individuals. Confidentiality breaches would endanger the strict compact between the individual and the ECP, potentially endangering the program's effectiveness.

3.1.2. Differing Professional Opinions (DPOs)

Similar to the ECP, the process for addressing Differing Professional Opinions (DPOs) should be handled with a high degree of confidentiality. It should be consistent with DOE Order 442.2, Differing Professional Opinions for Technical Issues Involving Environmental, Safety, and Health Technical Concerns [8], and to the extent practicable, with observations and guidance in NUREG-1763 [9] and the NRC's 2014 Differing Professional Opinions Program Assessment [10].

3.1.3. Training

The training function is integrally tied to the enterprise's operations and Quality Assurance (NQA-1 Requirement 2, Quality Assurance Program; Section 200 Indoctrination and Training) [11]. MOWs must be trained to perform certain functions as a high-quality, regulation-aware business and technical team. Such training applies to both the technical organization that will be performing 'quality affecting' work as well as the support organizational elements. The latter's understanding and awareness of QA requirements can be critical to their ability to provide effective support to the technical organization. Some elements of the support

organization will need extensive QA training and detailed familiarity with the QA program to perform their roles.

Providing or arranging for the necessary training from either internal or external sources, and maintaining the related records is key to demonstrating that MOWs are qualified to perform specific work. Some of the information gathered and used by this function may be considered PII. Scrupulous maintenance of training records is crucial to satisfying QA requirements as well as providing a positive influence on NRC's perspective of the licensee's activities. Existing processes for training practices may be influenced by enterprise-specific requirements such that separate systems may be necessary for enterprise-related training.

3.2. Organizational Assurance

Organizational Assurance includes the activities necessary to oversee the organization's operational and functional fidelity to ensure integration and appropriate conduct of operations, including the concepts and processes listed below. Organizational Assurance has a significant role in the organization. It serves to support a multitude of functions that enable the effort to assert and document that it is a functional quality organization with a persistent Nuclear Safety Culture. Elements of Organizational Assurance include:

— Requirements Management;
— Commitment Management;
— Self-Assessment;
— Risk Management;
— Nuclear Safety Culture;
— Safety Conscious Work Environment;
— Corrective Action Program;
— Knowledge Management.

The following elements deserve more elaboration.

3.2.1. Nuclear Safety Culture

This aspect of the Organizational Assurance function enables the development and implementation of the organization's NSC philosophy by:

— Promoting an NSC within the organization similar to that of other high performing nuclear organizations consistent with the expectations of the NRC [12];
— Developing and guiding implementation of the plan for ensuring and independently verifying that the NSC permeates all organizational elements and monitoring how well the organization exhibits the requisite NSC.

Conformance to the NRC's safety culture policy statement [12] will be necessary for a successful licensing program. The Commission defines Nuclear Safety Culture as the core values and behaviors resulting from a collective commitment by leaders and individuals to emphasize safety over competing goals to ensure protection of people and the environment. Management will periodically direct Organizational Assurance to survey the workforce to assess the state of the NSC across the enterprise.

3.2.2. Safety Conscious Work Environment

SCWE [13] [14] is the aspect of Organizational Assurance responsible for development, implementation, and assessing the organization's work environment where:

— Employees are encouraged to raise safety concerns;
— Concerns are promptly reviewed;
— Concerns are given the proper priority based on their potential safety significance; and
— Concerns are appropriately resolved with timely feedback to the originator of the concerns and to other employees, as appropriate.

NRC licensees and contractors are expected, to establish and maintain a SCWE, which is defined by the NRC as an environment in which "employees feel free to raise safety concerns, both to their management and to the NRC, without fear of retaliation" [12].

3.2.3. Corrective Action Program

The CAP function develops and implements the organization's corrective action program and system consistent with current regulatory guidance. Specific areas of review for a licensee's CAP are:

— Policies, programs, and procedures;
— Identification, reporting, and documentation of safety and security issues;
— Significance classification and causal evaluation of safety and security issues;
— Development and implementation of corrective actions; and
— Assessment of corrective action and program effectiveness.

The CAP process is a pivotal element of overall operations and should be an integral part of enterprise management and effective organizational assurance. It is the vehicle by which the effort demonstrates that problems are being recognized, reported, evaluated for their consequences and extent of condition, and managed to a responsible resolution with a documented conclusion. The CAP system should be robust, easy to use, and oriented toward complete electronic documentation and trending.

3.2.4. Knowledge Management

The Knowledge Management function is responsible for development and implementation of the organization's effort directed at compiling, organizing, leveraging, and preserving the organization's knowledge base(s) to support organizational goals and anticipated future needs. It includes a diverse range of efforts to identify, analyze, optimize, and apply information that the organization deems important. In the context of repository systems, it spans matters ranging from the purely technical, well understood (certain) physical/chemical characteristics (waste packages materials, waste forms, corrosion, and waste locations); to less well understood (uncertain) characteristics, (natural fluid flow, volcanism, other low probability events); to very poorly definable characteristics, (cultural influences, societal characteristics). The current concept of knowledge management was not practiced on projects for previously proposed repository site(s). It is currently recognized internationally as a practice that should be undertaken for nuclear waste repositories [15] .

Knowledge Management functions are often categorized into two broad areas; applied knowledge management and knowledge preservation. The purpose of applied knowledge management is to design processes to ensure the promulgation of current information or impending changes to the workforce. Such processes are useful operational tools and are largely directed at information necessary to maintain or improve current business practices and models. Knowledge management techniques would be useful for maintaining the continuity of procedural processes (technical culture) over the decades of repository development and operations.

The second area, knowledge preservation, consists of efforts to safeguard our understanding of important issues for continuing long-term safety of the repository system by avoiding the loss of institutional and societal knowledge long after repository closure. This includes capturing tacit knowledge and establishing a long-term historical record of the participant's and enterprise developments. Preservation of the historical record will be important, considering that the effort's objectives will span 2 to 3 workforce generations.

3.3. Information Management

Information Management includes activities that enable a workforce to accomplish its objectives using enterprise-wide information processes and IT systems. Information Management designs and oversees the processes that generate, transmit, and store information. Information Management, with the assistance of IT systems, operates and maintains the information in electronic systems required to process, store and access enterprise information in the principal areas listed below. Herein, Information Management has been separated from its customary association within Business Management to avoid dilution of this functional element because of its importance to the successful outcome of a compliance-oriented effort.

Information managed via this element is the organizational, technical, regulatory, and quality assurance related documentation and information (documentary evidence) necessary to document accomplishment of enterprise objectives and confirm the integrity of the organization's work products. Throughout the effort's timeline, at least until issuance of a construction authorization, and probably significantly thereafter, the most important products will consist of recorded information demonstrating compliance with various enterprise and regulatory requirements. The importance of a robust, integrated, and accessible information management function cannot be understated. Elements of Information Management for a license applicant include:

— Correspondence Control;
— Document Development;
— Document Control;
— Data Management;
— Records Management;
— Email Considerations;

— Reference Registry;
— Software Configuration Management;
— Licensing Support Network.

The following elements deserve more elaboration.

3.3.1. Records Management

Records Management is the process for capturing information related to the effort, independent of its origin or form. The records management program will need to conform to DOE Order 243.1B Records Management Program, including development of records retention and disposition schedules approved by National Archives and Records Administration (NARA) (DOE O 243.1B (4)(a)(2)) [16]. As stated in DOE O 243.1B [16], the effort will need to maintain electronic records in accordance with 36 CFR Subchapter B, Records Management [17], by "building electronic records keeping functionality into the native electronic information systems or by capturing the electronic information systems records in an electronic records management application" (DOE O 243.1B (4)(b)) [16]. The use of records management systems that meet the functional requirements of the Department of Defense (DoD) standard 5015.2-STD, Electronic Records Management Software Application Design Criteria Standard [18], satisfies this requirement.

3.3.2. Email Considerations

The importance of proper management and attention to maintenance of email processes/systems cannot be overstressed. The 2012 OMB/NARA Managing Government Records Directive (M-12-18) [19] includes a requirement that Federal agencies must manage all email records in an electronic format.

MOW training should stress that use of the email system forfeits any right to privacy and that emails are records even though the retention period will vary according to the content. This should be much easier than in the past, as most users will be able to access a web-based version of their private email client from work; however, MOWs will need to be cautioned that work related information exchange must take place on the enterprise email system.

3.3.3. Reference Registry

Thousands of references will be cited in documentation produced during the effort, consisting of both public and copyrighted information in addition to the enterprise's own documentation. Reference registry processes and systems for documenting and retaining copies of references is necessary for ensuring the integrity and defensibility of enterprise documents.

3.3.4. Software Configuration Management

Software configuration management is an element of information management providing for the necessary control of software used in the conduct of operations. Software configuration management is the means of ensuring the availability and appropriate use of the current authoritative version of software, whether it is commercial off the shelf (COTS) or developed software. Similar to document control, software configuration management has an important interface with QA, since the appropriate use of software is often based on the specific version employed. This is most efficiently accomplished by establishing a single software configuration control process and system. Software configuration management is addressed in NQA-1 Subpart 2.7, Quality Assurance Requirements for Computer Software for Nuclear Facility Applications [11].

3.3.5. Licensing Support Network

License Support Network (LSN) is an element of records management that consists of processes and protocols designed to satisfy the procedural requirements of 10 CFR Part 2, Subpart J of NRC's [20] licensing rules (see also NRC 2004 [21]). The purpose of this rule is to facilitate the discovery process for an eventual NRC evidentiary proceeding. LSN requires any documentary evidence that is 'relevant' to an applicant's submittal, be provided for posting on the LSN within 90 days. The importance of LSN compliance is unmistakable, as the applicant must certify it is in compliance with the rule at least six months before submittal of a license application.

3.4. IT Systems

The IT systems or services include activities necessary to define, design, implement, and maintain IT systems to support the organization's processes and functions. Systems that are developed to support the business and technical efforts are essentially important to the overall success of the enterprise and generally fall into two categories: a) information systems; and b) high performance computing systems. The purpose of information systems is to collect and store administrative and technical information and its associated metadata for day-to-day use and compliance with information related requirements. High performance computing systems provide the calculation capability or other data intensive systems to support science and engineering efforts.

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