01-0000949

Department of Energy

Washington, DC 20585

May 18, 2001

Honorable John T. Conway
Chairman, Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW, Suite 700
Washington, DC 20004

Dear Mr. Chairman:

Enclosed is a status report of the actions described in the Department of Energy's (DOE) report, dated October 2, 2000, addressing issues raised in the January 2000 Technical Report 25 – *Quality Assurance for Safety-Related Software at Department of Energy Defense Nuclear Facilities.*

In summary, Actions 1.0 to 5.0 are completed or nearing completion. As a result of the establishment of the Safety Analysis Software Group (SASG), Actions 6.0 to 11.0 have been revised. Consequently, a supplementary report, which will replace the October 2 report, will be forwarded by separate letter from the Secretary.

If you have any questions, please contact me at 202-586-0166.

Sincerely,

Howard Landon
Acting Chief Information Officer

Enclosures
1. Status Report
2. N 203.1, Software Quality Assurance
3. Summary Report on Standards
4. Summary Report on Training
5. DOE October 2 Memo Establishing SASG

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Enclosure

STATUS UPDATE TO

THE OCTOBER 2, 2000 DOE RESPONSE TO

DNFSB TECHNICAL REPORT 25

May 1, 2001

Action 1.0: Develop an SQA directive

Purpose: To provide requirements that are conducive to actions necessary for implementing improvements in guidance, processes, standards identification, training, code development and maintenance. To provide a framework for sites and organizations to make decisions for what needs to be included in an effective SQA program. To specify the level of SQA needed for all software and emphasize a risk-based approach to SQA.

Responsible Manager: Chief Information Officer (CIO)

Deliverables: Letter to the Board announcing placement of draft directive into the Directives System for DOE-wide review.

Due Date: October 16, 2000

Status: Completed. Notice signed by the Deputy Secretary on October 2, 2000, and placed into DOE Directives System. An announcement was provided verbally to DNFSB staff. Deliverable is attached as Enclosure 2.

Action 2.0: Identify industry safety and SQA standards used by the field (e.g., policies, requirements and guidance).

Purpose: To determine where the current set of DOE directives (including Integrated Safety Management (ISM) and DOE's Functions, Responsibilities and Authorities Manuals (FRAM) may not adequately express DOE expectations for SQA practices or may not be appropriately applied. To obtain data needed to identify areas where additional requirements are warranted. To identify a set of standards that include DOE and Nuclear Regulatory Commission (NRC) directives and describe how the standards would be applied based on benchmark data.

Responsible Manager: EH and CIO

Deliverables: A list of Recommended Standards to the LPSOs

Due Date: October 30, 2000

Status: Completed. A survey was issued to determine what DOE, other government or industry safety and SQA standards are used by the field for defense nuclear facilities. The survey compilation was completed on January 15, 2001. Survey results revealed that sites develop their own policies, requirement and guidance to implement DOE directives and requirements. No other government or industry safety and SQA standards are used. A list of the current DOE directives and standards recommended for field usage was compiled. The survey results and deliverable are enclosed as attachments to the Summary Report on Standards, which is attached as Enclosure 3.

Action 3.0: Evaluate survey results to confirm and/or identify policy/standard changes needed for SQA and safety.

Purpose: Same as Action 2.0.

Responsible Manager: EH and CIO

Deliverables: Survey results, Summary Report of Analysis with Recommendations for Improvements to the LPSOs.

Due Date: November 30, 2000

Status: Completed. In addition to the survey discussed in Action 2.0, an independent assessment was conducted to review other DOE contractor, other government and industry standards organizations for safety/safety analysis and software/SQA standards. The results of the assessment and survey questions with responses were incorporated into the Summary Report on Standards, which is attached as Enclosure 3, on February 14, 2001. The report includes recommendations for improvements to the LPSOs. A memo has been prepared to transmit the Report to the LPSOs. Also, the report was provided to the Safety Analysis Software Group (SASG) as a tool for their action in defining a toolbox of standards for defense nuclear facilities; i.e., safety analysis and I&C software.

Action 4.0 Develop and formalize a matrix of organizations (and identify coordinating points) cognizant of QA and capable of addressing issues as they are identified.

Purpose: To identify organizations/groups which may not be designated by name as having QA responsibility, but who implement or support some component of QA. To identify safety groups and determine how to enhance relationships and improve information exchange between those groups and QA.

Responsible Manager: Chairman, QAWG

Deliverables: Revised QAWG Charter, Integrated QA Organizational Structure Matrix, Summary Report of Analysis with Recommendations to the LPSOs.

Due Date: November 30, 2000

Status: Incomplete. An integrated matrix QA organizational structure identifying interface/communication channels, reporting and working relationships, roles and responsibilities, sponsorship, and a central point-of-contact for resolving QA issues was developed. The matrix shows the QAWG as the central point-of-contact or central liaison, among other independent and interdependent organizations and groups. However; the reorganizations in NNSA/Defense Programs and DOE/Science are impacting the ability to produce a final charter. A summary report, which will include the matrix, will be developed once the revised charter is finalized.

Action 5.0: Identify appropriate types and levels of SQA training commensurate to the requirements of the safety analysis and I&C functions performed. Compare to current training programs available at DOE. Calibrate DOE SQA training practices with industry and those maintaining similar mission-critical facilities and processes in the nuclear and chemical sectors to identify areas where additional emphasis is needed to correct deficiencies, or reduce "gaps".

Purpose: To obtain details on current practices and obtain data for identifying the need to establish a standardized and minimum level of training requirements for personnel using software associated with safety analysis (primarily accident and consequence analysis) and I&C systems.

Responsible Manager: EH and DP

Deliverables: Survey results, Summary Report of Analysis with Recommendations for additional guidelines, clarifications, or other improvement actions or a Profile of Training Requirements will be provided to LPSOs.

Due Date: November 30, 2000

Status: Completed. The survey was limited to an identification of safety and SQA training used by the field for defense nuclear facilities. Survey results revealed no defined safety analysis and SQA training requirements, including user training for specified software. In addition to the survey, an independent assessment was conducted to review other DOE contractor, other government and industry training programs for safety/safety analysis and software/SQA standards. The results of the assessment and survey questions with responses were incorporated into the Summary Report on Training, which is attached as Enclosure 4, on March 30, 2001. The report includes recommendations for improvements to the LPSOs. A memo has been prepared to transmit the Report to the LPSOs. Also, the Report was provided to the Safety Analysis Software Group (SASG) as a tool for their action in defining training requirements for defense nuclear facilities; i.e., safety analysis and I&C software.

Action 6.0: A memorandum from the Deputy Secretary will be sent to the Under Secretary (NNSA) and to Assistant Secretaries (EM and EH) to establish an initial Safety Analysis Software Group (SASG) to evaluate survey results and to assess requirements, attributes and selection of tool-box computer models for accident and consequence applications. The group will be led by the NNSA representative.

Purpose: To establish a centralized group (comprised of DOE, contractors and subject matter experts including expertise in safety analysis, software development and SQA, and authorization basis implementation), with coordinated support from the Energy Facilities Contractors Group (EFCOG), to take a leadership role for DOE and its contractors in the specific safety-related software areas of concern highlighted in Technical Report 25.

Responsible Managers: NNSA/DP, EM, EH

Deliverable: A memorandum tasking NNSA, EM and EH to form the Group and to identify required DOE, contractor, and consultant representation for Safety Analysis Software Group (SASG). Develop selection criteria for tool-box of codes. Identify software candidates for tool-box and outline remedial SQA activities for the tool-box codes

Due Date: **September 30, 2000** for SASG establishment and **December 15, 2000** for the analysis results and recommendations.

Status: Incomplete. A memorandum was signed by the Deputy Secretary on October 2, 2000 establishing the SASG and requesting that participants from NNSA/DP, EM, and EH be named by October 16, 2000. The SASG is chaired by the NNSA/DP subject matter expert and held its first meeting February 14-15, 2001. The SASG has revised Actions 6.0 through 11.0. Because of the revisions, the OCIO developed a supplementary report which supersedes the October 2, 2000 report. The supplementary report is being coordinated for the Secretary's signature. The activities for this action are addressed in the supplementary report as Actions 1.0, 2.0, 4.0, and 6.0.

Action 7.0: Identify software used for safety analysis and I&C processes. Compare practices and training for these codes and software. Analyze for deficiencies and improvements.

Purpose: To identify high-use software and relevant software standards and practices to determine specific remedial activities necessary to upgrade non-compliant safety-related software. To obtain data for assessing the degree of reliance on computer modeling for developing the safety bases for nuclear facilities.

Responsible Manager: Chair, Safety Analysis Software Group

Deliverable: Survey results, Summary Report with Analysis and Recommendations for additional guidelines, clarifications or other improvement actions and/or Profile of Safety and I&C Codes will be provided to affected PSOs

Due Date: December 29, 2000

Status: Action not yet taken. The SASG has revised Actions 6.0 through 11.0. Because of the revisions, the OCIO developed a supplementary report which supersedes the October 2, 2000 report. The supplementary report is being coordinated for the Secretary's signature. The activities for this action are addressed in the supplementary report as Actions 4.0, 5.0, 6.0 and 7.0.

Action 8.0: Safety Analysis Software Group (SASG) determine if any site visits are required to finalize the tool-box of codes.

Purpose: To earmark candidate software for the software tool-box. To determine the adequacy of the tool-box software and individual site applications and the impacts of the use of candidate software relative to the authorization basis for the facilities in question.

Responsible Managers:	Chair, SASG
Deliverable:	Conduct visits and make recommendations on the tool-box codes
Due Date:	March 1, 2001

Status: Action not yet taken. The SASG has revised Actions 6.0 through 11.0. Due to the revisions, the OCIO developed a supplementary report which supersedes the October 2, 2000, report. The supplementary report is being coordinated for the Secretary's signature. The activities for this action are addressed in the supplementary report as Action 5.0.

Action 9.0: Conduct Pilot Integrated Accident/Consequence Analysis Training.

Purpose: To obtain best practices and other guidance for DOE safety analysts who are responsible for performing hazard, accident and consequence analysis upon which the identification of control sets is based.

Responsible Managers: EH/NNSA-DP

Deliverable: Provide pilot training at EFCOG SAWG Workshop on hazard, accident, and consequence methods.

Due Date: June 16, 2001

Status: Action not due. The SASG has revised Actions 6.0 through 11.0. Due to the revisions, the OCIO developed a supplementary report which supersedes the October 2, 2000, report. The supplementary report is being coordinated for the Secretary's signature. The activities for this action are addressed in the supplementary report as Action 7.0.

Action 10.0: Determine whether the Safety Analysis Software Group (SASG) needs to be transitioned to a permanent organization.

Purpose: To establish a permanent expert advisory team in a DOE nuclear national laboratory.

Responsible Manager: Chair, SASG

Deliverable: Letter memorandum to LPSOs on permanent organizational make-up, roles and responsibilities and cross-ties to EFCOG

Due Date: July 31, 2001

Status: Action not due. The SASG has revised Actions 6.0 through 11.0. Due to the revisions, the OCIO developed a supplementary report which supersedes the October 2, 2000, report. The supplementary report is being coordinated for the Secretary's signature. The activities for this action are addressed in the supplementary report as Action 3.0.

Action 11.0: Perform backfit SQA program for MACCS2.

Purpose: To pilot the processes established by the SASG on MACCS2 code because it has widespread use for authorization basis calculations and has many documented deficiencies. To conduct a concentrated verification and validation effort to bootstrap MACCS2 into a level of compliance commensurate to safety-related software standards. To evolve the tool-box into a manageable number of one to two codes for each phenomenological area (e.g. fire, spill, deflagration/detonation).

Responsible Managers:	Chair, SASG
Deliverable:	Provide SQA program documents and put required pedigree MACCS2 software into configuration control as initial code into DOE Safety Software Tool-Box.
Due Date:	December 31, 2001

Status: Action not due. The SASG has revised Actions 6.0 through 11.0. Because of the revisions, the OCIO developed a supplementary report which supersedes the October 2, 2000, report. The supplementary report is being coordinated for the Secretary's signature. The activities for this action are addressed in the supplementary report as Action 8.0.

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U.S. Department of Energy
Washington, D.C.

NOTICE

DOE N 203.1

Approved: 10-02-00
Expires: 06-02-01

SUBJECT: SOFTWARE QUALITY ASSURANCE

1. OBJECTIVES. To define requirements and responsibilities for software quality assurance (SQA) within the Department of Energy (DOE) to ensure that—

   a. all software owned or maintained by DOE, as referenced in paragraph 3c, Applicability, is subjected to formal quality assurance;

   b. all DOE software engineering follows identified standards and best practices throughout the project and product lifecycle;

   c. due to the spectrum of requirements, the degree of SQA is risk-based; and

   d. personnel are capable of correctly developing, using, and managing software.

2. CANCELLATION. None.

3. APPLICABILITY.

   a. DOE Elements. This directive applies to Departmental elements that acquire, develop, modify, or maintain computer software.

   b. Contractors. The Contractor Requirements Document, Attachment 1, sets forth the requirements to be applied to all management and operating and other contracts that require the acquisition, development, modification, or maintenance of computer software, as provided by contract and as implemented by the appropriate contracting officer. Compliance with the Contractor Requirements Document will be required to the extent set forth in the contract.

   c. DOE Software. The provisions of this Notice apply to all DOE software or software customized for DOE use, proposed for use, under development, or being maintained and used, whether that software was developed in-house, licensed from a commercial vendor for customized use, obtained from another organization, or otherwise acquired. The type of software includes, but is not limited to (a) administrative/business-oriented software, (b) scientific/engineering software except as identified in paragraph 3.d. below, (c) manufacturing-oriented software, and (d) process control; (e.g., Programmable Logic Control instructions).

   d. Basic Research Activities. The requirements of this Notice are not mandatory for basic scientific research and development activities conducted to support the Office of Science mission unless those activities are governed by the requirements in 10 CFR part 830. However, line management is encouraged to consider all or part of the Notice requirements in meeting its responsibilities to ensure the quality of the software

developed for basic research. Business systems that support basic research are not exempted from the Notice requirements.

e. Exclusion. Executive Order 12344 (set forth in Public Law 106-65 of October 5, 1999 [50 U.S.C. 2406]) establishes the responsibilities and authority of the Director, Naval Nuclear Propulsion Program, for all facilities and work that comprise the Program, which is a joint Navy/DOE organization. The Director's responsibilities include the operating practices and procedures applicable to Naval nuclear propulsion plants. The Director must establish the quality assurance requirements implemented within the Program. Accordingly, this Notice does not apply to the Naval Reactors Program.

4. REQUIREMENTS.

a. This directive is effective upon issuance.

b. SQA Program. Each Departmental element shall develop, document, and implement an SQA program. Each SQA program will consist of an identified focal point of contact, defined authorities, policies, procedures, training, adopted standards, and conventions tailored to local needs. Each program will treat SQA initiatives appropriately, commensurate with their size, complexity, cost, degree of external impact, degree of customization, functions performed, and other factors important to local management. The SQA program will describe how project SQA plans are to be developed and implemented.

c. Risk-Based, Graded Approach. All software, which is owned or maintained by DOE, must be subjected to a degree of formal SQA commensurate with the safety, security, and risk involved in developing and using the software. This approach allows all software, including that which may be categorized as "research and development", to be assessed for and receive an appropriate and commensurate amount of SQA.

d. Lifecycle-Based SQA Processes and Procedures. The SQA processes and procedures used must be software product and project lifecycle based; documented to provide a baseline for auditing; and applied in a consistent, repeatable, and predictable manner. The adequacy of selected processes and practices, as well as their oversight, is the responsibility of each individual Departmental element.

e. Project SQA Plans. Project SQA plans will be developed and address testing (e.g., unit, integration, system, acceptance), verification and validation, structured walkthroughs, peer reviews, inspections, audits and any other requirements specified for an application (e.g., by contract). Each plan should be commensurate with the level of the size, complexity, and scope of the software project.

f. Oversight. Each Departmental element will conduct systematic reviews to ensure that the requirements of this directive and DOE O 414.1A, QUALITY ASSURANCE, are met and determine the need to update its own SQA program. Relative to software,

these reviews should also ensure that appropriate safety and security controls are in place, are effective, and reflect currently accepted industry practices. For line management assessment of an SQA program, the principles and guidelines in DOE P 450.5, LINE ENVIRONMENT, SAFETY AND HEALTH OVERSIGHT, will apply and should be followed.

g. Training. Sites are responsible for ensuring the adequacy of training programs to meet current and future personnel skill needs in the areas of SQA, software engineering, and software user training.

h. Integration. Sites must integrate the SQA program planning process with the strategic planning, Safety Management System, and budget process, as appropriate, to ensure that SQA program decisions are made, adequately funded, and executed to support DOE organizational and site missions and priorities.

5. RESPONSIBILITIES.

a. Office of the Chief Information Officer.

(1) Establishes and maintains Departmentwide direction and guidance for SQA management processes.

(2) Periodically reviews the results of internal and external compliance assessments and determines if the Departmentwide direction and guidance need to be improved or assistance provided.

b. Power Marketing Administrations. Execute program office responsibility, accountability, and oversight for SQA management process compliance within their respective program areas.

c. Departmental Elements. Implement the appropriate level of management effort, and assume responsibility, accountability, and oversight for continued SQA management process compliance within their respective program areas. Specifically—

(1) Establish and document SQA programs.

(2) Identify a focal point of contact.

(3) Ensure that the SQA programs conduct risk assessments and determine the level of SQA to be applied.

(4) Ensure that the level of SQA is tailored to the site needs.

(5) Oversee development and implementation of SQA processes and procedures.

(6) Ensure the production and delivery of quality software products.

(7) Ensure that SQA programs are reviewed.

(8) Ensure SQA plans are approved.

(9) Relative to software, ensure that appropriate safety and security controls are in place, are effective, and reflect currently accepted industry practices.

(10) Ensure the adequacy of training programs for SQA, software engineering and software user training.

(11) Ensure that any SQA program related to safety is developed and implemented in a manner that is consistent with DOE P 450.4, SAFETY MANAGEMENT SYSTEM POLICY, and associated standards and manuals.

(12) Ensure that any nuclear software program related to safety is developed and integrated with existing nuclear safety policies and standards.

(13) Ensure that all SQA programs are developed and implemented in a manner that is consistent with applicable classified and/or unclassified policy.

d. Assistant Secretary for Environment, Safety, and Health (EH-1), acting as DOE's independent element responsible for safety aspects relative to public and worker health, and safety and environmental protection, shall provide advice and assistance to the Chief Information Officer concerning policy requirements and guidance necessary to implement this directive on software used for safety applications.

e. Deputy Assistant Secretary for Oversight, acting as the Department's independent element responsible for the oversight of environment, safety, and health has the following responsibilities.

(1) Assess and report to the Secretary of Energy on all aspects of safety related to implementation of this directive, including performance of the Secretarial Offices, field elements and contractors.

(2) Review and comment on proposed SQA policy, regulations, standards and requirements to assess their potential effects on the safety of operations at DOE facilities.

f. Director, Office of Independent Oversight and Performance Assurance, acting as the Department's independent element responsible for the oversight of safeguards and security has the following responsibilities.

(1) Assess and report to the Secretary of Energy on all aspects of safeguards and security related to implementation of this directive, including performance of the Secretarial Offices, field elements and contractors.

(2) Review and comment on proposed SQA policy, regulations, standards and requirements to assess their potential effects on the security of operations at DOE facilities.

6. IMPLEMENTATION. Implementation of this directive is site-specific. An implementation plan that describes the actions necessary to comply with this directive and the expected date for completing those actions must be submitted to the applicable Program Secretarial Office (PSO) or Power Marketing Administration management 90 days after the approval date of this directive. Where there are multiple programs, coordination should be implemented by the Lead Program Secretarial Officers. SQA program plans should be approved by PSOs within 120 days of receipt.

7. ASSESSMENTS OF SQA IMPLEMENTATIONS. Assessments of SQA implementations of this directive will be forwarded to the Office of the Chief Information Officer.

8. REFERENCES.

   a. 10 CFR part 830, Nuclear Safety Management.

   b. DOE O 414.1A, QUALITY ASSURANCE, dated 9-29-99.

   c. DOE O 5480.23, NUCLEAR SAFETY ANALYSIS REPORTS, dated 4-10-92.

   d. DOE P 450.4, SAFETY MANAGEMENT SYSTEM POLICY, dated 10-15-96.

   e. DOE P 450.5, LINE ENVIRONMENT, SAFETY AND HEALTH OVERSIGHT, dated 6-26-97.

   f. DOE S 1027-92, HAZARD CATEGORIZATION AND ACCIDENT ANALYSIS TECHNIQUES FOR COMPLIANCE WITH DOE ORDER 5480.23, NUCLEAR SAFETY ANALYSIS REPORTS, updated 9-97.

   g. DOE G 200.1-1, DEPARTMENT OF ENERGY SOFTWARE ENGINEERING METHODOLOGY, dated 5-21-97.

   h. DOE G 414.1-2, QUALITY ASSURANCE MANAGEMENT SYSTEM GUIDE FOR USE WITH 10 CFR 830.120 AND DOE O 414.1, dated 7-17-99.

   i. Quality Criteria (QC-1), invoked via reference in DOE/AL Supplemental Directive 56XB (Nuclear Weapon Development and Production Manual).

9. CONTACT. For additional information or assistance in interpreting or implementing this directive, please contact the Office of the Chief Information Officer at 202-586-0166.

10. DEFINITIONS. To promote a common understanding of SQA and systems engineering concepts, the following definitions are provided.

a. Acceptance Testing. Formal testing conducted to determine whether or not a software product or system satisfies its acceptance criteria and to enable the system owner to determine whether or not to accept the product or system. *IEEE Standard Glossary of Software Engineering Terminology, Std. 610.12-1990.*

b. Configuration Management (CM). A discipline applying technical and administrative direction and surveillance to identify and document the functional and physical characteristics of a configuration item, control changes to those characteristics, record and report change processing and implementation status, and verify compliance with specified requirements. *IEEE Standard Glossary of Software Engineering Terminology, Std. 610.12-1990.*

c. Departmental Element. A Departmental Element is defined as a first-tier organization at Headquarters and in the Field. First-tier at Headquarters is the Secretary, Deputy Secretary, Under Secretary, and Secretarial Officers (Assistant Secretaries and Staff Office Directors). First-tier in the Field is Managers of the eight Operations Offices, Managers of the three Field Offices, and the Administrators of the Power Marketing Administrations. Headquarters and Field Elements are described as follows: (1) Headquarters Elements are DOE organizations located in the Washington Metropolitan Area; and (2) "Field Elements" is a general term for all DOE sites (excluding individual duty stations) located outside of the Washington, DC, Metropolitan Area. *DOE Glossary in the Directives System.*

d. Information System. 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, 1988.*

e. Integration Testing. Testing in which software components, hardware components, or both are combined and tested to evaluate the interaction between them. *IEEE Standard Glossary of Software Engineering Terminology, Std. 610.12-1990.*

f. Project Planning. The planning of project technical and management activities that are documented in a project plan. The plan typically describes the work to be done, the resources required, the methods to be used, the procedures to be followed, the schedules to be met, and the way the project will be organized. It includes a list of deliverables, actions required, and other key events needed to accomplish the project. *DOE Software Quality and Systems Engineering support team, 1999.*

g. Project Tracking and Oversight. The tracking and reviewing of accomplishments and results against documented estimates, commitments, and plans. Includes the adjusting of plans based on actual accomplishments and results. *DOE Software Quality and Systems Engineering support team, 1999.*

h. Quality Assurance. (1) A planned and systematic pattern of all actions necessary to provide adequate confidence that the item or product conforms to established operational, functional, and technical requirements. (2) A set of activities designed to evaluate the process by which products are developed or manufactured. *IEEE Standard Glossary of Software Engineering Terminology, Std. 610.12-1990.*

i. Quality Control.

(1) The process by which product correctness is determined and action is initiated when nonconformance is detected.

(2) A line function; the work done within a process to ensure that the work product conforms to standards/requirements. *Effective Methods for Software Testing by William Perry, John Wiley & Sons, 1995.*

j. Requirements Management. In system/software system engineering, the process of controlling the identification, allocation, and flowdown of requirements from the system level to the module or part level, including interfaces, verification, modifications, and status monitoring. *Software Requirements Engineering, edited by Thayer & Dorfman, IEEE Computer Society Press, 1997.*

k. Risk Management. An approach to problem analysis that is used to identify, analyze, prioritize, and control risks. *DOE Software Engineering Methodology, March 1999.*

l. Software Design. In software engineering, the process of defining the software architecture (structure), components, modules, interfaces, test approach, and data for a software system to satisfy specified requirements. *Software Requirements Engineering, edited by Thayer & Dorfman, IEEE Computer Society Press, 1997.*

m. Software Engineering. (1) The application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software; that is, the application of engineering to software. (2) The study of approaches as in (1). *IEEE Standard Glossary of Software Engineering Terminology, Std. 610.12-1990.*

n. Software Quality Assurance. See Quality Assurance. *IEEE Standard Glossary of Software Engineering Terminology, Std. 610.12-1990.*

o. System Testing. Testing conducted on a complete, integrated system to evaluate the system's compliance with its specified requirements. *IEEE Standard Glossary of Software Engineering Terminology, Std. 610.12-1990.*

p. Unit Testing. Testing of individual hardware or software units or groups of related units. The isolated testing of each flowpath of code with each unit. The expected output from the execution of the flowpath should be identified to allow comparisons of the planned output against the actual output. *DOE Software Engineering Methodology, March 1999.*

q. Validation. The process of evaluating a system or component during or at the end of the development process to determine whether it satisfies specified requirements. *IEEE Standard Glossary of Software Engineering Terminology, Std. 610.12-1990.*

r. Verification. (1) 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. (2) Formal proof of program correctness. *IEEE Standard Glossary of Software Engineering Terminology, Std. 610.12-1990.*

BY ORDER OF THE SECRETARY OF ENERGY:

T.J. GLAUTHIER
Deputy Secretary

CONTRACTOR REQUIREMENTS DOCUMENT
DOE N 203.1, SOFTWARE QUALITY ASSURANCE

The requirements in this Contractor Requirements Document must be applied to all management and operating and other contracts that require the acquisition, development, modification, or maintenance of computer software, as provided by contract and as implemented by the appropriate contracting officer. Compliance with this Contractor Requirements Document will be required to the extent set forth in the contract.

1. The provisions of this Contractor Requirements Document apply to DOE software or software customized for DOE use, proposed for use, under development, or being maintained and used, whether that software was developed in-house, licensed from a commercial vendor for customized use, obtained from another organization, or otherwise acquired shall be subjected to formal quality assurance. The type of software includes, but is not limited to—

   (a) administrative/business-oriented software,

   (b) scientific/engineering software within the context of considerations identified in number 2,

   (c) manufacturing-oriented software, and

   (d) process control (e.g., Programmable Logic Control instructions).

2. The provisions of this Contractor Requirements Document are not mandatory for basic scientific research and development activities conducted to support the Office of Science mission unless those activities are governed by the requirements in 10 CFR part 830. However, as directed, contractor line management is encouraged to consider all or part of the Notice requirements in meeting its responsibilities to ensure the quality of the software developed for basic research. Business systems that support basic research are not exempted from the Contractor Requirements Document provisions.

3. The contractor must develop, document, and implement an SQA program for projects under its contract. Each SQA program will consist of an identified focal point of contact, defined authorities, policies, procedures, training, adopted standards, and conventions tailored to local needs. Each program will treat SQA initiatives appropriately, commensurate with their size, complexity, cost, degree of external impact, degree of customization, functions performed, and other factors important to the site's management.

4. The contractor must ensure all software, which is owned or maintained by DOE, is subjected to a degree of formal SQA commensurate with the safety, security, and risk involved in developing and using the software. This approach allows all software, including that which may be categorized as "research and development", to be assessed for and receive an appropriate and commensurate amount of SQA.

5. The contractor must ensure the SQA processes and procedures are software product and project lifecycle based; documented to provide a baseline for auditing; and applied in a consistent, repeatable, and predictable manner. The contractor must ensure the adequacy of selected processes and practices, as well as their oversight.

6. The contractor must develop project SQA plans and address testing (e.g., unit, integration, system, acceptance), verification and validation, structured walkthroughs, peer reviews, inspections, audits and any other requirements specified for an application (e.g., by contract). The contractor must ensure that each plan is commensurate with the level of the size, complexity and scope of the software project. As appropriate, a standard SQA plan may be adopted and/or adapted for subsequent projects within a program.

7. The contractor must conduct systematic reviews to ensure that the requirements of this directive and DOE O 414.1A, QUALITY ASSURANCE, are met and determine the need to update its own SQA program. Relative to software, these reviews should also ensure that appropriate safety and security controls are in place, are effective, and reflect currently accepted industry practices.

8. The contractor must ensure the adequacy of training programs to meet current and future personnel skill needs in the areas of SQA, software engineering, and software user training.

9. The contractor must ensure the integration of the SQA program planning process with DOE strategic planning, Safety Management System, and budget process, as appropriate, to ensure that SQA program decisions are made, adequately funded, and executed to support DOE organizational and site missions and priorities.

SEPARATION

PAGE

Summary Report on Standards to Department of Energy (DOE) Lead Principal Secretarial Officers (LPSO)

Response to Defense Nuclear Facilities Safety Board (DNFSB) Technical Report 25, Focus Area No. 1 – Standards Software – Safety Software – Safety Analysis

April 14, 2001

by
Standards Focus Area Team
Developed under the auspices of the
Office of the Chief Information Officer and the
Office of Environment, Safety and Health

Table of Contents

Attachments

Executive Summary

To address the concerns presented by the Defense Nuclear Facilities Safety Board (DNFSB) in Technical Report 25 "*Quality Assurance for Safety-Related Software at Department of Energy Defense Nuclear Facilities*", a Response Team was formed in February 2000. The Response Team was led by the Office of the Chief Information Officer (OCIO) and composed of participants from National Nuclear Security Administration/Defense Programs (NNSA/DP); Environmental Management (EM); Environment, Safety and Health (EH); and other Principal Secretarial Offices (PSO). The Response Team developed a three-pronged approach which investigated Infrastructure, Training, and Safety Analysis and Instrumentation and Control (I&C) codes. Three subteams were formed to address each of these focus areas. The Infrastructure Focus Team divided its efforts into three areas to review Software Quality Assurance (SQA) Requirements, Standards, and Organization.

This report is a Departmental perspective in regards to Standards for software, safety software, and safety analysis. Although discussed, this report does not endorse or provide consensus standards or guidance in regards to DOE safety analysis and I&C codes. The Safety Analysis Software Group (SASG), led by NNSA/DP, EM, and EH, will address this software and issue a report. The intent is to review the DOE standards programs and compare with standards of other government and industry organizations.

In summary, the Board stated a concern that there is a lack of an integrated and mandated or recommended comprehensive set of standards for ensuring quality software. The Board felt that DOE should clearly define requirements that are appropriate for use by its contractors. DOE did not entirely agree with the Board assertion that DOE does not have requirements for software or software quality, particularly for software that is used in safety applications. However, a study was undertaken by the Standards Focus Area Team (a subset of the Infrastructure Focus Team) to assess the Department's guidance for these standards; and a survey was developed to focus on standards for safety analysis and I&C codes in defense nuclear facilities.

This report is a compilation of the study and survey results. It is intended to be used as a resource by the SASG and others involved in managing, engineering, or assuring DOE software.

1.0 Standards Focus Area Description

The Standards Focus Area Team's direction was to review and assess directives and standards guidance for safety software, safety analysis, and software quality assurance (SQA) to ensure the pedigree of all DOE software, particularly safety software, and to understand the use of these standards on safety analysis and instrumentation and control (I&C) software. This review and assessment is focused at the Departmental level. Although discussed, a similar review will be conducted by the Safety Analysis Software Group (SASG) to specifically address safety analysis and I&C codes.

An independent evaluation by the Standards Focus Area Team was conducted to identify a set of foundation standards that could include DOE and other government and industry directives and to describe how the standards would be applied based on benchmark data. Attachment 1 lists the organizations reviewed and Attachment 2 lists the DOE directives and standards currently required. Directives and practices regarding Integrated Safety Management (ISM) and DOE's Functions, Responsibilities, and Authorities Manuals (FRAM) were included in the review. In addition, to determine whether the current set of DOE directives adequately address DOE expectations and are appropriately applied to safety analysis and I&C software, DOE surveyed contractor safety analysis and SQA practices. Attachment 3 is a compilation of the survey.

The Office of the Chief Information Officer (OCIO) has primary responsibility for identifying software standards and guidance, and the Office of Environment, Safety and Health (EH) has primary responsibility for identifying safety standards and guidance, including those for safety software. These two Offices worked together to prepare this report and to make recommendations to the Lead Principal Secretarial Offices (LPSO) and also to recommend any specific line management follow-up actions to the Deputy Secretary (e.g., special assessments, contract changes, Safety Management System enhancements).

1.1 DOE Directives and Standards

DOE Federal directives and standards and contractor guidance organizations were reviewed to assess not just the guidance but the infrastructure for disseminating guidance. The review included directives for safety/safety analysis and software/SQA. It appears that there is an adequate number of organizations who have developed websites as their repository of standards information. However, better communication and connectivity among these groups is needed for information sharing.

1.1.1 Federal Directives and Standards Programs and Organizations

DOE has established three programs for defining Departmental requirements and expectations, which are the Departmental Directives repository system and two standards programs; i.e., DOE Technical Standards program and the DOE Information Architecture Standards program. These programs provide various Departmental directives and standards to DOE Federal and contractor staffs. Councils, committees, and working groups have also been established to interpret and implement the directives and standards. The most notable ones involved in software, quality assurance, and safety are discussed in this section.

DOE Directives. The DOE Directives System repository is managed by Management and Administration (MA) at Headquarters. DOE directives include Policies, Orders, Notices, Manuals, and Guides which are intended to direct, guide, inform, and instruct employees in the performance of their jobs, and enable them to work effectively within the Department and with agencies, contractors, and the public. Directives establish the minimum requirements that must be met and the results that must be accomplished to ensure successful and compliant solutions. Guides allow the most flexibility in implementation. Federal site and contractor implementations of DOE directives should address all aspects of the directives, including the reason(s) why specific aspects cannot be implemented or are not applicable to local needs. For information on DOE Directives, access the http://www.explorer.doe.gov:1776/htmls/directives.html website.

Safety and Safety Analysis. Below is a listing of directives for safety and safety analysis that contain software provisions or imply SQA. These directives are sponsored by EH and do not apply to the Naval Nuclear Propulsion Program.

- DOE P 450.4, SAFETY MANAGEMENT SYSTEM POLICY, defines the policy for integrating safety into management and work practices at all levels and all facets of work planning and execution based on six components. Quality assurance is implied in Component 3, Core Functions for Integrated Safety Management, by requiring a confirmation of readiness, feedback, oversight, and continuous improvement. DOE G 450.4-1A is the implementing guide.

- DOE P 450.5, LINE ENVIRONMENT, SAFETY AND HEALTH OVERSIGHT, defines the policy for Federal and contractor staffs to conduct Environment, Safety, and Health line oversight in a cost-effective, coordinated, integrated, and efficient manner. Quality assurance is implied by requiring compliance with applicable requirements, readiness assessments, verification reviews, for-cause reviews, and performance improvement.

- DOE O 420.1, FACILITY SAFETY, establishes facility safety requirements related to nuclear safety design, criticality safety, fire protection and natural phenomena hazards mitigation. It references standards required for certain safety applications, such as ANS-8.1-1983 that includes requirements for validating computer programs. DOE G 420.1-1 is the implementing guide.

- DOE O 5480.21, UNREVIEWED SAFETY QUESTIONS, sets forth the definition and basis for determining the existence of an Unreviewed Safety Question (USQ). The intent of this Order is to provide contractors with the flexibility needed to conduct day-to-day operations and to require that those issues with a potential impact on the authorization basis, and therefore the safety of the facility, be brought to the attention of DOE–thus maintaining the proper safety focus. The Order is focused on safety analysis of facilities, of which software could be a factor.

- DOE O 5480.22, TECHNICAL SAFETY REQUIREMENTS, states the requirements to have Technical Safety Requirements (TSR) prepared for DOE nuclear facilities and to delineate the criteria, content, scope, format, approval process, and reporting requirements of these documents and revisions thereof. The Order is focused on technical safety requirements of facilities, of which software could be a factor.

- DOE O 5480.23, NUCLEAR SAFETY ANALYSIS REPORTS, establishes requirements for contractors responsible for the design, construction, operation, decontamination, or decommissioning of nuclear facilities to develop safety analyses that establish and evaluate the adequacy of the safety bases of the facilities and to document this in Safety Analysis Reports (SAR), which includes addressing quality assurance.

- DOE M 411.1-A, SAFETY MANAGEMENT FUNCTIONS, RESPONSIBILITIES, AND AUTHORITIES, is a mechanism for implementing the Department's guiding principles established in DOE P 450.4, discussed above, and the safety management functions outlined in DOE P 411.1, SAFETY MANAGEMENT FUNCTIONS, RESPONSIBILITIES, AND AUTHORITIES POLICY.

- DOE G 421.1-1, GOOD PRACTICES GUIDE, is a comprehensive guidance document to assist in developing a criticality safety program to implement the DOE Order (or Rule) on nuclear criticality safety, and the invoked ANSI/ANS standards, through use of good practices. It provides brief information on SQA and verification, and an appendix on a software configuration control procedure.

Software and Software Quality Assurance. Below is a listing of directives for software and SQA or for quality assurance that imply SQA provisions.

- DOE O 200.1, INFORMATION MANAGEMENT, was canceled in FY 2000. It contained no explicit requirements for software development, but did reference DOE G 200.1-1, SOFTWARE ENGINEERING METHODOLOGY. DOE O 1330.1D, COMPUTER SOFTWARE MANAGEMENT, (superseded by DOE O 200.1) contained more explicit requirements for software development, including software quality assurance. A replacement Order is under development for DOE O 200.1.

- DOE N 203.1, SOFTWARE QUALITY ASSURANCE, specifies the requirements for an SQA program and SQA for projects. The Notice references DOE directives and industry standards applicable to safety or safety software. This Notice will be made into an Order.

- DOE G 200.1-1, SOFTWARE ENGINEERING METHODOLOGY, contains guidance in regards to the application of SQA on software projects. The Guide can and should be supplemented by site guidance to meet local needs. Included in the appendices in the guide are three SQA processes endorsed by the OCIO; i.e., In-Stage Assessment (ISA) process, Structured Walkthrough process, and the Stage Exit process.

- DOE O 414.1A, QUALITY ASSURANCE, states the requirements for DOE elements and contractors to develop Quality Assurance Programs (QAPs). The Order states, "The QAPs must discuss how it integrates and satisfies quality requirements or similar management system requirements (such as environmental or safety) from sources other than this Order." The Order directs organizations to develop an integrated management approach or system to show linkage among various organization functions and programs. It is consistent with the American Society of Mechanical Engineers (ASME) NQA-1 standard, which includes criteria for SQA. DOE O 5700.6C, QUALITY ASSURANCE (superseded by DOE O 414.1A), stated the quality criteria applied to all work and the items and services resulting from work. It referenced the national consensus standard ASME NQA-1.

- DOE G 414.1-2, QUALITY ASSURANCE MANAGEMENT SYSTEM GUIDE FOR USE WITH 10 CFR 830.120 AND DOE O 414.1 contains a section (4.6.3) related to the Design Process, which calls for validation of the software used in the design process and refers to ASME NQA-1 for acceptable methods. DOE G 830.120 (superseded by DOE G 414.1-2) was issued to implement 10 CFR 830.120, Quality Assurance. This guide clearly referenced the ASME NQA Part 2.7 for SQA.

Some Principal Secretarial Offices (PSO) have issued more specific guidance for their programs and field sites under their purview. For example, Civilian Radioactive Waste Management (RW) issued DOE/RW-0333P, "Quality Assurance Requirements and Description" as guidance for its programs such as the DOE Spent Nuclear Fuel and High

Level Waste program; and the former Office of Field Management issued a Good Practice Guide on Quality Assurance, which is available at the http://www.er.doe.gov/ website. (Once on the Office of Science website, at the end of the locator address type production/er-80/er-82/gpguides.html.)

Some sites have also issued specific guidance for their programs. For example, the Albuquerque Operations Office issued Quality Criteria (QC-1), invoked by reference in DOE/AL Supplemental Directive 56XB (Nuclear Weapon Development and Production Manual), which establishes general requirements for SQA of software used for specified functions in the design, production, and testing of weapons and weapons related materials; and the Development and Production (D&P) Manual, which references several Technical Business Practices (available on the official Nuclear Weapons Complex (NWC) http://prp.lanl.gov:8686/ website) for usage by the NWC.

DOE Technical Standards Program. The DOE Technical Standards program, which is managed by the Environment, Safety and Health (EH) organization at Headquarters, promotes the use of non-Government standards across the Department. The issuance of DOE standards is governed by Public Law 104-113, National Technology Transfer and Advancement Act of 1995; OMB Circular No. A-119, Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities; DOE O 252.1, TECHNICAL STANDARDS PROGRAM; DOE G 252.1-1, TECHNICAL STANDARDS PROGRAM GUIDE; and DOE's Technical Standards Program Procedures (TSPP). Public Law 104-113 requires that Federal agencies use existing voluntary consensus standards where they are available and suitable, and that Federal agencies work with standards development organizations to develop needed new standards.

EH also oversees the development of DOE technical standards, including information technology standards, as they relate to health and safety. The standards are not mandatory, but they can be mandated in an Order or clause. The process for proposing, developing, and maintaining DOE standards is contained in the TSPPs and explained in DOE G 252.1-1. Each organization's Technical Standards Manager is responsible for assisting in the implementation of the standards and assisting standards developers in their organization. Additional information on DOE Technical Standards and access to the Standards repository can be obtained on the http://tis.eh.doe.gov/techstds/ website.

Safety and Safety Analysis. Below is a listing of DOE standards on safety and safety analysis that contain provisions for software or imply software in the DOE Technical Standards program.

- DOE-STD-1027-92, HAZARD CATEGORIZATION AND ACCIDENT ANALYSIS TECHNIQUES FOR COMPLIANCE WITH DOE ORDER 5480.23, NUCLEAR SAFETY ANALYSIS REPORTS, establishes guidance for the preparation and review of hazard categorization and accident analyses techniques.

- DOE-STD-3009-94, PREPARATION GUIDE FOR U.S. DOE NONREACTOR NUCLEAR FACILITY SAFETY ANALYSIS REPORTS, establishes guidance for consistency with DOE O 5480.23 requirements and its safety guide, and describes a safety analysis report (SAR) preparation method for DOE. The standard contains a chapter on quality assurance.

Software and Software Quality Assurance. Below is a listing of DOE standards for software and SQA or for quality assurance that have SQA provisions in the DOE Technical Standards program.

- DOE-STD-4001-2000, DOE DESIGN CRITERIA STANDARD FOR ELECTRONIC RECORDS MANAGEMENT SOFTWARE APPLICATIONS, establishes the recommended method for meeting the functional requirements of the laws and regulations pertaining to managing records using electronic Records Management Application (RMA) software (submitted to the DOE Technical Standards program by the OCIO).

DOE Information Architecture (IA) Standards Program. The DOE IA Standards program is managed by the OCIO. The OCIO has the responsibility to lead, manage, integrate, and coordinate efforts centrally to achieve and implement standards to support the DOE IA. The purpose of the DOE IA is to ensure the wise stewardship of information technology resources by promoting a Departmental 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 of the program 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 *DOE IA Profile of Adopted Standards* (latest is version *2000*) 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 information technology standards activities. It is developed through consensus, with all of these representatives, thus ensuring that DOE Elements have a voice in the process. 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.

The *DOE IA Profile of Adopted Standards 2000* includes DOE standards, industry standards, and standards from recognized national and international bodies. These standards provide the framework and roadmap on how to accomplish successful projects and Departmental IA-compliant information technology solutions. The Profile is comprised of standards currently adopted in each of 10 service areas, reflecting the components of the Technical Reference Model necessary to build a complete technical infrastructure. The service areas are:

User	Application	Programming	Data Management	Data Interchange
Network	Operating System	Hardware Platform	Security	Management

For information on the *DOE IA Profile of Adopted Standards 2000*, access the http://cio.doe.gov/standards website. The *DOE IA Profile of Adopted Standards 2000*, DOE/SO-0002, January 2000 is available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge TN 37831 (423) 576-8401.

Safety and Safety Analysis. Below is a listing of DOE consensus standards on safety and safety analysis in the *DOE IA Profile of Adopted Standards 2000* that contain provisions for software or imply software.

- None.

Software and Software Quality Assurance. Below is a listing of DOE consensus standards for software and SQA or for quality assurance that have SQA provisions in the *DOE IA Profile of Adopted Standards 2000*.

- DOE G 200.1-1A (Draft), DOE Software Engineering Methodology (SEM) Version 2 (1999), is a lifecycle methodology providing guidance for software engineering, project management, and quality assurance.

- DOE-STD-4001-2000, DOE Design Criteria Standard for Electronic Records Management Software Applications, March 2000, establishes the recommended method for meeting the functional requirements of the laws and regulations pertaining to managing records using electronic Records Management Application (RMA) software (submitted to the DOE Technical Standards program by the OCIO).

- IEEE 828-1988, IEEE Standard for Software Configuration Management Plans, establishes minimum required contents of a software configuration management plan and defines specific activities to be addressed.

- IEEE 1042-1987 (R1993), Guide to Software Configuration Management, discusses context, process, implementation, tools, techniques, supplier control, records management, and planning methodologies for software configuration management.

- ISO 9000, Quality Management and Quality Assurance Standards - Guidelines for Selection and Use, contains a consensus on the essential features of a quality system to ensure the effective operation of a business, whether a manufacturer or service provider, or other type of organization, either in the public or private sector.

- ISO 10005:1995, Quality Management - Guidelines for Quality Plans, provides guidance for preparing quality plans for control of specific products, projects, or contracts.

Quality Assurance Working Group (QAWG). The QAWG is composed of senior QA professionals throughout DOE, both Federal and contractor staffs. The QAWG addresses QA problems as they arise and advises the Deputy Secretary (i.e., the Chief Operating Officer) on the health of DOE QA programs. In support of line management, the QAWG:

- Identifies and recommends resolution of crosscutting QA issues impacting the safety of the worker, the public, and the environment

- Provides appropriate recommendations to the Deputy Secretary through the Field Management Council (FMC) for action by Field Elements and/or their contractors

- Proposes and comments on Departmental positions on QA safety issues, policies, and guidance

- Periodically reports on the status of identified crosscutting QA safety issues requiring resolution

- Identifies other DOE crosscutting organizations and work on integrated efforts to improve the efficiency and effectiveness of the Department QA and Integrated Safety Management programs

- Assists with implementation of QA safety recommendations

The QAWG can issue QA requirements, guides, and standard documents, which would be issued through the DOE Directives System or DOE Technical Standards program. For more information on the QAWG, access the http://twilight.saic.com/qawg website.

Federal Technical Capability Panel. The Federal Technical Capability Panel was created by DOE P 426.1, FEDERAL TECHNICAL CAPABILITY POLICY FOR DEFENSE NUCLEAR FACILITIES, and is responsible for implementing the program supporting that policy. The Panel, which consists of senior technical managers from across the Department, oversees the implementation of the Senior Technical Safety Manager and Facility Representative programs. The elements of this program include recruiting and hiring technically capable personnel, continuously developing the technical expertise of the workforce, and retaining critical technical capabilities within the Department at all times. The Panel also performs periodic assessments of the effectiveness of the recruitment, development and retention of technically capable DOE personnel. The Panel is described in the DOE M 411.1-1, SAFETY MANAGEMENT FUNCTIONS, RESPONSIBILITIES, AND AUTHORITIES MANUAL. Information on the Panel can be obtained on the Environment, Safety, and Health http://tis.eh.doe.gov website.

Field Management Council (FMC). The FMC was created by a Secretarial memo dated April 21, 1999, and charged with "corporate program integration and the integration of support activities with line programs." It was established to ensure consistent implementation of DOE policy in environment, safety, and health; safeguards and security; and business management. All staff and support office policy and guidance which impact the field must flow through the FMC. Policies and guidance developed by the staff and support offices are reviewed by the FMC and, if approved, passed to the Lead Principal Secretarial Officers (LPSO) for implementation. It is the responsibility of the FMC to ensure consistency in the application of DOE policy and to maximize uniformity of operational management approaches. Any conflict between a Principal Secretarial Officer (PSO) and the LPSO, or among PSOs, concerning direction to the field is resolved by the FMC. The FMC is chaired by the Deputy Secretary, and includes the Under Secretary, the Assistant Secretaries for Defense Programs and Environmental Management, and the Director of the Office of Science. Two other members, one from among the other PSOs and the other a Field Element Manager (FEM), serve in rotation. The FMC recently assumed the responsibilities of the former Secretarial Safety Council, which was formed to provide DOE with leadership and guidance to meet integrated safety management targets; develop and maintain performance standards to be used to hold Federal personnel accountable for effective and timely implementation of integrated safety management, and to oversee the viability and effectiveness of the DOE employee concerns program. The Secretarial Safety Council was composed of the same senior managers as the FMC and chaired by the Deputy Secretary. The FMC is described in the DOE M 411.1-1, SAFETY

MANAGEMENT FUNCTIONS, RESPONSIBILITIES, AND AUTHORITIES MANUAL. The FMC does not have a website.

Departmentwide Systems Engineering Process Group (DSEPG). The DSEPG, which is sponsored by the OCIO, provides advice and support on the development and maintenance of DOE information systems and software management programs by developing DOE directives or recommending flexible and adaptable industry standard project management, information systems engineering, and quality assurance guidance, procedures and other support. The mission of the DSEPG is to move the Department towards achieving higher levels of capability, maturity, and quality in information system solutions provided to the DOE customer. Membership includes volunteers from Headquarters and field sites, both Federal and contractor staffs. Thus far, the DSEPG has developed one guidance document–*Volume 1, Information Systems Engineering Guide*, of the *Departmental Information Systems Engineering (DISE)* series. Both safety and SQA are addressed in this guide. Information on the DSEPG will be appearing on the http://cio.doe.gov/smp (soon to be http://cio.doe.gov/sqse) website.

1.1.2 Contractor Standards Programs and Organizations

Contractors are required to follow applicable DOE directives and standards, usually through a general statement or a specific listing in DOE contracts. Contractors also follow their own internal processes and procedures, which are generally based on industry standards. Several of the Management and Operating (M&O) contractors are moving toward Software Engineering Institute (SEI) or International Organization of Standards (ISO) 9000 certifications, which are intended to result in better management of software.

There are several contractor groups that meet regularly to establish and promote best practices for safety and software. The most notable for safety is the Safety Analysis Working Group (SAWG) of the Energy Facilities Contractor Group (EFCOG). Also, a new temporary group called the Safety Analysis Software Group (SASG), led by DP, EH, and EM, has been established to address software issues for safety analysis and I&C software. The most notable contractor groups for software and systems engineering are the Software Quality Assurance Subcommittee (SQAS) and the DOE International Council on Systems Engineering (DOE INCOSE).

The Energy Facility Contractors Group (EFCOG) and **The Safety Analysis Working Group (SAWG)**. The EFCOG is a self-directed group of Management and Operating (M&O) contractors, Management and Integrating (M&I) contractors, and Environmental Restoration Management Contractors (ERMC) of DOE facilities. The purpose of the EFCOG and the SAWG, a working group of EFCOG, is to promote excellence in all aspects of operation and management of DOE facilities in a safe, environmentally sound,

more efficient and cost-effective manner through the ongoing exchange of information. Through meetings, workshops and conferences, working group participants share proven (not theoretical or philosophical) management and technical processes, procedures, and programs. They also share both positive and negative lessons learned. The exchange of best practices and information between EFCOG members across the DOE complex is achieved without regard to competitive boundaries. EFCOG/SAWG has a publications library on their website. For more information on EFCOG and SAWG, access the http://www.efcog.org website. (SAWG can be accessed after getting on the EFCOG website by clicking on Work Groups, then Working Groups and Subgroups, then Safety Analysis.)

Safety Analysis Software Group (SASG). The SASG is initially established as a temporary group to respond to the Defense Nuclear Facilities Safety Board (DNFSB) Technical Report 25 regarding issues for safety analysis and I&C software. The group is led by three Headquarters Federal employees (one each in DP (chair), EH, and EM) and is comprised of DOE and contractor subject matter experts in safety analysis, software development, SQA, and authorization basis implementation. Their task is challenging since the management of the safety analysis function and the organization of technical staff at M&O contractors in the DOE nuclear complex vary considerably. The spectrum spans a centralized safety analysis (or authorization basis) organization to individual facilities, each relying on outside consultants. Since there are a large number of widely scattered analysts performing safety analyses, the SASG serves as a centralized group and will try to obtain coordinated support from the EFCOG. The SASG provides:

- Leadership for DOE and its contractors in safety analysis, design, and I&C software issues relating to safe design and operation of DOE nuclear facilities
- A mechanism to identify, address, and disposition major safety and I&C software issues that have crosscutting impact across DOE
- Identification of support mechanisms and resource allocation from stakeholder contractors and line organizations in the Department

As part of its advisory activities, the SASG has responsibility for identifying model improvements, and recommending new software development. This activity incorporates not only DOE applicability and needs, but references "like" facilities and safety basis analytical support modeling advances found in commercial industry. The SASG will work with the EFCOG to ensure that the newer versions of tool-box software are placed into proper configuration management, that users are notified of changes, and earlier versions are retired. This configuration management process will follow software lifecycle protocol, per standards identified by the Software Quality Assurance Subcommittee

(SQAS) and the working group on policy. The initial activities by the SASG will eventually be the basis for a permanent expert and advisory team in a DOE nuclear national laboratory. As needs and specific issues arise, the advisory team will change in numbers and skill mix to meet these challenges at the appropriate level.

The SASG will use existing safety analysis Internet links to inform users of safety analysis issues. Software user alerts will be communicated via the EFCOG/SAWG website, listed above. This website will be expanded to:

- Provide lessons learned in the application of codes in safety analysis
- Share benchmark data and test problem sets
- Maintain site-specific data sets such as site distances, meteorological data, etc.
- Message board features that communicate software news and developments, and user feedback.

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

SQAS has developed several guidance documents for the NWC, some of which can be and are recommended for Departmentwide use. Most of the documents were developed based on industry standards and guidance from the Software Engineering Institute (SEI). For more information on SQAS, access the http://cio.doe.gov/sqas website. Also, as stated previously, several Technical Business Practices used by the NWC (as referenced in the Development and Production (D&P) Manual) can be accessed on the official NWC http://prp.lanl.gov:8686/ website.

International Council on Systems Engineering (INCOSE) and the DOE INCOSE Systems Engineering (SE) Practices Interest Group. (See also 1.3.1 INCOSE.) DOE employees participate in INCOSE and have formed the DOE SE Practices Interest Group

(DOESEPIG), which is a technical committee of INCOSE. The DOESEPIG 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. They can be accessed through the INCOSE website at http://www.incose.org by clicking on Table of Contents, then scrolling down to Working Groups and Interest Groups. The former Headquarters Field Management (FM) organization had close ties to this group. Some Headquarters members attend its annual meeting.

1.2 Other Government Standards

DOE interacts with other U.S. Government agencies on a regular basis in the course of fulfilling the DOE mission. These agencies develop and maintain standards to support the accomplishment of their missions, to enable computer systems to interface and communicate with each other, and to ensure the health and safety of the general public, where that is a concern. DOE also interacts with other agencies to both ensure standards compatibility and to assess the maturity of DOE processes and standards relative to other agencies.

Other Government agencies can be a good benchmark since they also must comply with the same legislation (such as the Clinger-Cohen Act and OMB Circular A-130, which specify information technology requirements and practices) and external agency direction and review such as OMB and GAO. In regards to nuclear safety management, DOE must comply with 10 CFR Part 830, Nuclear Safety Management (which includes guidelines on quality assurance) and the Price-Anderson Act. These legislative acts have been implemented through the DOE directives noted in Section 1.1.1.

Some of the government agencies DOE interfaces with are the Nuclear Regulatory Commission, Department of Defense, Department of Transportation, National Institutes of Standards and Technology, National Aeronautical and Space Administration, and Defense Threat Reduction Agency.

1.2.1 U.S. Nuclear Regulatory Commission (NRC)

The NRC is an independent agency established by the U.S. Congress under the Energy Reorganization Act of 1974 to ensure adequate protection of public health and safety, common defense and security, and the environment in the use of nuclear materials in the United States. The NRC's scope of responsibility includes regulation of commercial nuclear power reactors, nonpower research, test, and training reactors, fuel cycle facilities, medical, academic, and industrial uses of nuclear materials, and the transport, storage, and disposal of nuclear materials and waste.

The NRC provides a Standards website which supports NRC's strategy to increase involvement by licensees and others in its regulatory development process consistent with the National Technology and Transfer Act of 1995. Compiled on this website at http://www.nrc.gov/NRC/REFERENCE/STANDARDS/index.html is information on NRC's participation in the development and use of consensus standards. NRC also has developed several standards (1.168 through 1.173) for software used in safety systems that are available at the http://www.nrc.gov/NRC/RG/01/index.html website. In addition, the NRC has developed "NUREG-0800, the Standard Review Plan," that contains Section 7.0 Instrumentation and Control–Overview of Review Process, which is directed at the staff review of I&C safety systems (called BTP-14) in reactor designs. The review guidance is specialized to real-time process control safety (especially reactors).

1.2.2 U.S. Department of Defense (DOD)

The DOD is responsible for providing the military forces needed to deter war and protect the security of our country. In doing so, DOD interacts in joint DOE/DOD missions. Recognizing the importance of providing official, timely and accurate information about defense policies, organizations, functions and operations, DOD established an information repository called DefenseLINK. DefenseLINK is the single, unified starting point for finding military information online. It can be accessed on the http://www.defenselink.mil website.

In 1994, DOD began an effort to reform its standards and specifications program and established the DOD Standards Improvement Council. Within one year, 1200 commercial standards were adopted, and an initiative for a national software development standard was proposed. The Defense Standardization Program is managed by the Center for Information Technology Standards under the auspices of the Defense Information Systems Agency (DISA). The DISA Standards Library can be accessed on the http://www.itsi.disa.mil website. DOD also has another organization, the Defense Technical Information Center, which is under the auspices of DISA as well, to facilitate the exchange of scientific and technical information (see the http://www.dtic.mil website). DISA is available at the http://www.disa.mil website. Military specifications and standards, federal specifications and standards, QPLs, CIDs, DIDs, and other standardization documents, can be ordered by visiting the DOD Single Stock Point (DODSSP) website. Registration for an account and password for the Acquisition Streamlining and Standardization System (ASSIST), which will enable access to standardization documents directly through your Web Browser, is available. For additional information on U.S. DOD standards, access the http://dodssp.daps.mil or http://dodssp.daps.mil/assist.htm website.

1.2.3 U.S. Department of Transportation (DOT)

DOE must interact with DOT because of the transport of defense nuclear materials throughout the United States and the world. The mission of the DOT is to serve the United States by ensuring a fast, safe, efficient, accessible and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people, today and into the future. The DOT consists of eleven individual operating administrations including the Bureau of Transportation Statistics, U.S. Coast Guard, the Federal Aviation Administration, the Federal Highway Administration, the Federal Railroad Administration, the Federal Transit Administration, the Maritime Administration, National Highway Traffic Safety Administration, the Research and Special Programs Administration, the Saint Lawrence Seaway Development Corporation, the Surface Transportation Board and the Transportation Administrative Services Center. For more information on the DOT, access the http://www.dot.gov website.

To expedite the development and deployment of interoperable Intelligent Transportation Systems (ITS) and services, the U.S. DOT supports standards activities in areas that have significant public benefit. ITS standards are industry consensus standards that specify how different technologies, products, and components interconnect so they can be used within a consistent framework. The framework is known as the National ITS Architecture. The standards can be accessed at the http://www.its.dot.gov/Standard/Standard.htm website.

1.2.4 The National Institutes of Standards and Technology (NIST)

NIST is an agency of the U.S. Department of Commerce's Technology Administration. Established in 1901, NIST strengthens the U.S. economy and improves the quality of life by working with industry to develop and apply technology, measurements, and standards. Under the Information Technology Management Reform Act (Public Law 104-106), known as the Clinger-Cohen Act, the Secretary of Commerce approves standards and guidelines that are developed by NIST for Federal computer systems. These standards and guidelines are issued by NIST as Federal Information Processing Standards (FIPS) for use government-wide.

Also, the National Center for Standards and Certification Information (NCSCI) at NIST is the ISO Information Network (ISONET) member for the United States (see http://ts.nist.gov/ts/htdocs/210/217/bro.htm website). ISONET is a worldwide network of national standards information centers which have cooperatively agreed to provide rapid access to information about standards, technical regulations, and testing and certification activities currently used in different parts of the world. NIST's Information Technology Laboratory (ITL) concentrates on developing tests and test methods for

information technologies that are still in the early stages of development, and once products are available, tests to allow developers and users to evaluate how products perform and assess their quality based on objective criteria. For more information on ITL or NIST, access the http://www.nist.gov website.

NIST has recently prepared a study which examines the contents of an SQA standard for nuclear applications, available at http://hissa.ncsl.nist.gov/publications/nistir4909/ website. The study includes recommendations for the documentation of software systems. Background information on the standard, documentation, and the review process is provided. The report includes an analysis of the applicability, content, and omissions of the standard and compares it with a general SQA standard produced by the Institute of Electronics and Electrical Engineers (IEEE). Information is provided for the content of the different types of documentation. This report describes information for use in safety evaluation reviews. Many recommendations in this report are applicable for SQA in general.

1.2.5 National Aeronautical and Space Administration (NASA)

NASA is an independent agency established by the U.S. Congress in 1958 to conduct space missions and for national defense. It is a Federal research and engineering agency that accomplishes most of its space, aeronautics, science, and technology programs through Field Centers and contractors across the United States. It consists of the NASA Headquarters, nine Centers, the Jet Propulsion Laboratory (operated by the California Institute of Technology), and several ancillary installations and offices in the United States and abroad. Its mission is to advance and communicate scientific knowledge and understanding of the Earth, the solar system, and the universe; to advance human exploration, use, and development of space; and to research, develop, verify, and transfer advanced aeronautics and space technologies. For more information on NASA, access the http://www.nasa.gov or http://www.nasa.gov/search website.

NASA has developed an Information Technology program to enhance the safety and security of the National Airspace System through the development of technologies for systems control and operations, and flight critical software systems. Two significant projects are the Intelligent System Controls and Operations (ISCO) project and the Software Integrity, Productivity and Security (SIPS) project. The program can be viewed on the http://www.nas.nasa.gov/IT/test/index.htm website. Also, the NASA Ames Research Center (ARC) is NASA's "Center of Excellence" for information sciences and technologies, and is available at the http://www.arc.nasa.gov website. Contained within ARC are the System Safety and Mission Assurance Office, and the Quality Management Program Office. Additionally, information on High Performance Computing and Communications is available at the http://hpcc.arc.nasa.gov website.

1.2.6 Defense Threat Reduction Agency (DTRA)

DTRA was created to integrate and focus the capabilities of DOD which address the weapons of mass destruction (WMD) threat. DTRA safeguards the United States and its friends from WMD by reducing the present threat and preparing for the future threat. DTRA's work covers a broad spectrum of activities – shaping the international environment to prevent the spread of WMD; responding to military requirements to help the United States deter, withstand, prevail against and recover from the use of such weapons; and preparing the warfighter to counter the full spectrum of future WMD threats. DTRA can be accessed on the http://www.dtra.mil website.

One of DTRA's major mission areas is Technology Development which focuses on several areas, three of which are the Scientific Computing Program, Radiation Test Facilities and Capabilities, and Hazard Prediction Assessment Capability (HPAC). The DTRA Scientific Computing Program is responsible for DOD's High Performance Computing Modernization Program (HPCMP), whose mission is to modernize the total high performance computational capability of DOD Science and Technology (S&T), Development Test and Evaluation (DT&E) and Ballistic Missile Defense Organization (BMDO). Use of DTRA scientific computing resources at DTRA, Los Alamos National Laboratory (LANL) and the High Performance Computing (HPC) sites are available to both contractor and government organizations who are performing research under contract with DTRA. Two products that are readily available are a brochure describing the Radiation Test Facilities and Capabilities and its resources, and HPAC software which predicts the effects of hazardous material releases into the atmosphere and its collateral effects on civilian and military populations. The HPAC software is available by license from the DTRA, to U.S. government entities, their contractors, and educational institutions for non-commercial research. DTRA has published several documents in nuclear radiation and safety software but they are not listed on the website.

1.3 Industry Organizations and Standards

For compliance with legislation to use consensus standards and facilitate management improvements, DOE practices are generally based on guidance from industry organizations and standards. The following sections focus on industry organizations and standards for general software and safety software.

1.3.1 Software and Engineering Organizations and Standards

Major industry organizations, who address issues on various software topics regarding information systems engineering, project management, and quality assurance, include the Software Engineering Institute (SEI), International Council on Systems Engineering

(INCOSE), Electronic Industries Alliance (EIA), Institute of Electronics and Electrical Engineers (IEEE), the International Organization for Standardization (ISO), American Society of Mechanical Engineers (ASME), American National Standards Institute (ANSI), American Nuclear Society (ANS), Society for Automotive Engineers (SAE), American Society for Quality (ASQ), Quality Assurance Institute (QAI), and Project Management Institute (PMI®). DOE Federal and contractor organizations use standards and guidance from these organizations to accomplish missions.

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. Searches for software information such as "defense nuclear facilities safety and safety analysis software" can be made by accessing the http://www.sei.cmu.edu/about/website/search.html website.

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. Many Federal and contractor organizations are seeking improvement in their software projects by using the SEI Software CMM (SW-CMM). It is estimated that about 50 percent of software contractors nationwide are self-assessed at SW-CMM Level 2; i.e., they have the basic project management processes for project planning, project tracking and oversight, configuration management, requirements management, and quality assurance instituted in their organization. For more information on SEI, access the http://www.sei.cmu.edu website.

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. Another is the Systems Engineering Management Methodology Working Group, whose purpose is to create, coordinate, and disseminate process definitions and methods for planning, organizing, integrating, and controlling the technical aspects of a project throughout a system's lifecycle. INCOSE has a publications library on its website. For more information on INCOSE, access the http://www.incose.org website.

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. Over 4,000 standards have been developed. Included in its resource listings are publications on system safety engineering and software. For more information on EIA and EIA standards, access the http://www.eia.org/ website.

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, and many other areas.

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. IEEE has issued several standards for software, SQA, and safety software. Two notable ones are IEEE 1228, Standard for Software Safety Plans, and IEEE 1044, Standard Classification for Software Anomalies. Additional information on IEEE standards can be viewed at the http://standards.ieee.org website. For more information on IEEE, access the http://www.ieee.org website.

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 published as International Standards. The ISO 9000 series of standards provides a framework for quality management and quality assurance, as well as other related ISO standards. The 9000 series are "management" standards rather than project-application standards. For more information on ISO and ISO standards, access the http://www.iso.ch website.

American Society of Mechanical Engineers (ASME). Founded in 1880 as the American Society of Engineers, today ASME International is a nonprofit educational and technical organization serving a worldwide membership. The ASME conducts one of the world's largest technical publishing operations, holds some 30 technical conferences and 200 professional development courses each year, and sets many industrial and manufacturing standards. Since 1884, when the first performance test codes were developed, ASME International has pioneered the development of codes, standards and conformity assessment programs. ASME maintains and distributes 600 codes and standards used around the world for the design, manufacturing and installation of mechanical devices. Two notable standards are NQA-1-1994, Quality Assurance Program Requirements for Nuclear Facilities, and NQA-1-1997, Quality Assurance Requirements for Computer Software for Nuclear Facility Applications. For more information on ASME, access the http://www.asme.org/ website.

The American National Standards Institute (ANSI). ANSI has served in its capacity as administrator and coordinator of the United States private sector voluntary standardization system for more than 80 years. Founded in 1918, the Institute remains a private, nonprofit membership organization supported by a diverse constituency of private and public sector organizations. ANSI has as its primary goal the enhancement of global competitiveness of United States business and the American quality of life by promoting and facilitating voluntary consensus standards and conformity assessment systems and promoting their integrity. ANSI does not itself develop American National Standards; rather, it facilitates development by establishing consensus among qualified groups. ANSI-accredited developers support the development of national and, in many cases, international standards, addressing the critical trends of technological innovation, marketplace globalization and regulatory reform. ANSI has a website at http://www.nssn.org that allows searches for standards by title, designation, sponsoring organization, or key word. For more information on ANSI, access the http://web.ansi.org/ website.

American Nuclear Society (ANS). ANS is a not-for-profit, international, scientific and educational organization. It was established by a group of individuals who recognized the need to unify the professional activities within the diverse fields of nuclear science and technology. December 11, 1954, marks the Society's historic beginning at the National Academy of Sciences in Washington, D.C. ANS has since developed a multifarious membership composed of approximately 11,000 engineers, scientists, administrators, and educators representing 1,600 plus corporations, educational institutions, and government agencies. It is governed by three officers and a board of directors elected by the membership.

ANS creates only a portion of the standards for the nuclear industry, which can be viewed on the http://store.ans.org website. The NAS-10 standards address mathematics and computation, and include some computer programming. The ANS-8 standards address a Criticality Safety Committee. One notable standard used at DOE is ANSI/ANS-10.4-1987, Guidelines for the Verification and Validation of Scientific and Engineering Computer Programs for the Nuclear Industry. For more information on ANS, access the http://www.ans.org website.

Society for Automotive Engineers (SAE). SAE provides technical information and expertise used in designing, building, maintaining, and operating self-propelled vehicles for use on land or sea, in air or space. Founded in 1905, nearly 80,000 engineers, business executives, educators, and students from more than 97 countries form a network of members who share information and exchange ideas for advancing the engineering of mobility systems. The SAE Cooperative Research Program helps facilitate projects that benefit the mobility industry as a whole. Also, technical committees are formed to write aerospace and automotive engineering standards, technical papers, books, and periodicals.

SAE maintains liaisons with a number of organizations to fully coordinate its standards and avoid duplication. The SAE Cooperative Engineering Program provides many standards each year that contain part and product qualification procedures. These procedures aid manufacturers in the production of quality products and save valuable engineering time. SAE publishes many new, revised, and reaffirmed standards each year in three categories: Ground Vehicle Standards (J-Reports); Aerospace Standards; and Aerospace Material Specifications (AMS). SAE Aerospace Standards are used extensively by the military services as well as by the private sector. Over 2,300 SAE Aerospace Material Specifications, covering a vast array of material and processes, are available to the aerospace engineer. Combine these with 2,100 more documents on a wide variety of subjects makes SAE the world's largest producer of non-government aerospace standards. For more about SAE, access the http://www.sae.org and http://www.normas.com websites.

1.3.2 Quality 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.

American Society for Quality (ASQ). Founded in 1946, ASQ advances individual and organizational performance excellence worldwide by providing opportunities for learning, quality improvement, and knowledge exchange. ASQ has more than 120,000 individual and 1,100 sustaining members. Since the establishment of its first certification program in 1966, ASQ has certified more than 80,000 quality practitioners as quality engineers, quality auditors, reliability engineers, quality technicians, mechanical inspectors, quality managers, and software quality engineers.

ASQ is charged with administering the standards committees on behalf of the American National Standards Institute (ANSI). The committees can be grouped within four broad technical disciplines: Quality Management, Environmental Management, Dependability, and Statistics; i.e., QEDS. As the secretariat for the ANSI Accredited Standards Committee (ASC) Z1 Committee on QEDS, ASQ provides direction on and builds consensus for national and international standards. ASQ plays a key role in developing the ISO 9000 series standards, which were originally adopted nationally as the Q90 series standards, and recently revised and redesignated as the Q9000 series standards. They do so through their involvement in the U.S. Technical Advisory Group for ISO Technical Committee 176, administered by ASQ on behalf of ANSI. (ANSI represents the U.S. within ISO.) ASQ is also the secretariat for ISO Technical Committee 69 Subcommittee 1 on Terminology and Symbols. In addition, ASQ administers the U.S. Technical Advisory Groups for several committees. For more information on ASQ, access the http://www.asq.org/ website.

Quality Assurance Institute (QAI). QAI was founded in 1980, and is an international organization of member companies in search of effective methods for defect detection/software quality control and defect prevention/software quality assurance. QAI's goal is to become the international standard of definition for professional status as an information services quality practitioner, and to provide leadership to the information services profession in improving quality, productivity, and effective solutions for process management. QAI provides leadership and state-of-the-art solutions in the form of consulting, education services, and assessments. It is exclusively dedicated to partnering with the enterprise-wide Information Quality profession for improving enterprise-wide information quality.

QAI offers three professional level certifications; namely, Certified Quality Analyst (CQA) for competency in the principles and practices of quality assurance in the information technology profession; the Certified Software Test Engineer Program which is intended to establish standards for initial qualification and provide direction for the testing function; and the Certified SPICE Assessor Program for ISO/IEC TR 15504 conformant assessments. For more information on QAI, access the http://www.qaiusa.com/ website.

Project Management Institute (PMI®). Since its founding in 1969, PMI® has become the organization of choice for project management professionalism. With over 70,000 members worldwide, PMI® is the leading nonprofit professional association in the area of project management. PMI® establishes project management standards, provides seminars, educational programs and professional certification. PMI®'s "A Guide to the Project Management Body of Knowledge (PMBOK® Guide)" was approved by ANSI as an American National Standard, ANSI/PMI 99-001-1999.

In addition, the PMI® Education Department supports the development of standards for accrediting degrees in project management and approving curriculums for master certificates in project management. PMI® also conducts a certification program in project management. PMI®'s Project Management Professional (PMP) credential is the project management profession's most globally recognized and respected certification credential. Worldwide there are over 20,000 PMPs who provide project management services in 26 countries. For more information on PMI®, access the http://www.pmi.org/ website.

1.3.3 Software Safety Organizations and Standards

Several organizations have been established to specifically address software system safety. Among these are the System Safety Society, the National Safety Council, and the International Safety Council. Additionally, in 1999, a Software Safety System Handbook was developed through a joint effort of Federal government staffs.

System Safety Society. Founded in 1964, the System Safety Society is composed of membership extending to over a dozen countries and a variety of professional occupations. It is a professional organization dedicated to the promotion of the system safety concepts at the local, national and international level to:

- Advance the state-of-the-art of system safety
- Contribute to a meaningful understanding of system safety
- Disseminate newly developed knowledge to all interested groups and individuals
- Further the development of the professionals engaged in system safety
- Improve the public understanding of the system safety discipline

- Improve the communication of the system safety movement and discipline to all levels of management, engineering, and other professional groups

Avoiding hazards has been a concern for some time; however, formalized efforts to incorporate activities specifically oriented toward hazard identification and control on a comprehensive and total lifecycle basis has occurred only in recent times. Safety publications endorsed by the System Safety Society include:

- MIL-STD-882, DOD Standard Practice for System Safety - released February 2000
- Software System Safety Handbook - A Technical and Managerial Team Approach - released December 1999
- MIL-STD-1472F, DOD Design Criteria Standard Human Engineering - released August 1999
- System Safety Analysis Handbook, 2nd edition, - released August 1999

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

National Safety Council (NSC). Founded in 1913, the NSC has served as the premier source of safety and health information in the United States. The Council is a nonprofit, governmental, international public service organization dedicated to improving the safety, health and environmental well-being of all people. An Act of Congress on August 13, 1953, created the Council as a body incorporated under Federal law; i.e., Public Law 259 of the 83rd Congress formally established NSC as a federally chartered organization. The charter mandates that the Council be nonpolitical and not contribute to or otherwise assist any political party or candidate. The mission of the NSC is to educate and influence society to adopt safety, health and environmental policies, practices and procedures that prevent and mitigate human suffering and economic losses arising from preventable causes. The Council has been working for generations to protect lives and promote health with innovative programs.

NSC does not issue standards, but does sell some ANSI standards. Various services, resources, and products are available. For more information on the NSC, access the http://nsc.org/ website.

The International Safety Council (ISC). The ISC is the National Safety Council's global subsidiary. Established in 1913, ISC is a not-for-profit, nongovernmental, membership based organization committed to the mission of protecting life and promoting

health. Over 17,000 members represent more than 70 countries around the world and include industry, labor, government, community groups and associations. They provide training, expertise, products and services related to all areas of safety, health and the environment. For more information on the ISC, access the http://safety.webfirst.com/isc.htm website.

Joint Software System Safety Handbook. The development of this Handbook is a joint effort by the U.S. Army, Navy, Air Force, and Coast Guard Safety Centers, in cooperation with the FAA, NASA, defense industry contractors and academia. The research involved captures the "best practices" pertaining to software safety systems program management and safety critical software design. The Handbook consolidates these contributions into a single, user-friendly resource guide for use in the understanding of both the complete software safety systems and the contribution of each functional discipline in identifying, controlling, and managing software-related hazards within safety-critical components of hardware systems.

For more information on, or to download the Joint Software System Safety Handbook, access the System Safety Society at the http://www.system-safety.org website. Other sources of the Handbook or safety information are the Navy Surface Warfare Center, which can be accessed at the http://www.nswc.navy.mil/safety website, and the Air Force Safety Center at the http://www.usaf.com/orgs/12.htm website.

2.0 Standards Analysis

In Technical Report 25, the Board expressed concern that there is no comprehensive set of standards in place for ensuring quality software. In regards to industry standards for SQA, the Board stated that DOE had not formally promulgated guidance that clearly defines which of those requirements are appropriate for use by its contractors. They further stated that there is a lack of guidance for safety analysts on the use of codes for performing safety analyses. Also, the Board referenced instances in which requirements for rudimentary SQA have been contractually stipulated, but did not flow down to implementation at the floor level. The Board further stated that although some quality processes are conducted, overall they are fragmented or isolated, and not integrated with safety.

The Board felt that DOE should clearly define requirements that are appropriate for use by its contractors. Possible resolutions or improvements provided by the Board included better documentation that would address consistent interpretation of parameter values, proper code utilization, use in bounding value calculations, postprocessors, use of industry standards, and a special emphasis on accident analysis codes and instrumentation and control (I&C) codes.

The independent evaluations and survey were conducted with these concerns in mind. This section addresses the findings, assessments, and gap analyses. Recommendations are provided.

2.1 Assessment of Independent Evaluation

Section 1.1 described the Departmental approach to software in general and in regards to safety software. The high-level directives infrastructure for safety and QA appears to be in place. The guidance in the QA rule, DOE O 414.1A, and other guidance issued by EH and the ASME NQA-1 standard are facility-oriented rather than product-oriented, such as Quality Criteria-1 (QC-1) issued by the Albuquerque Operations Office. Although the QA Rule and Order do not specify requirements and expectations for software, they apply to all work, and software development and use is considered one type of work. After the SASG reviews the directives infrastructure for safety software at the field sites, a determination should be made whether a Departmental directive is needed for safety software.

The OCIO agreed with the DNFSB that high-level direction for software needed to be improved. A replacement Order for DOE O 200.1, INFORMATION MANAGEMENT, is in process by the OCIO. DOE N 203.1, NOTICE FOR SOFTWARE QUALITY ASSURANCE, was issued to bring about improvement in software management. Further

actions will be taken to assess the adequacy of DOE's expectations and requirements for software systems management. As a positive, although no data was collected, verbal exchanges and interactions with DOE Federal and contractor groups affirm that implementation of SEI Level 2 processes is taking place.

Several of the Other Government organizations have standards programs and have identified a set of consensus standards that can be used as benchmarks. Some of the websites provide contact names. Industry organizations are addressing safety software issues and have issued standards and guidance that appear to be very appropriate for the DOE environment. DOE contractor organizations have even participated in the development of some of the guidance.

2.2 Assessment of Survey Results

A compilation of the survey is contained in Attachment 3. The following questions were asked in the survey, and the tentative analysis results of the answers follow each question. As an overall, many sites have their own local standards, with an additional half-dozen industry standards being frequently mentioned by those sites not having local guidance. Also, about two dozen programs common to many sites both within and outside DOE are mentioned, exclusive of local spreadsheets and other software unique to single facilities (e.g., blast codes). Some of the former are NRC or proprietary codes with firm QA, others are ad hoc and not particularly QA-ed. It appears that the software that most strongly supports safety (as opposed to rough, conservative measures of release consequences) are the most reliable.

I.1 What documented SQA programs or procedures do you follow for computer codes used for safety analysis in the areas of:

a) Software Development
b) Software Testing
c) Software Documentation
d) Software Maintenance
e) Software Usage

For the above, identify (1) which are DOE, in-house, and industry developed; (2) which are mandatory, and (3) what is the nature of the software quality assurance processes; i.e., structured walkthrough, peer review, inspection, audit, testing, etc.

Results: Sites indicate they have mandated internal developed processes for lifecycle management of DOE software. They indicate they do some form(s) of QA activity but a formal SQA program appears to be lacking.

I.2 Do these procedures comply with the following (check compliance and indicate whether in whole or in part):

a. DOE Order 420.1, *Facility Safety*
b. DOE Order 414.1, *Quality Assurance*
c. DOE Order 200.1, *Information Management Program*
d. DOE Guide 200.1-1, *Department of Energy Software Engineering Methodology*
e. DOE Guide 414.1-1, *Assessment Guide for QA* (esp., section 4.6.3)
f. Other Industry Standards, Requirements, or Guidelines (including, but not limited to)
   - American Nuclear Society, ANSI/ANS-10.4-1987, *Guidelines for the Verification and Validation of Scientific and Engineering Computer Programs for the Nuclear Industry*
   - American Society of Mechanical Engineers, 1997, *Quality Assurance Requirements for Computer Software for Nuclear Facility Applications*, NQA-1-1997 (esp. Part 2.7)
g. Others?

Results: Sites indicate a range of compliance with the above directives either "in part" or "whole". Some have mapped their directives to the Departmental directives. A couple of organizations indicate they are still under contract to adhere to canceled Orders such as:

- DOE 5480.28, *Natural Phenomena Hazards Mitigation*
- DOE 5480.7A, *Fire Protection*
- DOE 6430.1A, *General Design Criteria*
- DOE 5480.24, *Criticality Safety*

I.3 How frequently is compliance with these procedures audited?
Are audits performed by external groups?
What is the date (s) of your last SQA audit?

Results: Sites indicate that auditing does take place but may be inadequate for software assessment.

2.3 Gap Analysis of Survey Results and Independent Evaluation With the Directives and Standards Infrastructure

The OCIO has determined through an independent assessment that improvements need to be made in establishing a more adequate software standards infrastructure through the DOE Directives System and the Information Architecture (IA) Standards program. In regards to safety software, more investigation needs to take place. Organizations and processes are in

place for disseminating and making improvements to DOE Directives, IA Standards program, and the DOE Technical Standards program. Auditing processes may need to be improved to get better communication of Departmental guidance to the floor level.

Departmental websites have been established for the exchange of information. The DOE Directives System is the repository of all DOE directives, which can be accessed at the http://www.explorer.doe.gov:1776/htmls/directives.html website. The DOE Technical Standards program promotes the use of non-Government standards across the Department and has established a website at http://tis.eh.doe.gov/techstds/. The Office of the Chief Information Officer (CIO) has established a website for promotion of Departmental Information Technology (IT) standards at http://www-it.hr.doe.gov/Standards/index.html and has published a DOE Information Architecture (IA) Profile of Adopted Standards. In addition, the Office of the CIO has a website for Departmental guidance on Software Quality and Systems Engineering at http://cio.doe.gov/smp (soon to be http://cio.doe.gov/sqse) and provides support for the website for the Software Quality Assurance Subcommittee (SQAS) of the Nuclear Weapons Complex at http://cio.doe.gov/sqas.

2.4 Findings and Recommendations

It is the consensus of SQA and safety staffs that regular management attention from local DOE offices and its contractors is necessary to implement improvements in safety analysis and SQA. Proper contract requirements and implementing processes based on DOE rules, Orders, guides and reference standards must be established. In addition, assessment of proper implementation must be performed by local DOE organizations.

2.4.1 Findings

Several findings of governance and responsibility became apparent in the review of Departmental standards. These findings influence the implementation of standards since they establish protocols.

Finding No. 1: The Nuclear Safety Rule (10 CFR 830, Nuclear Safety Management) addresses the adequacy of "documented safety analysis" for nuclear facilities and activities and for non-nuclear hazardous facilities and activities, which could potentially impact the safety of nuclear operations. QA is very instrumental to assuring adequate documentation.

Finding No. 2: SQA needs to be addressed within the context of the overall quality assurance program for DOE's defense nuclear facilities, especially considering the criteria in 10 CFR 830, Nuclear Safety Management.

Finding No. 3: The Integrated Safety Management program, which evolved from DNFSB Recommendation 95-2, was expanded by the Safety Management Implementation Team (SMIT) to include both nuclear facilities and other hazardous (non-nuclear) facilities. The work of SMIT has been completed and implementation will be the responsibility of the DOE Cognizant Secretarial Offices (CSO) and contractors.

Finding No. 4: The DNFSB sent a letter to the Deputy Secretary on July 10, 2000, stating that ISM (includes QA integration) should be implemented by line management; i.e., each Program Secretarial Office (PSO), and not delegated to Environment, Safety and Health (EH) as it would be counter-productive. Because EH is not part of line management, the organization provides a better role as an independent assessor.

Finding No. 5: EH is the Office of Primary Interest (OPI) and owner of the QA rule (10 CFR 830.120); DOE O 414.1A, QUALITY ASSURANCE; and associated guides. Technical safety requirements are contained in the EH directives.

Finding No. 6: The OCIO has primary responsibility for software directives (e.g., Orders, Guides, Policies, etc.) per the Clinger-Cohen Act and must set expectations for software management, engineering, and assurance, and other information management requirements per OMB Circular A-130 and the Paperwork Reduction Act (as well as other legislation). The DOE computing environment has become very diverse and complex so that the software cannot be considered an entity of its own, but part of a larger total systems context that includes the infrastructure upon which it is executed. DOE is highly dependent on software not just only for information generation but to ensure that the software reflects the processes and scenarios needed for conducting its missions and businesses.

Finding No. 7: Information security; i.e., protecting the data, is a major issue for software systems. One of the strongest defenses against viruses and terrorist attacks is well-developed code that is structured, modular, and includes the inline information needed for understanding the code, as well as other documentation, so that updates can be made easily, swiftly, and cost-effectively. It is very beneficial for all software to undergo SQA, and of utmost importance that mission-critical, mission-essential, or high-risk code undergo SQA processes to ensure quality software is produced. SQA (as well as project management and software systems engineering) increases quality and saves time and money in the near and long term.

Finding No. 8: All Departmental Orders need to have the Secretary as the issuing authority for application to both DOE and NNSA.

2.4.2 Recommendations

As a result of the analysis of the data collected in the survey and the independent evaluation and the comparison of this information to the Departmental standards infrastructure, the following recommendations are made.

Recommendation No. 1: DOE Directives. DOE contractors have been consistently apprised by DOE rules, Orders, and guides of their responsibility to apply nationally recognized safety, safety analysis, and quality assurance standards to their work involving software. Departmental directives pertinent to software/SQA and safety/safety analysis are listed in Attachment 2.

Recommend DOE program and project managers become familiar with DOE directives as they relate to their projects and ensure their projects are in compliance with all applicable DOE directives. A memo from each LPSO to their organizations would be very conducive to ensuring this occurs.

Recommend the OCIO and EH conduct a more in-depth review of their directives for currency and ways to ensure their implementation.

Recommendation No. 2: DOE Standards. Before a project begins, the standards and processes that will be followed should be clearly defined. The DOE program manager and the DOE or contractor project manager should be aware of the international, national, Federal, and DOE information technology standards that should be specified or recommended for a particular type of project. There are several sources for determining these standards as noted in this study. Program and project managers should select and apply the most appropriate standards and best practices that will enable their projects to satisfy the requirements of DOE directives. Departmental standards and Departmental recommended standards pertinent to software/SQA and safety/safety analysis are listed in Attachment 2.

Recommend LPSOs affirm their support of OCIO and EH standards programs and processes. A memo from each LPSO reminding their staffs of these programs and encouraging participation would be conducive to ensuring DOE standards are consensus-based and appropriate and current for DOE.

Recommend the OCIO and EH conduct benchmarking activities of their standards program with other government organizations.

Recommendation No. 3: Other Government and Industry Standards and Best Practices. Adoption and tailoring of computer software engineering, project management, and quality assurance standards and best practices from related other government and industry are desirable. A consensus set of standards and best practices is conducive to ensuring consistency of practice and pedigree of DOE software. Software standards for adoption Departmentwide should be submitted to the Departmental Information Architecture (IA) Standards staff, located

in the OCIO, for incorporation into the DOE IA Profile of Adopted Standards document. Website addresses for the government and industry organizations reviewed are contained in Attachment 1.

Recommend the OCIO review and solicit Departmental comments for a consensus set of standards for software project management, engineering, and quality assurance.

Recommend EH review and solicit Departmental comments for a consensus set of standards for safety software and for safety and safety analysis projects which involve software.

Recommendation No. 4: Quality Software Products. Production and delivery of quality software products should be ensured. Quality assurance alone will not provide a quality product. Quality software products are developed by applying quality processes throughout the software lifecycle. To build quality in throughout the lifecycle, a software engineering methodology should be used. This methodology should include software engineering and project management best practices (e.g., project planning, project tracking and oversight, configuration management, requirements management, quality assurance, risk management, and training) and incorporate SQA. Quality assurance of the software can and should extend beyond the software itself and into the infrastructure and environment in which it is executed to ensure successful integration of the software.

Recommend the draft update of DOE G 200.1-1, SOFTWARE ENGINEERING METHODOLOGY (SEM), be submitted to the Directives system in FY 2002. A memo from the LPSOs endorsing the SEM would be conducive to ensuring quality software is produced.

Recommendation No. 5: Tools/Automation. As the DOE computing environment becomes more complex, it is increasingly difficult to rely on manual processes. For all projects, the use of information technology to automate elements of the software quality assurance processes and procedures selected is encouraged wherever it is found to be effective.

Recommend that LPSOs consider and encourage new technologies which would be conducive to ensuring quality software.

Recommendation No. 6: Link Organizations and Websites and Improve Line Management. It appears DOE has an adequate Federal and contractor organizational infrastructure. However, there seems to be a lack of interaction among these organizations and staffs. Contractor organizations such as SQAS, DOE INCOSE, and EFCOG SAWG need to be better aligned with the OCIO, QAWG, and SASG for better communication and dissemination of software and safety information. The QAWG has revised its charter and developed an organizational matrix as guidance for improving this linkage.

Recommend that the various Federal and contractor organizations link themselves through their websites and the websites established by the Program Offices and field sites for software and safety for the purpose of improving communications.

Recommend that better communication lines are defined for line management organizations to ensure that everyone can be apprised of issues, concerns, new practices, etc.

Recommendation No. 7: Followup Study. A more in-depth study of software used in safety analysis and I&C software at defense nuclear facilities needs to be conducted. The survey provided some high-level information, but more details are needed. The Safety Analysis Software Group (SASG) has been formed to address standards for software used in safety analysis and I&C at defense nuclear facilities.

Recommend LPSOs endorse and support the SASG and that the SASG share SQA implementations for safety software with the OCIO and QAWG. Planned deliverables of the SASG are a report of their in-depth study, including training opportunities, and possibly a toolbox of codes and consensus set of standards.

Recommend the SASG answer the following questions: What improvements can be made? Are DOE directives and standards adequate? Is there an adequate infrastructure for disseminating and promoting standards? Is there adequate interaction with government and industry organizations? Are any joint ventures needed? Are standards adequately covered in contracts? What improvements are needed in safety software management? Is software management and SQA adequate? Does safety analysis and I&C have a foundation?

3.0 Institutionalization and Follow-through

In addition to the actions recommended in Section 2.4.2, there are various ways to institutionalize and ensure continuation of the recommendations. It is important to institutionalize and provide follow-through to ensure improvements occur.

3.1 Promotion and Awareness

DOE governance groups can be a source for providing promotion and awareness of the need to have quality software and standards. These groups include the Executive Committee for Information Management (ECIM), the DOE CIO Council, the Quality Assurance Working Group (QAWG), and potentially the Safety Analysis Software Group (SASG). The OCIO and EH should take advantage to bring software issues and concerns to these groups.

Contractor groups such as the Software Quality Assurance Subcommittee (SQAS) and the Energy Facilities Contractor Group (EFCOG) Safety Analysis Working Group (SAWG) can be very instrumental in institutionalizing software quality and safety management. The OCIO and EH should form closer working relationships with these groups.

3.2 Web Linkages

Most of the organizations above in Section 3.1 have established websites. All of these should be linked, which would be conducive to ensuring better communication and sharing.

3.3 Update and Adoption Processes

Both the OCIO and EH have a standards program and processes that provide for DOE participation in these programs to update or adopt new standards. These programs can and are very conducive for ensuring improvements are made in the way DOE does business. A better integration with the Directives system for information sharing should be considered by both organizations, such as a direct link from the Directives Explorer website to the OCIO and EH standards websites.

3.4 Auditing Processes

DOE Federal and contractor organization auditing processes can be used to ensure software and safety standards are reviewed, where applicable. This would help to promote, keep current, and continually provide an awareness of the importance of standards.

The following is a listing of the websites for the organizations discussed in this study report.

LISTING OF STANDARDS ORGANIZATIONS		
DOE Websites		
DSEPG	Departmentwide Systems Engineering Process Group	http://cio.doe.gov/smp (soon to be http://cio.doe.gov/sqse)
Explorer	Directives System	http://www.explorer.doe.gov:1776/htmls/directives.html
FTCP	Federal Technical Capability Panel	http://tis.eh.doe.gov/
Science	Good Practices Guides	http://www.er.doe.gov/ once on the site add production/er-80/er-82/gpguides.html
OCIO	Information Architecture Standards Program	http://cio.doe.gov/standards
QAWG	Quality Assurance Working Group	http://twilight.saic.com/qawg
EH	Technical Standards Program	http://tis.eh.doe.gov/techstds/
Contractor Websites		
EFCOG/SAWG	Energy Facilities Contracting Group/Safety Analysis Working Group	http://www.efcog.org/
SQAS	Software Quality Assurance Subcommittee	http://cio.doe.gov/sqas
NWC	Product Realization Process (includes Technical Business Practices, QC-1, and D&P Manual)	http://prp.lanl.gov:8686/
Other Government Websites		
Air Force	Air Force Safety Center	http://www.usaf.com/orgs/12.htm
DISA	Defense Information Systems Agency	http://www.disa.mil
DISA	Defense Information Systems Agency Standards Library	http://www.itsi.disa.mil
DISA	Defense Technical Information Center	http://www.dtic.mil
DTRA	Defense Threat Reduction Agency	http://www.dtra.mil
DOD	Department of Defense	http://www.defenselink.mil
DODSSP	DOD Single Stock Point	http://dodssp.daps.mil

LISTING OF STANDARDS ORGANIZATIONS		
DODSSP	DOD Single Stock Point - ASSIST	http://dodssp.daps.mil/assist.htm
DOT	Department of Transportation	http://www.dot.gov
DOT	Department of Transportation Standards	http://www.its.dot.gov/Standard/Standard.htm
Joint SSSH	Joint Software System Safety Handbook	http://www.system-safety.org
NASA	National Aeronautical and Space Administration	http://www.nasa.gov
NASA	National Aeronautical and Space Administration Search	http://www.nasa.gov/search
NASA	National Aeronautical and Space Administration Ames	http://www.arc.nasa.gov
NASA	National Aeronautical and Space Administration High Performance	http://hpcc.arc.nasa.gov
NASA	National Aeronautical and Space Administration ISCO and SIPS	http://www.nas.nasa.gov/IT/test/index.htm
NIST	National Institutes of Standards and Technology	http://www.nist.gov
NIST/ISO	National Institutes of Standards and Technology ISONET	http://ts.nist.gov/ts/htdocs/210/217/hro.htm
NIST/SQA	National Institutes of Standards and Technology SQA Standard	http://hissa.ncsl.nist.gov/publications/nistir4909/
Navy/NSWC	Navy Surface Warfare Center	http://www.nswc.navy.mil/safety
NRC	Nuclear Regulatory Commission Safety Standards	http://www.nrc.gov/NRC/RG/01/index.html
NRC	Nuclear Regulatory Commission Standards	http://www.nrc.gov/NRC/REFERENCE/STANDARDS/index.html
Industry Websites		
ANSI	American National Standards Institute	http://www.ansi.org
ANSI	American National Standards Institute Standards	http://www.nssn.org
ANS	American Nuclear Society	http://www.ans.org
ANS	American Nuclear Society Standards	http://store.ans.org
ASME	American Society of Mechanical Engineers	http://www.asme.org
ASQ	American Society for Quality	http://www.asq.org
EIA	Electronic Industries Alliance	http://www.eia.org
IEEE	The Institute of Electrical and Electronics Engineers	http://www.ieee.org

LISTING OF STANDARDS ORGANIZATIONS		
IEEE	The Institute of Electrical and Electronics Engineers Standards	http://standards.ieee.org
INCOSE	International Council on Systems Engineering	http://www.incose.org
ISO	International Organization for Standardization	http://www.iso.ch
ISC	International Safety Council	http://safety.webfirst.com/isc.htm
NSC	National Safety Council	http://nsc.org/
PMI	The Project Management Institute	http://www.pmi.org
QAI	The Quality Assurance Institute	http://www.qaiusa.com
SAE	Society for Automotive Engineers	http://www.sae.org or http://www.normas.com
SEI	Software Engineering Institute	http://www.sei.cmu.edu
SEI	Software Engineering Institute Search	http://www.sei.cmu.edu/about/website/search.html
SSS	System Safety Society	http://www.system-safety.org

Note: Check http://cio.doe.gov/smp (soon to http://cio.doe.gov/sqse) or http://cio.doe.gov/sqas or http://cio.doe.gov/asci for other useful website links not reviewed for this report.

The following is a listing of the directives discussed in this study report.

LISTING OF DEPARTMENTAL DIRECTIVES AND STANDARDS		
DOE Safety and Safety Analysis Policies, Orders, Manuals, Standards		
DOE P 450.4	SAFETY MANAGEMENT SYSTEM POLICY	Defines the policy for integrating safety into management and work practices at all levels and all facets of work planning and execution based on six components. Quality assurance is implied in Component 3, Core Functions for Integrated Safety Management, by requiring a confirmation of readiness, feedback, oversight, and continuous improvement. DOE G 450.4-1A is the implementing guide.
DOE P 450.5	LINE ENVIRONMENT, SAFETY AND HEALTH OVERSIGHT	Defines the policy for Federal and contractor staffs to conduct Environment, Safety, and Health line oversight in a cost-effective, coordinated, integrated, and efficient manner. Quality assurance is implied by requiring compliance with applicable requirements, readiness assessments, verification reviews, for-cause reviews, and performance improvement.
DOE O 420.1	FACILITY SAFETY	Establishes facility safety requirements related to nuclear safety design, criticality safety, fire protection and natural phenomena hazards mitigation. It references standards required for certain safety applications, such as ANS-8.1-1983 that includes requirements for validating computer programs. DOE G 420.1-1 is the implementing guide.
DOE O 5480.21	UNREVIEWED SAFETY QUESTIONS	Sets forth the definition and basis for determining the existence of an Unreviewed Safety Question (USQ). The intent of this Order is to provide contractors with the flexibility needed to conduct day-to-day operations and to require that those issues with a potential impact on the authorization basis, and therefore the safety of the facility, be brought to the attention of DOE–thus maintaining the proper safety focus. The Order is focused on safety analysis of facilities, of which software could be a factor.
DOE O 5480.22	TECHNICAL SAFETY REQUIREMENTS	States the requirements to have Technical Safety Requirements (TSR) prepared for DOE nuclear facilities and to delineate the criteria, content, scope, format, approval process, and reporting requirements of these documents and revisions thereof. The Order is focused on technical safety requirements of facilities, of which software could be a factor.

LISTING OF DEPARTMENTAL DIRECTIVES AND STANDARDS		
DOE Safety and Safety Analysis Policies, Orders, Manuals, Standards		
DOE O 5480.23	NUCLEAR SAFETY ANALYSIS REPORTS	Establishes requirements for contractors responsible for the design, construction, operation, decontamination, or decommissioning of nuclear facilities to develop safety analyses that establish and evaluate the adequacy of the safety bases of the facilities and to document this in Safety Analysis Reports (SAR), which includes addressing quality assurance.
DOE M 411.1-A	SAFETY MANAGEMENT FUNCTIONS, RESPONSIBILITIES, AND AUTHORITIES	Is a mechanism for implementing the Department's guiding principles established in DOE P 450.4, discussed above, and the safety management functions outlined in DOE P 411.1, SAFETY MANAGEMENT FUNCTIONS, RESPONSIBILITIES, AND AUTHORITIES POLICY.
DOE G 421.1-1	GOOD PRACTICES GUIDE	Is a comprehensive guidance document to assist in developing a criticality safety program to implement the DOE Order (or Rule) on nuclear criticality safety, and the invoked ANSI/ANS standards, through use of good practices. It provides brief information on SQA and verification, and an appendix on software configuration control procedure.
DOE-STD-1027-92	HAZARD CATEGORIZATION AND ACCIDENT ANALYSIS TECHNIQUES FOR COMPLIANCE WITH DOE ORDER 5480.23, NUCLEAR SAFETY ANALYSIS REPORTS	Establishes guidance for the preparation and review of hazard categorization and accident analyses techniques.
DOE-STD-3009-94	PREPARATION GUIDE FOR U.S. DOE NONREACTOR NUCLEAR FACILITY SAFETY ANALYSIS REPORTS	Establishes guidance for consistency with DOE O 5480.23 requirements and its safety guide, and describes a safety analysis report (SAR) preparation method for DOE. The standard contains a chapter on quality assurance.

LISTING OF DEPARTMENTAL DIRECTIVES AND STANDARDS		
DOE Safety and Safety Analysis Policies, Orders, Manuals, Standards		
DOE Software and Quality Assurance Policies, Orders, Manuals, Standards		
DOE O 200.1	INFORMATION MANAGEMENT	Was canceled in FY 2000. It contained no explicit requirements for software development, but did reference DOE G 200.1-1, SOFTWARE ENGINEERING METHODOLOGY. DOE O 1330.1D, COMPUTER SOFTWARE MANAGEMENT, (superseded by DOE O 200.1) contained more explicit requirements for software development, including software quality assurance. A replacement Order is under development for DOE O 200.1.
DOE N 203.1	SOFTWARE QUALITY ASSURANCE	Specifies the requirements for an SQA program and SQA for projects. The Notice references DOE directives and industry standards applicable to safety or safety software. This Notice will be made into an Order.
DOE G 200.1-1	SOFTWARE ENGINEERING METHODOLOGY	Contains guidance in regards to the application of SQA on software projects. The Guide can and should be supplemented by site guidance to meet local needs.
DOE O 414.1A	QUALITY ASSURANCE	States the requirements for DOE elements and contractors to develop Quality Assurance Programs (QAPs). The Order states, "The QAPs must discuss how it integrates and satisfies quality requirements or similar management system requirements (such as environmental or safety) from sources other than this Order." The Order directs organizations to develop an integrated management approach or system to show linkage among various organization functions and programs. It is consistent with the American Society of Mechanical Engineers (ASME) NQA-1 standard, which includes criteria for SQA. DOE O 5700.6C, QUALITY ASSURANCE (superseded by DOE O 414.1A), stated that the quality criteria applied to all work and the items and services resulting from work. It referenced the national consensus standard ASME NQA-1.
DOE G 414.1-2	QUALITY ASSURANCE MANAGEMENT SYSTEM GUIDE FOR USE WITH 10 CFR 830.120 AND DOE O 414.1	Contains a section (4.6.3) related to the Design Process, which calls for validation of the software used in the design process and refers to ASME NQA-1 for acceptable methods. This guide superseded DOE G 830.120, which was issued to implement 10 CFR 830.120, Quality Assurance. This guide clearly referenced the ASME NQA Part 2.7 for SQA.

LISTING OF DEPARTMENTAL DIRECTIVES AND STANDARDS		
DOE Safety and Safety Analysis Policies, Orders, Manuals, Standards		
DOE-STD-4001-2000	DOE DESIGN CRITERIA STANDARD FOR ELECTRONIC RECORDS MANAGEMENT SOFTWARE APPLICATIONS	Establishes the recommended method for meeting the functional requirements of the laws and regulations pertaining to managing records using electronic Records Management Application (RMA) software (submitted to the DOE Technical Standards program by the OCIO).

LISTING OF DEPARTMENTAL DIRECTIVES AND STANDARDS		
DOE Safety and Safety Analysis Policies, Orders, Manuals, Standards		
DOE Information Architecture Profile of Adopted Standards 2000		
DOE G 200.1-1A (Draft)	DOE Software Engineering Methodology (SEM) Version 2 (1999)	Is a lifecycle methodology providing guidance for software engineering, project management, and quality assurance.
DOE-STD-4001-2000	DOE Design Criteria Standard for Electronic Records Management Software Applications, March 2000	Establishes the recommended method for meeting the functional requirements of the laws and regulations pertaining to managing records using electronic Records Management Application (RMA) software (submitted to the DOE Technical Standards program by the OCIO).
IEEE 828-1988	IEEE Standard for Software Configuration Management Plans	Establishes minimum required contents of a software configuration management plan and defines specific activities to be addressed.
IEEE 1042-1987 (R1993)	Guide to Software Configuration Management	Discusses context, process, implementation, tools, techniques, supplier control, records management, and planning methodologies for software configuration management.
ISO 9000	Quality Management and Quality Assurance Standards - Guidelines for Selection and Use	Contains a consensus on the essential features of a quality system to ensure the effective operation of a business, whether a manufacturer or service provider, or other type of organization, either in the public or private sector.
ISO 10005:1995	Quality Management - Guidelines for Quality Plans	Provides guidance for preparing quality plans for control of specific products, projects, or contracts.
EH Recommended Industry Standards (Not in the IA Profile of Standards)		
ANSI/ANS-10.4-1987	Guidelines for the Verification and Validation of Scientific and Engineering Computer Programs for the Nuclear Industry	Contains guidelines for software used in nuclear applications
ASME NQA-1-1997	Quality Assurance Requirements for Computer Software for Nuclear Facility Applications	Contains guidelines for software used in nuclear applications

SURVEY RESULTS FOR STANDARDS AT DEFENSE NUCLEAR FACILITIES – Section 1

Survey on Software Quality Assurance (SQA) Practices, Processes, and Procedures Impacting Safety Analysis and Instrumentation and Control (I&C) Software Information Request for Response to Defense Nuclear Facilities Safety Board (DNFSB) Technical Report 25

Note: The response to the survey should not include non-nuclear facilities since the DNFSB issues are exclusively with nuclear facilities. The survey, however, does include hazardous chemicals present at nuclear facilities. The survey is directed at contractors; however, DOE Federal organizations may complete the survey as their input might provide additional insight.

Survey Targets: LLNL, LANL, SNL, SRS, Pantex, Rocky Flats, Y-12, INEEL, Nevada Test Site, Hanford (including ORP), WIPP, and ORNL. Only response from ORNL is the Y-12 survey. The Nevada Test Site stated they had no nuclear facilities. Although not a major target, YMP submitted a survey.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
1. What documented SQA programs or procedures do you follow for computer codes used for safety analysis in the areas of software development, testing, documentation, maintenance, and usage?		
Development	LLNL	HCD/ABS--One code, HOTSPOT, was developed within HCD. No formal QA procedures.
	LANL	Varies by customer (note the majority of safety codes used for safety analysis of LANL nuclear facilities are not LANL developed codes). For specific customers, "Manufacturing Manual: Software Quality Assurance"; MFG-AP-0014 Rev. 0; and "Tru Waste Characterization Program: TWCP Quality Procedure", TWCP-QP-1.1-006 Rev. 7 are used.
	SNL	TA-V RREP QA Procedure, RREP 3-2, Computer Software Control; developed in-house, is mandatory for all software associated with the TA-V Nuclear Facilities; QA processes are peer review and testing.
	SRS	WSMS follows WSRC requirements on developing, testing, documenting, maintaining, and using computer codes used for safety analysis. Requirements are specified in standalone WSMS QA documentation, or are cited and referenced in WSRC documentation. This includes but is not limited to, the WSRC 1Q Manual, 11Q, Section 20-1, the E7 Manual, and WSMS Quality Assurance Procedures. Procedures are in-house developed and mandatory; QA processes are peer review.
	Pantex	In-house developed Software Quality Life Cycle (SQLC) Plant Standard STD-1875. Mandatory for all site-developed software, purchased software, contractor developed software, or design agency furnished software. The SQA process consists of peer reviews and approvals, and auditing.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
	Rocky Flats	The Computer Software Management Manual (1-MAN-004-CSMM) contains the procedures followed for software development, testing, documentation, and maintenance. This manual was developed in-house using best industry practices and is mandatory; QA processes are peer review and independent verification and validation. The processes invoked by the CSMM have been reviewed and audited by the Software Engineering Institute at Carnegie-Mellon University and given a SEI Level certification. They have also been reviewed and audited for Software Quality Assurance by the Carlsbad Area Office for WIPP certification. Since virtually all of the codes used in the nuclear safety areas are provided by outside sources (Oak Ridge, Los Alamos, RSICC, etc.) we cannot vouch for the SQA processes used by those developers. However, the implementation of the codes on site is guided by the CSMM and V&V testing is performed as part of the installation and configuration management process mandated by the CSMM.
	Y-12	Y80-100, *Project Initiation*, Y80-200, *Feasibility Study/Requirements Definition*, Y80-400, *Functional System Design*, Y80-500, *Computer System Design*, Y80-515, *Manufacturing Applications User Interface Standard*, and Y80-600, *Programming and Implementation*. The current software control program is defined by the, *Software Development and Control*, Y80 Series procedures; the upcoming revision will be based on DOE's Software Engineering Methodology (SEM). The Nuclear Criticality Safety organization uses the following safety-related software: (1) SCALE/KENO: Standard Computer Analyses for Licensing Evaluation and (2) MCNP: Monte Carlo N-particle Transport Code System. This software is controlled by the Y80 Series procedures including the Nuclear Criticality Safety organization procedures. The procedures were developed in-house at Y-12, based on software industry practices at the time. The procedures determine a software classification for each system based on various criteria. This classification is then used to drive the mandatory portions of the actual development process. It is mandatory that all Y-12 software use the Y80 procedures for guiding development. A combination of walkthroughs, reviews, and testing regimens are used as the basis for ensuring quality, per the Y80 procedures.
	INEEL	INEEL Program Requirements Document (PRD)-115, "Configuration Management;" INEEL Standard (STD)-107, "Configuration Management Program;" INEEL Management Control Procedure (MCP) 550, "Software Management"; INEEL MCP-3630, "Computer System Change Control;" INEEL Guide (GDE)-59, "Guide for Computer System Change Control;" DOE-STD-1073-93, "Guide for Operational Configuration Management Program;" ANSI/IEEE STD-828-1998;" IEEE Standard for Software Configuration Plans;" ANSI/ANS-10.4-1987, "Guidelines for the Verification and Validation of Scientific and Engineering Computer Programs for the Nuclear Industry." Compliance with the INEEL documents is mandatory. Software packages developed and maintained at INEEL that are used for nuclear facility safety analysis or for control of active Safety SSCs are subject to the INEEL CM Program, have received verification and validation (V&V), and have CM Plans in place. See survey for description of INEEL documents.
	YMP/TESS	•NQA-2, Subpart 2.7 •OCRWM Quality Assurance Requirements & Description •OCRWM AP-SI.1Q Software Management •NQA-2, Subpart 2.7 is the NRC Standard for software development, testing, documentation, maintenance and usage. OCRWM Quality Assurance Requirements & Description (QARD) reflects in total the requirements of NQA-2, Subpart 2.7. AP-SI.1Q Software Management is the implementing procedure for Supplement I of the QARD. Compliance with AP-SI.1Q is mandatory. SQA processes include independent peer review, inspection, audit, and verification and validation of software.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
	Hanford/RL	•Fluor Hanford–Primarily HNF-PRO-2778, *IRM Application System Life Cycle Standards* and HNF-PRO-309, *Computer Software Quality Assurance Requirements*. Procedures are in-house developed based on DOE Orders and other government agencies' requirements and mandatory. All the SQA processes listed in the survey are accepted in the procedures - they are based on defined scope and risk. The procedure requires that some form of change control and review process be established. Each project is allowed to define in their implementing procedures the specific configuration management processes they will apply. •Bechtel Hanford--In-house BHI-AT-01 Procedure 1.7 *Software Development & Maintenance*, and Bechtel Corp. Software Development Methodology Framework (SDMF). Procedures are based on industry standards and are mandatory. •PNNL Hanford–Any software developed or used at the Laboratory is required to be controlled in accordance with the Computer Software and Database Control subject area, which is aligned with the Software Systems Engineering Process (SSEP). The subject area was derived largely from the SSEP. The SSEP addresses each of the issues identified above. The subject area is mandatory for all PNNL staff. The SSEP is mandatory for all projects in the Information Science and Engineering Division and for all projects done for the Information Systems Engineering product line. The SSEP is more rigorous and more flexible than the subject area. However, each is based on the fundamental premise of defining a plan based on specific project or activity needs and executing the plan to develop, acquire, or use the software in involved. Both the subject area and the SSEP were developed at PNNL. The primary standard for the SSEP is the Software Engineering Institute's Capability Maturity Model for Software (see http://www.sei.cmu.edu/cmm/). It's also based to lesser extent on elements of IEEE standards, Department of Defense MIL-STD-498 (since replaced), and Iterative Process Models like the "Spiral Model" by Bochm and "Managed Evolutionary Development" by U.S. Patent Office.
	Hanford/ORP	•Tank Farm–HNF-PRO-309, *Computer Software Quality Assurance Requirements* and HNF-PRO-2778, *IRM Application System Life Cycle Standards*. Procedures developed in-house based on DOE Orders and other government agency requirements and are mandatory. Varying degrees of SQA processes are used based on the defined scope and risk of the specific project application. •Tank Waste–Procedure K70C515, *Code of Practice for Computer Program Use*, addresses all the elements of ASME NQA-1-1994, Part II, Subpart 2.7, including software life cycle, development and maintenance, software testing, software verification and validation, documentation, error identification and notification. Procedure was developed in-house based on the requirements of NQA-1-1994, Part II, Subpart 2.7 and DOE/RW/0333P, *Quality Assurance Requirements and Description (QARD)*, Supplement I. It is mandatory. SQA activities are installation testing and validation.
	WIPP	WP 16-IT3117, WIPP internal, mandatory, use-dependent; WP 16-2, WIPP internal, optional, use-dependent.
Testing	LLNL	HCD/ABS–HOTSPOT, EPI runs compared against ARAC runs by developer. Other codes (MACCS, MACCS II, ALOHA, GEN II) are widely used and accepted, but have no formal QA.
	LANL	Varies by customer. For specific customers, "Manufacturing Manual: Software Quality Assurance"; MFG-AP-0014 Rev. 0; and "Tru Waste Characterization Program: TWCP Quality Procedure", TWCP-QP-1.1-006 Rev. 7 are used.

L SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
	SNL	TA-V RREP QA Procedure, RREP 3-2, Computer Software Control; developed in-house, is mandatory for all software associated with the TA-V Nuclear Facilities; QA processes are peer review and testing.
	SRS	WSMS follows WSRC requirements on developing, testing, documenting, maintaining, and using computer codes used for safety analysis. Requirements are specified in standalone WSMS QA documentation, or are cited and referenced in WSRC documentation. This includes but is not limited to, the WSRC 1Q Manual, 11Q, Section 20-1, the E7 Manual, and WSMS Quality Assurance Procedures. Procedures are in-house developed and mandatory; QA processes are peer review.
	Pantex	In-house developed Software Quality Life Cycle (SQLC) Plant Standard STD-1875. Mandatory for all site-developed software, purchased software, contractor developed software, or design agency furnished software. The SQA process consists of peer reviews and approvals, and auditing.
	Rocky Flats	The Computer Software Management Manual (1-MAN-004-CSSM) contains the procedures followed for software development, testing, documentation, and maintenance. This manual was developed in-house using best industry practices and is mandatory; QA processes are peer review and independent verification and validation.. The processes invoked by the CSMM have been reviewed and audited by the Software Engineering Institute at Carnegie-Mellon University and given a SEI Level certification. They have also been reviewed and audited for Software Quality Assurance by the Carlsbad Area Office for WIPP certification. Since virtually all of the codes used in the nuclear safety areas are provided by outside sources (Oak Ridge, Los Alamos, RSICC, etc.) we cannot vouch for the SQA processes used by those developers. However, the implementation of the codes on site is guided by the CSMM and V&V testing is performed as part of the installation and configuration management process mandated by the CSMM.
	Y-12	Y80-700, *Validation and Acceptance*. The current software control program is defined by the, *Software Development and Control*, Y80 Series procedures; the upcoming revision will be based on DOE's Software Engineering Methodology (SEM). The Nuclear Criticality Safety organization uses the following safety-related software: (1) SCALE/KENO: Standard Computer Analyses for Licensing Evaluation and (2) MCNP: Monte Carlo N-particle Transport Code System. This software is controlled by the Y80 Series procedures including the Nuclear Criticality Safety organization procedures. The procedures were developed in-house at Y-12, based on software industry practices at the time. The procedures determine a software classification for each system based on various criteria. This classification is then used to drive the mandatory portions of the actual development process. It is mandatory that all Y-12 software use the Y80 procedures for guiding development. A combination of walkthroughs, reviews, and testing regimens are used as the basis for ensuring quality, per the Y80 procedures.
	INEEL	INEEL Program Requirements Document (PRD)-115, "Configuration Management;" INEEL Standard (STD)-107, "Configuration Management Program;" INEEL Management Control Procedure (MCP) 550, "Software Management"; INEEL MCP-3630, "Computer System Change Control;" INEEL Guide (GDE)-59, "Guide for Computer System Change Control;" DOE-STD-1073-93, "Guide for Operational Configuration Management Program;" ANSI/IEEE STD-828-1998;" IEEE Standard for Software Configuration Plans;" ANSI/ANS-10.4-1987, "Guidelines for the Verification and Validation of Scientific and Engineering Computer Programs for the Nuclear Industry." Compliance with the INEEL documents is mandatory. Software packages developed and maintained at INEEL that are used for nuclear facility safety analysis or for control of active Safety SSCs are subject to the INEEL CM Program, have received verification and validation (V&V), and have CM Plans in place. See survey for description of INEEL documents.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
	YMP/TESS	•NQA-2, Subpart 2.7 •OCRWM Quality Assurance Requirements & Description •OCRWM AP-SI.1Q Software Management •OCRWM AP-SV.1Q Control of Electronic Management of Data •NQA-2, Subpart 2.7 is the NRC Standard for software development, testing, documentation, maintenance and usage. OCRWM Quality Assurance Requirements & Description (QARD) reflects in total the requirements of NQA-2, Subpart 2.7. AP-SI.1Q Software Management is the implementing procedure for Supplement I of the QARD. Compliance with AP-SI.1Q is mandatory. SQA processes include independent peer review, inspection, audit, and verification and validation of software.
	Hanford/RL	•Fluor Hanford--Primarily HNF-PRO-2778, *IRM Application System Life Cycle Standards* and HNF-PRO-309, *Computer Software Quality Assurance Requirements*. Procedures are in-house developed based on DOE Orders and other government agencies' requirements and mandatory. All the SQA processes listed in the survey are accepted in the procedures - they are based on defined scope and risk. The procedure requires that some form of change control and review process be established. Each project is allowed to define in their implementing procedures the specific configuration management processes they will apply. •Bechtel Hanford–In-house BHI-AT-01 Procedure 1.7, BHI-AT-01 Procedure 1.8 *Software Acquisition and Maintenance*, and BHI-DE-01-EDPI-4.36-01, *Project Calculations*. Procedures are based on industry standards and are mandatory. •PNNL Hanford–Any software developed or used at the Laboratory is required to be controlled in accordance with the Computer Software and Database Control subject area, which is aligned with the Software Systems Engineering Process (SSEP). The subject area was derived largely from the SSEP. The SSEP addresses each of the issues identified above. The subject area is mandatory for all PNNL staff. The SSEP is mandatory for all projects in the Information Science and Engineering Division and for all projects done for the Information Systems Engineering product line. The SSEP is more rigorous and more flexible than the subject area. However, each is based on the fundamental premise of defining a plan based on specific project or activity needs and executing the plan to develop, acquire, or use the software in involved. Both the subject area and the SSEP were developed at PNNL. The primary standard for the SSEP is the Software Engineering Institute's Capability Maturity Model for Software (see http://www.sei.cmu.edu/cmm/). It's also based to lesser extent on elements of IEEE standards, Department of Defense MIL-STD-498 (since replaced), and Iterative Process Models like the "Spiral Model" by Boehm and "Managed Evolutionary Development" by U.S. Patent Office.
	Hanford/ORP	•Tank Farm–HNF-PRO-309, *Computer Software Quality Assurance Requirements* and HNF-PRO-2778, *IRM Application System Life Cycle Standards*. Procedures developed in-house based on DOE Orders and other government agency requirements and are mandatory. Varying degrees of SQA processes are used based on the defined scope and risk of the specific project application. •Tank Waste–Procedure K70C515, *Code of Practice for Computer Program Use*, addresses all the elements of ASME NQA-1-1994, Part II, Subpart 2.7, including software life cycle, development and maintenance, software testing, software verification and validation, documentation, error identification and notification. Procedure was developed in-house based on the requirements of NQA-1-1994, Part II, Subpart 2.7 and DOE/RW/0333P, *Quality Assurance Requirements and Description (QARD)*, Supplement I. It is mandatory. SQA activities are installation testing and validation.
	WIPP	WP 16-IT3117, WIPP internal, mandatory, use-dependent; WP 16-2, WIPP internal, optional, use-dependent.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
Documentation	LLNL	HCD/ABS--Manuals are available for codes. No formal QA was done for manual content.
	LANL	Varies by customer. For specific customers, "Manufacturing Manual: Software Quality Assurance"; MFG-AP-0014 Rev. 0; and "Tru Waste Characterization Program: TWCP Quality Procedure", TWCP-QP-1.1-006 Rev. 7 are used.
	SNL	TA-V RREP QA Procedure, RREP 3-2, Computer Software Control; developed in-house, is mandatory for all software associated with the TA-V Nuclear Facilities; QA processes are peer review and testing.
	SRS	WSMS follows WSRC requirements on developing, testing, documenting, maintaining, and using computer codes used for safety analysis. Requirements are specified in standalone WSMS QA documentation, or are cited and referenced in WSRC documentation. This includes but is not limited to, the WSRC 1Q Manual, 11Q, Section 20-1, the E7 Manual, and WSMS Quality Assurance Procedures. Procedures are in-house developed and mandatory; QA processes are peer review.
	Pantex	In-house developed Software Quality Life Cycle (SQLC) Plant Standard STD-1875. Mandatory for all site-developed software, purchased software, contractor developed software, or design agency furnished software. The SQA process consists of peer reviews and approvals, and auditing.
	Rocky Flats	The Computer Software Management Manual (1-MAN-004-CSSM) contains the procedures followed for software development, testing, documentation, and maintenance. This manual was developed in-house using best industry practices and is mandatory; QA processes are peer review and independent verification and validation.. The processes invoked by the CSMM have been reviewed and audited by the Software Engineering Institute at Carnegie-Mellon University and given a SEI Level certification. They have also been reviewed and audited for Software Quality Assurance by the Carlsbad Area Office for WIPP certification. Since virtually all of the codes used in the nuclear safety areas are provided by outside sources (Oak Ridge, Los Alamos, RSICC, etc.) we cannot vouch for the SQA processes used by those developers. However, the implementation of the codes on site is guided by the CSMM and V&V testing is performed as part of the installation and configuration management process mandated by the CSMM.
	Y-12	Required deliverables provided at the end of each procedure. The current software control program is defined by the, *Software Development and Control*, Y80 Series procedures; the upcoming revision will be based on DOE's Software Engineering Methodology (SEM). The Nuclear Criticality Safety organization uses the following safety-related software: (1) SCALE/KENO: Standard Computer Analyses for Licensing Evaluation and (2) MCNP: Monte Carlo N-particle Transport Code System. This software is controlled by the Y80 Series procedures including the Nuclear Criticality Safety organization procedures and Y/DD-834 "LMES Y-12 Nuclear Criticality Safety Software application Software Document for the HP C-180 Workstation". The procedures were developed in-house at Y-12, based on software industry practices at the time. The procedures determine a software classification for each system based on various criteria. This classification is then used to drive the mandatory portions of the actual development process. It is mandatory that all Y-12 software use the Y80 procedures for guiding development. A combination of walkthroughs, reviews, and testing regimens are used as the basis for ensuring quality, per the Y80 procedures.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
	INEEL	INEEL Program Requirements Document (PRD)-115, "Configuration Management;" INEEL Standard (STD)-107, "Configuration Management Program;" INEEL Management Control Procedure (MCP) 550, "Software Management"; INEEL MCP-3630, "Computer System Change Control;" INEEL Guide (GDE)-59, "Guide for Computer System Change Control;" DOE-STD-1073-93, "Guide for Operational Configuration Management Program;" ANSI/IEEE STD-828-1998;" IEEE Standard for Software Configuration Plans;" ANSI/ANS-10.4-1987, "Guidelines for the Verification and Validation of Scientific and Engineering Computer Programs for the Nuclear Industry." Compliance with the INEEL documents is mandatory. Software packages developed and maintained at INEEL that are used for nuclear facility safety analysis or for control of active Safety SSCs are subject to the INEEL CM Program, have received verification and validation (V&V), and have CM Plans in place. See survey for description of INEEL documents.
	YMP/TESS	•NQA-2, Subpart 2.7 •OCRWM Quality Assurance Requirements & Description •OCRWM AP-SI.1Q Software Management •NQA-2, Subpart 2.7 is the NRC Standard for software development, testing, documentation, maintenance and usage. OCRWM Quality Assurance Requirements & Description (QARD) reflects in total the requirements of NQA-2, Subpart 2.7. AP-SI.1Q Software Management is the implementing procedure for Supplement I of the QARD. Compliance with AP-SI.1Q is mandatory. SQA processes include independent peer review, inspection, audit, and verification and validation of software.
	Hanford/RL	•Fluor Hanford--Primarily HNF-PRO-2778, *IRM Application System Life Cycle Standards* and HNF-PRO-309, *Computer Software Quality Assurance Requirements*. Procedures are in-house developed based on DOE Orders and other government agencies' requirements and mandatory. All the SQA processes listed in the survey are accepted in the procedures - they are based on defined scope and risk. The procedure requires that some form of change control and review process be established. Each project is allowed to define in their implementing procedures the specific configuration management processes they will apply. •Bechtel Hanford--In-house BHI-AT-01 Procedure 1.7, BHI-AT-01 Procedure 1.8 *Software Acquisition and Maintenance*, and BHI-DE-01-EDPI-4.36-01, *Project Calculations*. Procedures are based on industry standards and are mandatory. •PNNL Hanford--Any software developed or used at the Laboratory is required to be controlled in accordance with the Computer Software and Database Control subject area, which is aligned with the Software Systems Engineering Process (SSEP). The subject area was derived largely from the SSEP. The SSEP addresses each of the issues identified above. The subject area is mandatory for all PNNL staff. The SSEP is mandatory for all projects in the Information Science and Engineering Division and for all projects done for the Information Systems Engineering product line. The SSEP is more rigorous and more flexible than the subject area. However, each is based on the fundamental premise of defining a plan based on specific project or activity needs and executing the plan to develop, acquire, or use the software in involved. Both the subject area and the SSEP were developed at PNNL. The primary standard for the SSEP is the Software Engineering Institute's Capability Maturity Model for Software (see http://www.sei.cmu.edu/cmm/). It's also based to lesser extent on elements of IEEE standards, Department of Defense MIL-STD-498 (since replaced), and Iterative Process Models like the "Spiral Model" by Bochm and "Managed Evolutionary Development" by U.S. Patent Office.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
	Hanford/ORP	•Tank Farm–HNF-PRO-309, *Computer Software Quality Assurance Requirements* and HNF-PRO-2778, *IRM Application System Life Cycle Standards*. Procedures developed in-house based on DOE Orders and other government agency requirements and are mandatory. Varying degrees of SQA processes are used based on the defined scope and risk of the specific project application. •Tank Waste–Procedure K70C515, *Code of Practice for Computer Program Use*, addresses all the elements of ASME NQA-1-1994, Part II, Subpart 2.7, including software life cycle, development and maintenance, software testing, software verification and validation, documentation, error identification and notification. Procedure was developed in-house based on the requirements of NQA-1-1994, Part II, Subpart 2.7 and DOE/RW/0333P, *Quality Assurance Requirements and Description (QARD)*, Supplement I. It is mandatory. SQA activities are installation testing and validation.
	WIPP	WP 16-IT3117, WIPP internal, mandatory, use-dependent; WP 16-2, WIPP internal, optional, use-dependent.
Maintenance	LLNL	HCD/ABS–HOTSPOT and EPI are tested by the developer with standard runs after modification. No formal QA documentation. Other codes are purchased or adopted when they become available. They are informally QA'd by comparison with older versions and other applicable codes.
	LANL	Varies by customer. For specific customers, "Manufacturing Manual: Software Quality Assurance"; MFG-AP-0014 Rev. 0; and "Tru Waste Characterization Program: TWCP Quality Procedure", TWCP-QP-1.1-006 Rev. 7 are used.
	SNL	TA-V RREP QA Procedure, RREP 3-2, Computer Software Control; developed in-house, is mandatory for all software associated with the TA-V Nuclear Facilities; QA processes are peer review and testing.
	SRS	WSMS follows WSRC requirements on developing, testing, documenting, maintaining, and using computer codes used for safety analysis. Requirements are specified in standalone WSMS QA documentation, or are cited and referenced in WSRC documentation. This includes but is not limited to, the WSRC 1Q Manual, 11Q, Section 20-1, the E7 Manual, and WSMS Quality Assurance Procedures.
	Pantex	In-house developed Software Quality Life Cycle (SQLC) Plant Standard STD-1875. Mandatory for all site-developed software, purchased software, contractor developed software, or design agency furnished software. The SQA process consists of peer reviews and approvals, and auditing.
	Rocky Flats	The Computer Software Management Manual (1-MAN-004-CSSM) contains the procedures followed for software development, testing, documentation, and maintenance. This manual was developed in-house using best industry practices and is mandatory; QA processes are peer review and independent verification and validation.. The processes invoked by the CSMM have been reviewed and audited by the Software Engineering Institute at Carnegie-Mellon University and given a SEI Level certification. They have also been reviewed and audited for Software Quality Assurance by the Carlsbad Area Office for WIPP certification. Since virtually all of the codes used in the nuclear safety areas are provided by outside sources (Oak Ridge, Los Alamos, RSICC, etc.) we cannot vouch for the SQA processes used by those developers. However, the implementation of the codes on site is guided by the CSMM and V&V testing is performed as part of the installation and configuration management process mandated by the CSMM.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
	Y-12	Y80-800, *Configuration Control*. The current software control program is defined by the, *Software Development and Control*, Y80 Series procedures; the upcoming revision will be based on DOE's Software Engineering Methodology (SEM). The Nuclear Criticality Safety organization uses the following safety-related software: (1) SCALE/KENO: Standard Computer Analyses for Licensing Evaluation and (2) MCNP: Monte Carlo N-particle Transport Code System. This software is controlled by the Y80 Series procedures including the Nuclear Criticality Safety organization procedures. The procedures were developed in-house at Y-12, based on software industry practices at the time. The procedures determine a software classification for each system based on various criteria. This classification is then used to drive the mandatory portions of the actual development process. It is mandatory that all Y-12 software use the Y80 procedures for guiding development. A combination of walkthroughs, reviews, and testing regimens are used as the basis for ensuring quality, per the Y80 procedures.
	INEEL	INEEL Program Requirements Document (PRD)-115, "Configuration Management;" INEEL Standard (STD)-107, "Configuration Management Program;" INEEL Management Control Procedure (MCP) 550, Software Management"; INEEL MCP-3630, "Computer System Change Control;" INEEL Guide (GDE)-59, "Guide for Computer System Change Control;" DOE-STD-1073-93, "Guide for Operational Configuration Management Program;" ANSI/IEEE STD-828-1998;" IEEE Standard for Software Configuration Plans;" ANSI/ANS-10.4-1987, "Guidelines for the Verification and Validation of Scientific and Engineering Computer Programs for the Nuclear Industry." Compliance with the INEEL documents is mandatory. Software packages developed and maintained at INEEL that are used for nuclear facility safety analysis or for control of active Safety SSCs are subject to the INEEL CM Program, have received verification and validation (V&V), and have CM Plans in place. See survey for description of INEEL documents.
	YMP/TESS	•NQA-2, Subpart 2.7 •OCRWM Quality Assurance Requirements & Description •OCRWM AP-SI.1Q Software Management •NQA-2, Subpart 2.7 is the NRC Standard for software development, testing, documentation, maintenance and usage. OCRWM Quality Assurance Requirements & Description (QARD) reflects in total the requirements of NQA-2, Subpart 2.7. AP-SI.1Q Software Management is the implementing procedure for Supplement I of the QARD. Compliance with AP-SI.1Q is mandatory. SQA processes include independent peer review, inspection, audit, and verification and validation of software.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
	Hanford/RL	•Fluor Hanford--Primarily HNF-PRO-2778, *IRM Application System Life Cycle Standards* and HNF-PRO-309, *Computer Software Quality Assurance Requirements*. Procedures are in-house developed based on DOE Orders and other government agencies' requirements and mandatory. All the SQA processes listed in the survey are accepted in the procedures - they are based on defined scope and risk. The procedure requires that some form of change control and review process be established. Each project is allowed to define in their implementing procedures the specific configuration management processes they will apply. •Bechtel Hanford--In-house BHI-AT-01 Procedure 1.7, BHI-AT-01 Procedure 1.8 *Software Acquisition and Maintenance*, and BHI-DE-01-EDPI-4.36-01, *Project Calculations*. Procedures are based on industry standards and are mandatory. •PNNL Hanford–Any software developed or used at the Laboratory is required to be controlled in accordance with the Computer Software and Database Control subject area, which is aligned with the Software Systems Engineering Process (SSEP). The subject area was derived largely from the SSEP. The SSEP addresses each of the issues identified above. The subject area is mandatory for all PNNL staff. The SSEP is mandatory for all projects in the Information Science and Engineering Division and for all projects done for the Information Systems Engineering product line. The SSEP is more rigorous and more flexible than the subject area. However, each is based on the fundamental premise of defining a plan based on specific project or activity needs and executing the plan to develop, acquire, or use the software in involved. Both the subject area and the SSEP were developed at PNNL. The primary standard for the SSEP is the Software Engineering Institute's Capability Maturity Model for Software (see http://www.sei.cmu.edu/cmm/). It's also based to lesser extent on elements of IEEE standards, Department of Defense MIL-STD-498 (since replaced), and Iterative Process Models like the "Spiral Model" by Boehm and "Managed Evolutionary Development" by U.S. Patent Office.
	Hanford/ORP	•Tank Farm–HNF-PRO-309, *Computer Software Quality Assurance Requirements* and HNF-PRO-2778, *IRM Application System Life Cycle Standards*. Procedures developed in-house based on DOE Orders and other government agency requirements and are mandatory. Varying degrees of SQA processes are used based on the defined scope and risk of the specific project application. •Tank Waste--Procedure K70C515, *Code of Practice for Computer Program Use*, addresses all the elements of ASME NQA-1-1994, Part II, Subpart 2.7, including software life cycle, development and maintenance, software testing, software verification and validation, documentation, error identification and notification. Procedure was developed in-house based on the requirements of NQA-1-1994, Part II, Subpart 2.7 and DOE/RW/0333P, *Quality Assurance Requirements and Description (QARD)*, Supplement I. It is mandatory. SQA activities are installation testing and validation.
	WIPP	WP 16-IT3117, WIPP internal, mandatory, use-dependent; WP 16-2, WIPP internal, optional, use-dependent.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
Usage	LLNL	•HCD/ABS--Printouts of ALOHA, HOTSPOT, and EPI code runs are included with the safety basis documents and QA'd as part of the document. •HCD/ABS--HOTSPOT is an LLNL-developed code adopted by DOE for evaluation of potential doses (50-yr CEDE based on ICRP-30 dose conversion factors). HCD uses it when reviewing radioactive material releases. •HCD/ABS--EPI is a commercially available code (by the developer of HOTSPOT) that models toxic material releases, giving respirable airborne material concentration as a function of distance from release point. •HCD/ABS--ALOHA is a NOAA product that models toxic material releases, giving respirable airborne material concentration as a function of distance from release point. One of its uses at LLNL is to model liquid and condensed gas releases from tanks. •HCD/ABS--GEN II and MACCS are more complex codes that are not generally used by HCD analysts for safety basis documents.
	LANL	Varies by customer. For specific customers, "Manufacturing Manual: Software Quality Assurance"; MFG-AP-0014 Rev. 0; and "Tru Waste Characterization Program: TWCP Quality Procedure", TWCP-QP-1.1-006 Rev. 7 are used.
	SNL	TA-V RREP QA Procedure, RREP 3-2, Computer Software Control; developed in-house, is mandatory for all software associated with the TA-V Nuclear Facilities; QA processes are peer review and testing.
	SRS	WSMS follows WSRC requirements on developing, testing, documenting, maintaining, and using computer codes used for safety analysis. Requirements are specified in standalone WSMS QA documentation, or are cited and referenced in WSRC documentation. This includes but is not limited to, the WSRC 1Q Manual, 11Q, Section 20-1, the E7 Manual, and WSMS Quality Assurance Procedures. Procedures are in-house developed and mandatory; QA processes are peer review.
	Pantex	In-house developed Software Quality Life Cycle (SQLC) Plant Standard STD-1875. Mandatory for all site-developed software, purchased software, contractor developed software, or design agency furnished software. The SQA process consists of peer reviews and approvals, and auditing.
	Rocky Flats	This is determined by the specific software used by the analysts.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
	Y-12	Y80-900, *Post-Implementation Review*. The current software control program is defined by the, *Software Development and Control*, Y80 Series procedures; the upcoming revision will be based on DOE's Software Engineering Methodology (SEM). The Nuclear Criticality Safety organization uses the following safety-related software: (1) SCALE/KENO: Standard Computer Analyses for Licensing Evaluation and (2) MCNP: Monte Carlo N-particle Transport Code System. This software is controlled by the Y80 Series procedures including the Nuclear Criticality Safety organization procedures and Y70-68-005, *Quality Assurance for Nuclear Criticality Safety Computer Calculations*, Y/DD-833, Lockheed Martin Energy Systems Y-12 Nuclear Criticality Safety Organization Plan for Administration of the HP Workstation, Y/DD-573, *MMES Y-12 Nuclear Criticality Safety Software Validation of Keno V.a on the HP 9000/Series 700 Workstation*, Y/DD-790, *Validation of MCNP4A for Criticality Safety and Shielding Analyses on the HP-735*, and Y/DD-860, *Validation of MCNP4B2 for Criticality Safety and Shielding Analyses on the HP C-180*. The procedures were developed in-house at Y-12, based on software industry practices at the time. The procedures determine a software classification for each system based on various criteria. This classification is then used to drive the mandatory portions of the actual development process. It is mandatory that all Y-12 software use the Y80 procedures for guiding development. A combination of walkthroughs, reviews, and testing regimens are used as the basis for ensuring quality, per the Y80 procedures.
	INEEL	INEEL Program Requirements Document (PRD)-115, "Configuration Management;" INEEL Standard (STD)-107, "Configuration Management Program;" INEEL Management Control Procedure (MCP) 550, "Software Management"; INEEL MCP-3630, "Computer System Change Control;" INEEL Guide (GDE)-59, "Guide for Computer System Change Control;" DOE-STD-1073-93, "Guide for Operational Configuration Management Program;" ANSI/IEEE STD-828-1998;" IEEE Standard for Software Configuration Plans;" ANSI/ANS-10.4-1987, "Guidelines for the Verification and Validation of Scientific and Engineering Computer Programs for the Nuclear Industry." Compliance with the INEEL documents is mandatory. Software packages developed and maintained at INEEL that are used for nuclear facility safety analysis or for control of active Safety SSCs are subject to the INEEL CM Program, have received verification and validation (V&V), and have CM Plans in place. See survey for description of INEEL documents.
	YMP/TESS	•NQA-2, Subpart 2.7 •OCRWM Quality Assurance Requirements & Description •OCRWM AP-SI.1Q Software Management •OCRWM AP-SV.1Q Control of Electronic Management of Data •NQA-2, Subpart 2.7 is the NRC Standard for software development, testing, documentation, maintenance and usage. OCRWM Quality Assurance Requirements & Description (QARD) reflects in total the requirements of NQA-2, Subpart 2.7. AP-SI.1Q Software Management is the implementing procedure for Supplement I of the QARD. Compliance with AP-SI.1Q is mandatory. SQA processes include independent peer review, inspection, audit, and verification and validation of software.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
	Hanford/RL	•Fluor Hanford--Primarily HNF-PRO-2778, *IRM Application System Life Cycle Standards* and HNF-PRO-309, *Computer Software Quality Assurance Requirements*. Procedures are in-house developed based on DOE Orders and other government agencies' requirements and mandatory. All the SQA processes listed in the survey are accepted in the procedures - they are based on defined scope and risk. The procedure requires that some form of change control and review process be established. Each project is allowed to define in their implementing procedures the specific configuration management processes they will apply. •Bechtel Hanford--In-house BHI-AT-01 Procedure 1.7, BHI-AT-01 Procedure 1.8 *Software Acquisition and Maintenance*, and BHI-DE-01-EDPI-4.36-01, *Project Calculations*. Procedures are based on industry standards and are mandatory. •PNNL Hanford--Any software developed or used at the Laboratory is required to be controlled in accordance with the Computer Software and Database Control subject area, which is aligned with the Software Systems Engineering Process (SSEP). The subject area was derived largely from the SSEP. The SSEP addresses each of the issues identified above. The subject area is mandatory for all PNNL staff. The SSEP is mandatory for all projects in the Information Science and Engineering Division and for all projects done for the Information Systems Engineering product line. The SSEP is more rigorous and more flexible than the subject area. However, each is based on the fundamental premise of defining a plan based on specific project or activity needs and executing the plan to develop, acquire, or use the software in involved. Both the subject area and the SSEP were developed at PNNL. The primary standard for the SSEP is the Software Engineering Institute's Capability Maturity Model for Software (see http://www.sei.cmu.edu/cmm/). It's also based to lesser extent on elements of IEEE standards, Department of Defense MIL-STD-498 (since replaced), and Iterative Process Models like the "Spiral Model" by Boehm and "Managed Evolutionary Development" by U.S. Patent Office.
	Hanford/ORP	•Tank Farm–HNF-PRO-309, *Computer Software Quality Assurance Requirements* and HNF-PRO-2778, *IRM Application System Life Cycle Standards*. Procedures developed in-house based on DOE Orders and other government agency requirements and are mandatory. Varying degrees of SQA processes are used based on the defined scope and risk of the specific project application. •Tank Waste--Procedure K70C515, *Code of Practice for Computer Program Use,* addresses all the elements of ASME NQA-1-1994, Part II, Subpart 2.7, including software life cycle, development and maintenance, software testing, software verification and validation, documentation, error identification and notification. Procedure was developed in-house based on the requirements of NQA-1-1994, Part II, Subpart 2.7 and DOE/RW/0333P, *Quality Assurance Requirements and Description (QARD)*, Supplement I. It is mandatory. SQA activities are installation testing and validation.
	WIPP	WP 16-IT3117, WIPP internal, mandatory, use-dependent; WP 16-2, WIPP internal, optional, use-dependent.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
2. Do these procedures comply with the following guidelines?		
DOE O 420.1	LLNL	CSG--Criticality safety software complies with DOE O 420.1 requirements.
	LANL	In part
	SNL	Yes
	SRS	Yes
	Pantex	See "Other" below.
	Rocky Flats	In Whole
	Y-12	See "Other" – Y80 Series based on DOE guidance indicated below.
	INEEL	Implemented but not mapped
	YMP/TESS	Not Applicable
	Hanford/RL	•Fluor Hanford--DOE Order 420.1 is not in the Project Hanford Management Contract (PHMC); however, the following DOE Orders and FH procedures are in compliance with them: DOE 5480.28, *Natural Phenomena Hazards Mitigation* DOE 5480.7A, *Fire Protection* DOE 6430.1A, *General Design Criteria* DOE 5480.24, *Criticality Safety* •Bechtel Hanford--DOE Order 420.1 is not included in the ERC Contract at this time. However, the ERC procedures identified above are consistent with the requirement of DOE Order 420.1 •PNNL Hanford--Not in PNNL's contract yet. Not applicable. (DOE Orders 5480.24 and 5480.7A have been implemented.)
	Hanford/ORP	•Tank Farm–The SQA program was not written to satisfy DOE O 420.1 specifically, but in that DOE O 420.1 invokes 10CFR830.120, the SQA program does comply with DOE O 420.1. Specifically, DOE O 420.1 requires design of safety structures, systems and components (SSCs) to be performed under a quality assurance program that satisfies 10 CFR830.120. Our quality assurance program satisfies 10 CFR830.120. Specifically, under design, SQA requirements are addressed to ensure that safety SSCs that are designed with the use of software are properly controlled. •Tank Waste–Under the privatization concept and under the current "bridge" design effort the cited DOE Orders are not applicable; see section V, Additional Comments.
	WIPP	Yes, compliance in whole.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
DOE O 414.1	LLNL	HCD/ABS--Compliance with applicable sections of 10 CFR 830.120 — on-the-job training, peer and independent review of calculations, record keeping, approved procedures for use of codes
	LANL	In part
	SNL	Yes
	SRS	In part
	Pantex	Mapped, see "Other" below
	Rocky Flats	In Whole
	Y-12	See "Other", based on DOE O 5700.6C
	INEEL	Implemented but not mapped
	YMP/TESS	Full compliance
	Hanford/RL	•Fluor Hanford--This Order is implemented through HNF-MP-599, *PHMC Quality Assurance Program Description*. The applicable requirements of HNF-MP-599 are implemented by HNF-PRO-2778, *IRM Application System Life Cycle Standards* and HNF-PRO-309, *Computer Software Quality Assurance Requirements*. •Bechtel Hanford--DOE Order 414.1 is not included in the ERC Contract at this time. The ERC procedures are compliant with DOE Order 5700.6C as required by the Contract. •PNNL Hanford--The "Computer Software and Database Control" subject area is compliant with this order.
	Hanford/ORP	•Tank Farm--Yes •Tank Waste--Under the privatization concept and under the current "bridge" design effort the cited DOE Orders are not applicable; see section V, Additional Comments.
	WIPP	Yes, compliance in whole.
DOE O 200.1	LLNL	HCD/ABS--Yes
	LANL	In part
	SNL	Yes
	SRS	Uncertain
	Pantex	See "Other" below

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
	Rocky Flats	In Whole
	Y-12	See "Other", based on DOE O 1360.1A
	INEEL	Implemented but not mapped
	YMP/TESS	Full compliance
	Hanford/RL	•Fluor Hanford--HNF-PRO-2778, *IRM Application Software System Life Cycle Standards* implements this Order. •Bechtel Hanford--DOE Order 200.1 is not included in the ERC Contract at this time. The ERC procedures are based on the Bechtel Corporate SDMF, which is consistent with DOE Order 200.1. •PNNL Hanford–Not in PNNL's contract yet. Not applicable. (DOE Order 1330.1D has been implemented.)
	Hanford/ORP	•Tank Farm–HNF-PRO-2778 implements this Order. •Tank Waste--Under the privatization concept and under the current "bridge" design effort the cited DOE Orders are not applicable; see section V, Additional Comments.
	WIPP	Yes, compliance in whole.
DOE G 200.1-1	LLNL	HCD/ABS--Not appropriate for desktop computing software
	LANL	In part
	SNL	No
	SRS	Uncertain
	Pantex	Mapped, see "Other" below
	Rocky Flats	In Whole
	Y-12	See "Other"
	INEEL	Implemented but not mapped
	YMP/TESS	Full compliance
	Hanford/RL	•Fluor Hanford--The FH procedures comply with DOE Order 200.1. The Guide is not in the PHMC. •Bechtel Hanford--DOE Order 200.1 is not included in the ERC Contract at this time. The ERC procedures are based on the Bechtel Corporate SDMF, which is consistent with DOE Order 200.1. •PNNL Hanford–The SSEP complies.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
	Hanford/ORP	•Tank Farm–Yes •Tank Waste–Under the privatization concept and under the current "bridge" design effort the cited DOE Orders are not applicable; see section V, Additional Comments.
	WIPP	No
DOE G 414.1-1	LLNL	HCD/ABS–DOE G 414.1 does not have a section 4.6.3. DOE G 414.2 *Quality Assurance Management System Guide* does have a section 4.6.3 related to the Design Process. It calls for validation of the software used in the design process. As noted above, informal validation is attained by comparison with standard output results, widespread use for exposure and dose calculations, and review and approval of output during the approval of the safety basis documents.
	LANL	In part
	SNL	No
	SRS	Uncertain
	Pantex	See "Other" below
	Rocky Flats	In Whole
	Y-12	See "Other", based on DOE AL QC-1
	INEEL	Implemented but not mapped
	YMP/TESS	Full compliance
	Hanford/RL	•Fluor Hanford--The FH procedures comply with section 4.6.3 of DOE G 414.1-2. •Bechtel Hanford--DOE Order 414.1 is not included in the ERC Contract at this time. The ERC procedures are compliant with DOE Order 5700.6C as required by the Contract. •PNNL Hanford--Was considered when developing the Integrated Assessment System within PNNL. (Note: August 1996 version does not contain a section 4.6.3)
	Hanford/ORP	•Tank Farm–Yes •Tank Waste--Under the privatization concept and under the current "bridge" design effort the cited DOE Orders are not applicable; see section V, Additional Comments.
	WIPP	Yes, compliance in whole.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
ANSI/ANS-10.4-1987	LLNL	–
	LANL	In part
	SNL	No
	SRS	In part
	Pantex	See "Other" below
	Rocky Flats	Yes
	Y-12	See "Other"
	INEEL	Implemented but not mapped
	YMP/TESS	Full compliance
	Hanford/RL	•Fluor Hanford–No response. •Bechtel Hanford–No. •PNNL Hanford–No response.
	Hanford/ORP	•Tank Farm–No response. •Tank Waste–No response.
	WIPP	–
NQA-1-1997	LLNL	CSG–Criticality safety software meets ANSI/ANS 8.1, Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors
	LANL	In part
	SNL	Yes
	SRS	In part
	Pantex	Mapped, see "Other" below
	Rocky Flats	Yes
	Y-12	See "Other"
	INEEL	Implemented but not mapped

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
	YMP/TESS	Full compliance
	Hanford/RL	•Fluor Hanford--The FH procedures comply with NQA-1-97, Subpart 2.7, *Quality Assurance Requirements of Computer Software for Nuclear Facility Application* with NQA-1-99 Addendum •Bechtel Hanford–No •PNNL Hanford–This can be applied on a project specific basis, as needed, but it is not a foundation for the entire Laboratory. For example, analysis for criticality and shielding is done using MCNP and SCALE. Control and maintenance of these codes is performed by the following procedure, PNL-MA-875 "Computer Code Maintenance Quality Assurance Manual". This manual is NQA-1 Part 2.7 Compliant.
	Hanford/ORP	•Tank Farm–The CHG quality assurance program invokes NQA-1-89 as a consensus standard for implementing 10CFR830.120 and utilizes the FH procedures for implementing the NQA-1-89 requirements. The FH procedures comply with NQA-1-97, Subpart 2.7, Quality Assurance Requirements of Computer Software for Nuclear Facility Application with NQA-1-99 Addendum. •Tank Waste–ASME NQA-1-1994, Part II, Subpart 2.7.
	WIPP	Yes, compliance in whole, where required.
Other	LLNL	No
	LANL	QC-1, IEEE STD 730-1998, IEEE STD 730.1-1995, IEEE STD 828-1998, ASME NQA-2-1989, NQA-2a-1990, NUREG/CR-0178, NUREG/CR 6463, NUREG/CR 4640, IEEE Std. 610.12-1990
	SNL	–
	SRS	–
	Pantex	The in-house developed Software Quality Life Cycle Plant standard has been mapped to the following: ANSI/ISO/ASQC Q9001 –1994 Quality Systems, DOE/HQ Software Engineering Methodology 3/96, DOE Order 5700.6C Quality Assurance (10 CFR 830.120, Quality Assurance Requirements), ASME NQA-1 Addenda Part 2.7, DOE/AL Quality Criteria (QC-1), and the Software Engineering Institute's (SEI) Capability Maturity Model's eighteen Key Process Areas.
	Rocky Flats	–
	Y-12	The current software procedures were issued in early 1991 and revised in early 1995. The procedures have not been evaluated against the above requirements. The new Y80 Series procedures, expected to be issued end of CY2000, will address the above requirements and be in line with the current safety criteria such as those required by Integrated Safety Management (ISM) processes. The revised procedures will incorporate the latest QA, security, and software engineering requirements.
	INEEL	–

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION		
	YMP/TESS	–
	Hanford/RL	•Fluor Hanford–The FH procedures also comply with Office of Civilian Radioactive Waste Management (OCRWM) QA Requirements and Description, Section 3 - Design Control, Section 11 - Test Control, and Supplement 1 - Software, and with Title 10, Code of Federal Regulations, Part 830.120 - *Quality Assurance Requirements.* •Bechtel Hanford–ISO 9000. The ERC has not developed in-house computer codes for safety analysis applications. All software in use for safety analysis was developed by third parties and is either in the public domain or commercially available. The ERC specifies, procures, and validates such software consistent with our SQA program. The minimum requirements are: •A determination by the applicable functional manager that the documentation supplied by the third party includes a description of the theoretical basis for the software package, instructions in the use of the package, and that the extent of software validation and verification is adequate for the ERC application. •Confirmation that the software as delivered reproduces the results of tests conducted as part of the software validation/verification. BHI's Automation Technology group is in the process of updating the SQA program, and existing procedures are being reviewed/ revised. The plan is to adopt the following DOE documents in their entirety: DOE Order 200.1 *Information Management Program*, and DOE Guide 200.1-1 *Department of Energy Software Engineering Methodology.* •PNNL Hanford–The primary standard for the SSEP is the Software Engineering Institute's Capability Maturity Model for Software (see http://www.sei.cmu.edu/cmm/)
	Hanford/ORP	•Tank Farm–The FH procedures comply with 10CFR830.120, Quality Assurance Requirements. Subsequent to creation of the DOE Office of River Protection (ORP) and changing the Tank Farm Contractor from a subcontractor under Fluor Hanford, Inc. (FH) to a prime contractor under ORP, the Tank Farm Contractor (now CH2M HILL Hanford Group, Inc. [CHG]) and FH agreed that common use of some existing FH procedures would facilitate consistency among interfacing Hanford contractors. CHG utilizes SQA programs that were written by FH for use with the Project Hanford Management System. •Tank Waste–DOE/RW/0333P, *Quality Assurance Requirements and Description (QARD)*, Supplements I and V.
	WIPP	N/A

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION			
3.	How frequently is compliance with these procedures audited?	Are audits performed by external groups?	What is the date(s) of your last SQA audit?
LLNL	•HCD/ABS--No formal audit program •CSG--Criticality safety is audited by both LLNL ARO and DOE-Oakland Operations Office. The ARO audit is on a three-year cycle. •HWM--Multiple times per year through assessments, audits, and surveillance. Audits are directly and indirectly performed of HWM's QA Program by DOE, State of CA/DTSC, internal and external audits of the Waste Certification Program, internally by Hazards Control and Assurance Review Office. SQA has not been the main subject of an audit, but some components of SQA have been assessed as part of a audit.	•HSD/ABS –No •CSG–Yes, Criticality safety audit by LLNL Assurance Review Office which did include external experts. •HWM--Yes, by the Assurance Review Office (ARO) and State and Federal agencies.	•HCD/ABS --N/A •CSG–Last ARO audit on Criticality safety was in January of 2000.
LANL	Varies by customer	Varies by customer	Varies by code, by as an example TWCP was audited in August 2000.
SNL	Once per Year	No – Internal Independent	January, 2000
SRS	Compliance with WSRC software and practices, and evolving WSMS procedures are audited in part every 3 to 4 years.	The audits are usually performed by external groups (WSRC, others). Occasionally, self-assessments are conducted by WSMS. The latter are mostly spot-checks of some software users and only apply to a few software packages.	Compliance has been checked once (~ 1998) since the formation of WSMS (1 October 1997). It's unclear to the degree this activity was an audit.
Pantex	As determined by the Internal Auditing department relative to the risk assessment process (Criticality Safety – annually).	Several Y2K audits were conducted by external groups.	9/00 by DOE/AAO relative to QC-1 compliance. Criticality Safety – 2/00.
Rocky Flats	Audits are conducted on various aspects of SQA and Nuclear Safety matters throughout the year according to the site Master Audit Schedule.	Yes, both actual external groups (EPA, CAO, etc.), as well as internal, but independent, groups (K-H Internal audit, Independent Safety Oversight)	June 26, 2000.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION			
Y-12	SQA is not singled-out as a specific entity. It is integrated into the overall software control process. Therefore, an assessment just on the SQA elements of the software control program would not be performed.	The Plant Quality Assurance Organization assesses software associated with a work process when the work process is being assessed.	November 1999 (QAS-2)
INEEL	Compliance with INEEL procedures is a typical subject for facility self-assessments.	Not specified	No comprehensive sitewide audit has been performed. Flowdown review conducted in FY 99.
YMP/TESS	Monthly	Yes	8/25/2000
Hanford/RL	•Fluor Hanford--There isn't a set frequency; however, audits have occurred approximately annually. --- •Bechtel Hanford--Comprehensive compliance audits, as referred to here, are not routinely scheduled. Audits for software licensing are performed annually. --- •PNNL Hanford--Assessment for Laboratory compliance to the subject area has not been conducted. However, there is a SSEP assessment program that focuses on projects performed by IS&E and for the ISE product line.	•Fluor Hanford--Yes, audit groups include: Fluor Corporate Auditors, DOE-RL Auditors, IG Auditors, DNFSB Auditors, OCRWM Auditors, and other oversight agencies. The frequency and schedule of audits are not known until an audit notification is sent. --- •Bechtel Hanford-No --- •PNNL Hanford--The SSEP assessments are performed by representatives from the Quality organization.	•Fluor Hanford--1997 - Fluor Corp (97-001-1), General and Applications Controls Audit; June, 1999 - DOR-AUD-PAD-99-021, Software Quality Assurance; July, 2000 - IA2000-06, Software Acquisition/Development --- •Bechtel Hanford--The last documented SQA audit was performed in February 1996. --- •PNNL Hanford--SSEP assessments are performed continually. There are currently several in progress. In FY00 Internal Auditing performed an audit on General Information Systems Controls which included looking at the subject area and SSEP, but did not cover them in depth or specifically focus on them.

I. SOFTWARE QUALITY ASSURANCE (SQA) INFORMATION			
Hanford/ORP	•Tank Farm–Specific frequencies for audits of the SQA program are not set. However, as a program implementing quality assurance requirements, the implementation of these requirements are required to be audited on an annual basis. --- •Tank Waste–No frequency is established; however, audits have been performed approximately annually. In addition, management assessments and surveillance have been performed more frequently.	•Tank Farm–CHG has performed no audits on SQA since October 1,1999. Prior to October 1, 1999, the SQA program was under FH and was audited by internal and external groups. --- •Tank Waste–Yes. Audit groups included DOE/RL-Regulatory Unit, DOE-Office of River Protection	•Tank Farm–June 1999 --- •Tank Waste–External audit: 11/4/99; internal audit: 2/16/00
WIPP	Periodically.	Sometimes external, sometimes internal.	External, Environmental Protection Agency, March 1999 –WWIS Programmatic Audit; Internal, WID QA, November 2000 – WWIS Programmatic audit to NQA-2A; Each Software Quality Assurance plan (per WP 16-IT3117) is reviewed and approved by WID QA.

SEPARATION

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01-0949

Summary Report on Training to Department of Energy (DOE) Lead Principal Secretarial Officers (LPSO)

Response to Defense Nuclear Facilities Safety Board (DNFSB) Technical Report 25, Focus Area No. 2 – Training Software – Safety Software – Safety Analysis

March 30, 2001

by
Training Focus Area Team
Developed under the auspices of the
Office of the Chief Information Officer, the
Office of Environment, Safety and Health, and
NNSA/Office of Defense Programs

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Attachments

Executive Summary

To address the concerns presented by the Defense Nuclear Facilities Safety Board (DNFSB) in Technical Report 25 "*Quality Assurance for Safety-Related Software at Department of Energy Defense Nuclear Facilities*", a Response Team was formed February 2000. The Response Team was led by the Office of the Chief Information Officer (OCIO) and composed of participants from Defense Programs (NNSA/DP); Environmental Management (EM); Environment, Safety and Health (EH); and other Principal Secretarial Offices (PSO). The Response Team developed a three-pronged approach which investigated Infrastructure, Training, and Safety Analysis and Instrumentation and Control (I&C) codes. Three subteams were formed to address each of these focus areas. The Infrastructure Focus Team divided its efforts into three areas to review Software Quality Assurance (SQA) Requirements, Standards, and Organization.

This report is a Departmental perspective in regards to Training for software, safety software, and safety analysis. Although discussed, this report does not endorse or provide consensus standards or training requirements in regards to DOE safety analysis and I&C codes. The Safety Analysis Software Group (SASG), led by NNSA/DP, EM, and EH, will address this software and issue a report. The intent is to review the DOE training programs and compare with training by other government and industry organizations.

In summary, the Board felt that problems with the implementation and use of software codes partially resulted from a lack of training of safety analysts and I&C personnel on the use of analytical and I&C codes, and applying I&C software to assist in the control of DOE facility processes. Related to this concern is the degree of training by SQA staffs in assuring safety analysis and I&C systems. The Board addressed a lack of a formal program for training Federal or contractor personnel who perform safety analysis or oversight functions. A study was undertaken by the Training Focus Area Team to assess the Department's guidance for training in these areas; and a survey was developed to focus on training for safety analysis and I&C codes in defense nuclear facilities.

This report is a compilation of the study and survey results. It is intended to be used as a resource by the SASG and others involved in managing, engineering, or assuring DOE software.

1.0 Training Focus Area Description

The Training Focus Area Team's direction was to review and assess training requirements needed for safety software, safety analysis, and software quality assurance (SQA) to ensure the competency of personnel involved in the operation and management of DOE's software, particularly safety software. The Team also was to review the adequacy of training in the usage of safety analysis and instrumentation and control (I&C) software by safety analysts. There were three basic issues, which needed to be addressed in addressing these concerns:

- What training is currently provided by DOE facilities to personnel involved in development or use of software, especially software with safety-critical applications?

- What training is available to DOE facilities if DOE determines that its personnel need more training in SQA or in the use of safety-critical software; and what mechanisms exist to implement this training?

- What are the training requirements and practices implemented at other safety-critical facilities for software development or use?

An independent evaluation by the Training Focus Area Team was conducted to identify a set of training courses that could include DOE and other government and industry directives and to describe how the training would be applied based on benchmark data. Attachment 1 lists the organizations reviewed, Attachment 2 lists the DOE training directives, and Attachment 3 lists a sampling of the training courses currently available. Training regarding Integrated Safety Management (ISM) and DOE's Functions, Responsibilities, and Authorities Manuals (FRAM) were included in the review. In addition, to determine whether the current set of training opportunities adequately address DOE requirements and are appropriately applied to safety analysis and I&C software, DOE surveyed contractor safety analysis and SQA training. Attachment 4 is a compilation of the survey.

The Office of the Chief Information Officer (OCIO) has primary responsibility for identifying general software training requirements, and the Office of Environment, Safety and Health (EH) has primary responsibility for identifying safety software training requirements. These two Offices worked together with NNSA/Defense Programs (DP) to prepare this report and to make recommendations to the Lead Principal Secretarial Offices (LPSO) and also to recommend any specific line management follow-up actions to the Deputy Secretary.

1.1 DOE Training

DOE Federal and contractor training organizations were reviewed to assess not just training requirements but the infrastructure for ensuring that training requirements can be met. The review included training for safety/safety analysis and software/SQA. It appears that there is an adequate number of organizations who have developed websites as their repository of training information. In general, DOE does not control nor establish specific training requirements for contractor personnel. There is a general requirement in DOE quality assurance (QA) Orders (and other directives) that contractor personnel are trained to perform their jobs.

1.1.1 Federal Training Programs and Organizations

DOE has established a Departmental Training Program, which is managed by the Office of Management and Administration (MA) located at DOE Headquarters. In addition, DOE has established a technical training program, which is managed by the Office of Environment, Safety, and Health (EH) but considered part of the Departmental Training Program. Partner relationships have also been established with other DOE training groups. The Departmental directives, committees, training dissemination methods, and courses for software, quality assurance, and safety are discussed in this section.

The Departmental Training Program is responsible for Departmentwide Federal and contractor training funding. The FY 2000 estimate for training was about $415 million, with around $65 million going to Federal employee training and about $350 million for Management and Operating/Integration (M&O/I) contractor training. There is a great concern at the Department that substantial cuts by Congress similar to the cuts experienced in travel funding may occur.

DOE Directives and Standards (MA and EH). MA and EH have established directives and standards for Federal and contractor staff training. DOE directives and standards establish the requirements that must be met and the results that must be accomplished to ensure a successfully trained Federal and contractor workforce. Both DOE O 350.1 and DOE 0 360.1, discussed below, assign MA with the responsibility to design, manage, and coordinate training. DOE directives issued by MA and EH are available at the http://www.explorer.doe.gov/ website. DOE Technical Standards issued by EH are available at the http://tis.eh.doe.gov/techstds/ website.

General Departmental Training Directives. Below is a listing of directives issued by MA that apply to all DOE training.

- DOE O 350.1, CONTRACTOR HUMAN RESOURCE MANAGEMENT PROGRAMS, applies to contractor training programs. It requires the use of a systematic approach to develop training. Change 2 (draft), (a) establishes DOE responsibilities, requirements, and cost allowability criteria for the management and oversight of contractor Human Resource (HR) Management programs, (b) ensures that DOE contractors manage their HR programs to support the DOE mission, promote work force excellence, champion work force diversity, achieve effective cost management performance, and comply with applicable laws and regulations, © implements consistent requirements that allow contractors flexibility in determining how to meet the requirements, and (d) ensures that all elements of cash and non-cash compensation are considered in the design and implementation of an appropriate total compensation philosophy, but are not used as a means to deflect needed cost reductions in either or both. A re-write of various chapters of DOE O 350.1 (in response to GAO recommendations and a Secretarial letter entitled "Effectively Managing Training Resources", dated March 4, 1999), is nearing completion and is expected to be forwarded to Directives for beginning the review process. The contact for the rewrite is John Edmondson, MA-53).

- DOE O 360.1A, FEDERAL EMPLOYEE TRAINING, applies to Federal personnel and was issued to plan and establish requirements and assign responsibilities for DOE Federal employee training, education, and development under the Government Employees Training Act of 1958, as amended, to improve workforce performance related to the mission and strategic objectives of DOE through a cyclical program of training planning, needs analysis and assessment, design, development, implementation, and evaluation.

- DOE M 360.1A-1, FEDERAL EMPLOYEE TRAINING MANUAL, provides detailed requirements to supplement DOE O 360.1A, FEDERAL EMPLOYEE TRAINING. The information is intended to assist in improving Federal workforce performance through training, academic and other education programs, developmental assignments, workforce development programs, which may use a range of personnel and training authorities, and other learning-related activities.

- DOE P 360.X, POLICY FOR A CORPORATE APPROACH TO TRAINING AND DEVELOPMENT FOR THE DOE COMPLEX, provides a framework for the corporate approach to training and development for the entire DOE complex, including contractor training.

Safety/Safety Analysis Training Directives and Standards. This is a listing of DOE directives and standards issued by EH governing Departmental policies on safety and safety analysis training that may also be applicable to software staff.

- DOE O 5480.20A, PERSONNEL QUALIFICATIONS AND TRAINING REQUIREMENTS FOR DOE NUCLEAR FACILITIES, assigns responsibility to EH to develop Department-wide training requirements. Specific requirements in DOE O 5480.20A for technical personnel training include:

  - Facility organization
  - Facility fundamentals
  - Facility systems, components, and operations
  - Simulator training
  - Environment, Safety, and Health Orders
  - Codes and standards overview
  - Facility document system
  - Safety Analysis Reports and Technical Safety Requirements
  - Nuclear criticality control
  - Material, maintenance, and modification control
  - ALARA and radiation waste reduction program
  - Quality Assurance/Quality Control practices

- DOE P 426.1, FEDERAL TECHNICAL CAPABILITY FOR DEFENSE NUCLEAR FACILITIES, establishes the Federal Technical Capability Program to provide for the recruitment, deployment, development, and retention of Federal personnel with the demonstrated technical capability to safely accomplish the Department's missions and responsibilities. It establishes general training requirements for DOE personnel involved in facility operations and safety oversight.

- DOE G 426.1-1, RECRUITING, HIRING, AND RETAINING HIGH-QUALITY TECHNICAL STAFF, provides DOE managers with information on available administrative flexibilities that can be utilized in day-to-day HR management activities–especially those bearing on the recruitment and retention of high-quality technical staff.

- DOE M 426.1-1, FEDERAL TECHNICAL CAPABILITY MANUAL, provides the process for the recruitment, deployment, development, and retention of Federal personnel with the demonstrated technical capability to safely accomplish the Department's missions and responsibilities at defense nuclear facilities.

- DOE-STD-3009-94, PREPARATION GUIDE FOR U.S. DEPARTMENT OF ENERGY NON-REACTOR NUCLEAR FACILITY SAFETY ANALYSIS REPORTS, establishes guidance for consistency with DOE O 5480.23 requirements and its safety guide and describes a safety analysis report (SAR) preparation method for DOE. The standard includes the following requirement in section 3.4.1 "Briefly

summarize and reference detailed information on algorithms, computational and analytical bases, and software quality assurance measures."

- DOE-STD-1135-99, GUIDANCE FOR NUCLEAR CRITICALITY SAFETY ENGINEER TRAINING AND QUALIFICATION, describes the requirements for training and qualification of contractor Nuclear Criticality Safety (NCS) engineers in the DOE complex to facilitate hiring and maintaining trained and qualified NCS staff. The standard briefly addresses SQA for criticality codes in section IV.5.0 "Evaluators should use configuration controlled, verified, and validated software and data sets"; and should be able to "Describe the importance of validation of computer codes and how it is accomplished." (A recent review found that DOE has not met commitments to ensure that this standard is implemented by its contractors.)

- DOE-STD-1063-2000, FACILITY REPRESENTATIVES, defines the duties, responsibilities, and qualifications for DOE Facility Representatives, based on facility hazard classification; risks to workers, the public, and the environment; and the operational activity level. The standard addresses selection, qualification, and training for facility representatives. It does not list specific topics to be included in training and qualification, but does discuss a Needs Analysis process to determine requirements for specific Facility Representatives.

Software/SQA Training Directives and Standards. There are no training directives issued by the Department nor the Office of the CIO specifically for software and SQA training. The following directives, however, have provisions for software training.

- DOE O 200.1, INFORMATION MANAGEMENT, was canceled in FY 2000. It contained no explicit requirements for training, but did reference DOE G 200.1-1, SOFTWARE ENGINEERING METHODOLOGY. DOE O 1330.1D, COMPUTER SOFTWARE MANAGEMENT, (superseded by DOE O 200.1) contained more explicit requirements for software training. A replacement Order is under development for DOE O 200.1.

- DOE N 203.1, SOFTWARE QUALITY ASSURANCE, specifies a requirement for training in an SQA program. The Notice references DOE directives and industry standards applicable to safety or safety software. This Notice will be made into an Order.

- DOE G 200.1-1, SOFTWARE ENGINEERING METHODOLOGY, contains guidance in regards to the application of training on software projects. The Guide can and should be supplemented by site guidance to meet local needs.

- DOE O 414.1A, QUALITY ASSURANCE, states the requirements for DOE elements and contractors to develop Quality Assurance Programs (QAPs). The Order directs organizations to include training in their QAPs.

Departmental Committees. The Training and Development Management Council oversees the Departmental Training Program. In addition, monthly teleconferences, chaired by Dr. Butler in MA are held with Departmentwide staff to discuss issues and concerns of the training community. Information on the Council and attendees of the teleconferences is provided in Attachment 5. Information on all that is offered by the Departmental training program can be obtained on the http://cted.inel.gov/cted website, including EH training material, Integrated Safety Management training, nuclear safety training, and the EM training program. Listed on this website are training catalogs from many field sites. Also, the Department has established two technical training programs to oversee technical training, which are the Federal Technical Capability Program and the Technical Qualification Program. For complete information, view the http://tis.eh.doe.gov/training/resources/resources.htm and the http://cted.inel.gov/cted/qualstd.html websites. In addition, there are other DOE groups that provide training such as the Training Resources and Data Exchange (TRADE) and the Albuquerque Central Training Academy, now known as Nonproliferation and National Security Institute (NNSI).

Training and Development Management Council. The Council is comprised of senior managers from 32 Departmental elements (includes field sites) and is chaired by the Director of Management and Administration (MA). The Council also has an Executive Committee which is comprised of 15 of these members who meet bi-monthly in Washington, DC, to address Departmentwide Federal and contractor training issues. Attachment 5 contains a listing of the members.

In February 2000, each member of the Executive Committee was asked to invite one management and operation (M&O) contractor representative to the meeting. The purpose was to reach a common understanding of critical issues that both Federal and contractors needed to identify and address to improve the quality and cost-effectiveness of training Departmentwide. At the conclusion of the meeting it was the consensus that the M&Os should continue to participate in the Executive Committee meetings.

Monthly Teleconferences. Formerly, the Training and Development Coordinating Group, composed of all training directors and coordinators from every major Headquarters program office and field organization, was the working group for the Council. The Group was disbanded to consolidate the various training groups and reduce the time requirements

for training personnel to participate in meetings. Attachment 5 contains a listing of the members of the Group who ow participate in a monthly teleconference, as needed.

Federal Technical Capabilities Program. The Federal Technical Capabilities Program establishes general training requirements for DOE personnel involved in facility operations and safety oversight, and provides for the recruitment, deployment, development, and retention of Federal personnel. The Federal Technical Capability Program Panel is responsible for overseeing the overall implementation of the Program. Headquarters and field elements are responsible for implementing specific activities within the program. The Panel consists of senior line managers who have been designated as Agents to represent Headquarters and Field Offices with defense nuclear facility responsibilities. The Panel reports to the Deputy Secretary and is responsible for overseeing and resolving issues affecting the Program. The Board is described in DOE M 426.1-1, FEDERAL TECHNICAL CAPABILITY MANUAL. More information is available at the website cited above.

Technical Qualification Program. The Technical Qualification Program (TQP) became a part of DOE's Federal Technical Capability Program (FTCP) upon implementation of the FTCP in FY 1999. The TQP establishes a process to objectively determine that individuals performing activities related to the technical support, management, oversight, or operation of defense nuclear facilities possess the necessary knowledge, skills, and abilities to perform their assigned duties and responsibilities. There are also a number of Technical Qualification Competencies and Standards. They can be viewed at the http://cted.inel.gov/cted/qualstd.html website. Among the positions are standards covering:

- Instrumentation and Control personnel. This standard briefly discusses knowledge of computers, but no software-specific items.

- Facility Representatives. A long list of specific competencies is included (steam systems, HVAC, chemistry, etc.), but does not include software.

- Quality Assurance personnel. No specific software competencies are included.

Training Resources and Data Exchange (TRADE). The Departmental Training Program has formed a partnership with the Training Resources and Data Exchange (TRADE). One notable group is the *Quality and Safety Management Special Interest Group*. This group began as a result of an ad hoc committee of individuals with quality assurance (QA) responsibilities at the TRADE Conference in 1988. First known as the TRADE QA Special Interest Group (SIG), then later the Quality Management SIG, the group changed their name again in 1997 to the Quality and Safety Management SIG. The QSM SIG

serves as a network for quality and safety management training and issues information for DOE and DOE contractor personnel to promote consistency in application and reduce duplication of effort. The QSM SIG develops, improves, and provides management information related to quality and safety issues involving the U.S. Department of Energy (DOE) community. More information is available at the http://www.orau.gov/qsm website. The DOE QA Working Group (QAWG) is a participant with the QSM SIG. More information on the QAWG is available at the http://twilight.saic.com/qawg website.

Nonproliferation and National Security Institute (NNSI). NNSI was formerly known as the Albuquerque Central Training Academy, and is composed of four academies. It is located at Kirtland Air Force Base in Albuquerque, New Mexico. DOE facilities located throughout the contiguous United States are responsible for producing, storing, and handling significant quantities of nuclear materials, weapons, classified information, and equipment that require extensive protection in the interest of national security. In 1984 the Academy was established to provide DOE safeguards and security personnel with standardized training in a broad variety of disciplines, including tactical and firearms; crisis negotiation; management and instructional training; information and personnel security; and material control and accountability. In 1998 the Academy changed its name and expanded training operations into three academies to include: Nonproliferation and Arms Control, Safeguards, and Security and Emergency Management. The Counterintelligence Training Academy (CITA), the fourth addition to NNSI, was dedicated in 2000 A.D. More information on the NNSI can be obtained at the http://www.nnsi.doe.gov/ website, then by adding nn50/ to the website address.

DOE Training Dissemination. There are a number of training sources, working groups, websites, and other mechanisms for disseminating training information, issues, DOE's expectations, and best practices. The main website is the Clearinghouse for Technical Education and Training (CTED) at http://cted.inel.gov/cted. Also, three training-related corporate systems have been established for managing and providing training opportunities. These are the Corporate Human Resources Information System (CHRIS), the Online Learning Center (ONLL) formerly called Technology Supported Learning (TSL), and the Cross-Cutting Training Forum (CCTF). Information on these systems is available from the CTED website.

Clearinghouse for Technical Education and Training (CTED). The database of existing training at the CTED includes a number of courses related to SQA, hazard analysis, and safety analysis reports. This database provides a method to disseminate courses and/or work with the sponsors of existing courses to incorporate necessary software elements in training.

Corporate Human Resources Information System (CHRIS). CHRIS is the Departmental solution to the human resource, benefits, payroll and time and labor best business practices and information needs of the Department of Energy. CHRIS keeps tracks of the training attendance of Federal staff in its Training Administration module. More information on CHRIS is available at the http://chris.inel.gov website.

Online Learning Center (ONLL) formerly called Technology Supported Learning (TSL). The Departmental Training Program began the DOE OLLC in June 2000 to bring training to the desktop of all DOE Federal and contractor employees. The OLLC working group consists of staff throughout the Department; but the core group is composed of participants from Oak Ridge, Savannah River, Los Alamos National Laboratory, PNNL, NETO, and MA-31. The system is currently being deployed as a pilot for one year to Federal employees in FY 2001, and it is planned to include contractor employees in FY 2002.. Processes are being planned for placing courses on DOE OLLC and tracking course completion. More information on ONLL is available at the http://cted.inel.gov/cted website by clicking on TSL.

Cross-Cutting Training Forum (CCTF). This Forum is established to enable the DOE, Federal, and contractor community to communicate rapidly with each other regarding prospective training course needs/development efforts. Through this Forum, authorized individuals are able to identify new training needs to one another and indicate potential opportunities for sharing existing resources. More information on CCTF is available at the http://cted.inel.gov/cted website.

DOE Training Courses and Opportunities. Courses offered by the Department can be reviewed on the http://cted.inel.gov/cted website. Departmental training opportunities are included in the DOE Universal Catalog and under the Nuclear Safety Training listing and the Integrated Safety Management training buttons, as well as other sources listed on the website such as the Online Learning Center. In addition to what is offered on the website, safety/safety analysis training is also provided by EH. The OCIO does not provide formal Departmentwide software/SQA training, but does training when requested.

Departmental Training. The Departmental Training Program's website is a repository of various training opportunities. In particular, the DOE Universal Catalog was initiated to provide access to training information that would enable DOE employees and DOE's contractor employees to take an active role in planning their own training programs. It facilitates DOE and contractor ability to perform planning, budgeting, and prioritizing for employee training needs. The DOE Universal Catalog is the gateway through which users may access data from eleven sites who have included their training catalogs in the DOE Universal Catalog through web technology. These sites are:

EH Technical Training and Professional Development
Office of Training and Human Resource Development(HR-31)
Idaho National Engineering and Environmental Laboratory (INEEL)
Office of Nuclear Safety Policy and Standards (EH-31)
Office of Transportation (EM-76)
DOE-Idaho Training
Quality Training and Resource Center-Hanford
DOE-Albuquerque Training
Central Training Academy
DOE Savannah River Site
National Environmental Training Office

Safety/Safety Analysis Training. A DOE safety training program has been established by EH. The program is available on the Departmental Safety Training website at http://www.pnl.gov/eshs by clicking on Training to view the courses. A new DOE safety training program was established at Hanford called the HAMMER program, which can be accessed at the http://www.hammertraining.com website. HAMMER prepares workers and emergency responders to safely perform high-risk tasks and use new technology. Special training is sometimes conducted such as in the annual conference on Integrated Safety Management (ISM), generally advertised on http://tis.eh.doe.gov website.

Software/SQA Training. There is no formal Departmental training program for software/SQA. The OCIO does not provide scheduled ongoing Departmental software training but does provide periodic or just-in-time training, as needed, at Headquarters for Federal and contractor staffs. Training to field sites is done upon request. The Headquarters Information Technology Training Bulletin includes training courses for specific software systems, generally conducted by the organization responsible for the software.

1.1.2 Contractor Training Programs and Organizations

There is a general requirement in DOE O 414.1A, QUALITY ASSURANCE, among others, that contractor personnel are trained to perform their jobs. Although sites may have training programs, most do not have a formal software/SQA training program. SQA-specific training is generally conducted on a project-by-project basis. The need for software/SQA training is a matter of individual discretion and sometimes is acquired through mentoring or at off-site locations. Information on contractor directives and training opportunities for safety/safety analysis and software/SQA training were researched and is provided.

Contractor Directives and Guidance. Contractors are required to follow applicable DOE directives and standards. Contractors also follow their own internal processes and procedures, which are generally based on DOE guidelines and industry standards.

Contractor Training Structures and Dissemination. The most notable contractor-wide organizations available for the dissemination of training opportunities is the Software Quality Assurance Subcommittee (SQAS) and the Energy Facilities Contractors Operating Group (EFCOG). Individual site efforts were researched, as well as the new temporary Safety Analysis Software Group (SASG), led by DP, EH, and EM to address software issues for safety analysis and I&C software.

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)). SQAS does not conduct training, but has developed a few guidance documents on training and software qualifications. They prepared an "NWC Software Training Directory", Version 1.0 in October 1993, and are in process of developing a new directory. Information on SQAS is available at the http://cio.doe.gov/sqas website.

Energy Facilities Contractors Operating Group (EFCOG) and the Safety Analysis Working Group (SAWG). EFCOG is a self-directed group of Management and Operating (M&O) contractors, Management and Integrating (M&I) contractors, and Environmental Restoration Management Contractors (ERMC) of DOE facilities. EFCOG provides training through the Training Subgroup for safety and safety analysis and for the usage of specific software for performing these tasks. At the April 2000 meeting of SAWG, training was provided on the GENII, RadCalc, MACCS2, and RSAC software programs used for safety analyses (see the http://www.sawg2000.org website). The training was designed to help ensure that the codes are used correctly and that safety analysis personnel are aware of their limitations (i.e., software V&V).

Other Contracting Training Groups. Several efforts for complex-wide contractor opportunities are also available. A sample of these efforts is provided as follows:

- The Nuclear Weapons Complex (NWC) is establishing a training website that will be available via the http://prp.lanl.gov:8686/ website (click on Training).

- Sandia Information Technology/Computer Science (IT/CS) Retraining Program and the Computer Science/Software Engineering Skills Enhancement Program are two programs being established by Sandia National Laboratories to ensure information technology professionals keep current in their field.

- INEEL has a technology-supported learning and lessons learned initiative at the Center for Performance Improvement. INEEL also has been involved in establishing several DOE-wide programs and offers Departmentwide training in the:

  - DOE Reactor Training Coordination Program
  - DOE Nuclear Facility Training Coordination Program
  - DOE Training Accreditation Program
  - Conduct of Operations Support Program
  - DNFSB Recommendation 93-3 Implementation
  - DOE Technical Qualification Program
  - DOE Technology Supported Learning Program
  - Nuclear Facility Personnel Qualification and Standards Program

- Oak Ridge Institute for Science and Education ORISE is a DOE facility managed by Oak Ridge Associated Universities. It is a resource for science education programs; research and training in workforce health, safety, and security; emergency preparedness and response; radiological site characterization and cleanup verification; technical training systems; and integrated scientific and technical expertise. More on ORISE is available at the http://www.orau.gov/orise.htm website.

Safety Analysis Software Group (SASG). The SASG is initially established as a temporary group to respond to the Defense Nuclear Facilities Safety Board (DNFSB) Technical Report 25 regarding issues for safety analysis and I&C software. The group is led by three Headquarters Federal employees (one each in DP (chair), EH, and EM) and is comprised of DOE and contractor subject matter experts in safety analysis, software development, SQA, and authorization basis implementation. Their task is challenging since the management of the safety analysis function and the organization of technical staff at M&O contractors in the DOE nuclear complex vary considerably. The spectrum spans a centralized safety analysis (or authorization basis) organization to individual facilities, each relying on outside consultants. Since there are a large number of widely scattered analysts performing safety analyses, the SASG serves as a centralized group and will try to obtain coordinated support from the EFCOG. The SASG provides:

- Leadership for DOE and its contractors in safety analysis, design, and I&C software issues relating to safe design and operation of DOE nuclear facilities

- A mechanism to identify, address, and disposition major safety and I&C software issues that have crosscutting impact across DOE

- Identification of support mechanisms and resource allocation from stakeholder contractors and line organizations in the Department

As part of its advisory activities, the SASG has responsibility for identifying model improvements, and recommending new software development. This activity incorporates not only DOE applicability and needs, but references "like" facilities and safety basis analytical support modeling advances found in commercial industry. The SASG will work with the EFCOG to ensure that the newer versions of tool-box software are placed into proper configuration management, that users are notified of changes, and earlier versions are retired. This configuration management process will follow software lifecycle protocol, per standards identified by the Software Quality Assurance Subcommittee (SQAS) and the working group on policy. The initial activities by the SASG will eventually be the basis for a permanent expert and advisory team in a DOE nuclear national laboratory. As needs and specific issues arise, the advisory team will change in numbers and skill mix to meet these challenges at the appropriate level.

The SASG will use existing safety analysis Internet links to inform users of safety analysis issues. Software user alerts will be communicated via the EFCOG/SAWG website, listed above. This website will be expanded to:

- Provide lessons learned in the application of codes in safety analysis
- Share benchmark data and test problem sets
- Maintain site-specific data sets such as site distances, meteorological data, etc.
- Message board features that communicate software news and developments, and user feedback.

Contractor Training Courses. Contractor training requirements are guided by DOE directives and programs. EH has identified the types of training for safety/safety analysis as mentioned previously. The OCIO has not identified the types of training for software/SQA. SQAS identified a set of training courses in 1993, but the listing needs to be refreshed. A sampling from some of the NWC laboratories of the types of training for software/SQA was recently and is contained in Attachment 4. General training in the areas of safety/safety analysis and software/SQA can be provided to contractors by several of the established DOE training facilities or industry organizations mentioned in this report. Some contractors may provide in-house formal training in these areas. However, training for specific software is usually provided onsite through formal classroom, working group conferences, mentoring, or on-the-job training.

1.2 Other Government Training

DOE interacts with other agencies through the Federal Inter-Agency Training Council (FIATC). FIATC was established and spearheaded by the Albuquerque Operations Office in October 1996 and consists of Federal agencies in the Albuquerque/Santa Fe area that sponsor training and human resource development activities. The Council was established to participate with the DOE to develop strategies aimed at sharing training resources within the Federal community. FIATC serves as a clearinghouse of training information, servicing and promoting the sharing and partnering of training resources among Federal agencies. Participating agencies on the FIATC Steering Committee include:

- Defense Nuclear Weapons School
- Federal Aviation Administration
- Nonproliferation and National Security Institute
- U.S. Air Force
- U.S. Army Corps of Engineers
- U.S. Department of Defense
- U.S. Department of Energy
- U.S. Department of Interior

The FIATC membership and contacts list includes staff from:

- Albuquerque Area Indian Health Service
- Bureau of Indian Affairs
- Defense Criminal Investigative Service
- Federal Bureau of Investigation
- Federal Highway Administration
- General Services Administration
- Kirtland AFB Mediation Center
- National Labor Relations Board
- National Oceanic and Atmospheric Administration
- New Mexico Air National Guard
- Occupational Safety and Health Administration
- Social Security Regional Training Center
- U.S. Air Force AFOTEC
- U.S. Air Force Inspection Agency
- U.S. Air Force Medicine
- U.S. Air Force Nuclear Weapons Integration
- U.S. Air Force Research Laboratory
- U.S. Air Force Space and Missile Command
- U.S. Bankruptcy Court
- U.S. Department of Agriculture
- U.S. District Court

- USDA Graduate School
- U.S. Geological Survey
- U.S. Navy Recruiting District

More information on FIATC is available on the Energy Training Complex page located at the http://www.doeal.gov/qtd/etc.htm website.

DOE interacts with other U.S. Government agencies on a regular basis in the course of fulfilling the DOE mission. These agencies develop and maintain training to support the accomplishment of their business and missions, to enable successful installation of computer systems for meeting business and mission needs, and to ensure the health and safety of the general public, where that is a concern. DOE also interacts with other agencies to both ensure training compatibility and to assess the maturity of DOE processes and training relative to other agencies.

Other Government agencies can be a good benchmark since they also must comply with the same legislation (such as the Clinger-Cohen Act and OMB guidelines such as Circular A-130, which specify information technology requirements and practices) and therefore can have similar training requirements. In regards to nuclear safety management, DOE must comply with 10 CFR Part 830, Nuclear Safety Management (which includes guidelines on quality assurance) and the Price-Anderson Act. Training is required by this legislation.

Some of the government agencies DOE interfaces are the Nuclear Regulatory Commission, Department of Defense, Department of Transportation, National Institutes of Standards and Technology, National Aeronautical and Space Administration, and Defense Threat Reduction Agency.

1.2.1 U.S. Nuclear Regulatory Commission (NRC)

The NRC is an independent agency established by the U.S. Congress under the Energy Reorganization Act of 1974 to ensure adequate protection of the public health and safety, the common defense and security, and the environment in the use of nuclear materials in the United States. The NRC's scope of responsibility includes regulation of commercial nuclear power reactors, nonpower research, test, and training reactors, fuel cycle facilities, medical, academic, and industrial uses of nuclear materials, and the transport, storage, and disposal of nuclear materials and waste. The NRC is the sole Federal point of contact for reporting oil and chemical spills. The NRC provides a website which supports NRC's strategy to increase involvement by licensees and others in its regulatory development process consistent with the National Technology and Transfer Act of 1995. For more information on NRC, access the http://www.nrc.gov website.

NRC requirements (10CFR50.120 and 10CFR55.4) require a systematic approach for development of training for certain categories of reactor personnel. NRC has established a Technical Training Center in Tennessee, and has developed technical training programs in areas such as Probabilistic Risk Assessment (PRA) and digital instrumentation and control systems. Although NRC inspections include a review of a site's training and qualifications program, NRC does not have specific standards for training and qualification for individual job categories. There appears to be no specific NRC requirement for software/SQA training, other than a general requirement that people be trained appropriately for their job function. This approach is similar to the existing DOE training expectations. More information on NRC's training can be obtained by contacting the Technical Training Center or the NRC CIO, whose phone numbers are available by clicking on Telephone Directory on the NRC website.

1.2.2 U.S. Department of Defense (DOD)

DOD is responsible for providing the military forces needed to deter war and protect the security of our country. In doing so, DOD interacts in joint DOE/DOD missions. Recognizing the importance of providing official, timely and accurate information about defense policies, organizations, functions and operations, DOD established an information repository called DefenseLINK. DefenseLINK is the single, unified starting point for finding military information online, such as training. It can be accessed on the http://www.defenselink.mil website.

Besides training conducted by the individual armed services organization, DOD operates Joint Service Schools (JSS), one of which is the Information Resources Management College. Also, although no training has been determined, there was a joint endeavor for the development of the "Joint Software System Safety Handbook" which is available on the http://www.nswc.navy.mil/safety website. For more information on JSS training, access the http://fedgate.org/fg_jss.htm website. Information about training for each branch of DOD can be accessed through the http://www/firstgov.gov website.

1.2.3 U.S. Department of Transportation (DOT)

DOE must interact with DOT because of the transport of defense nuclear materials throughout the United States and the world. The mission of the DOT is to serve the United States by ensuring a fast, safe, efficient, accessible and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people, today and into the future. The DOT consists of eleven individual operating administrations including the Bureau of Transportation Statistics, U.S. Coast Guard, the Federal Aviation Administration, the Federal Highway Administration, the Federal Railroad Administration, the Federal Transit Administration, the Maritime

Administration, National Highway Traffic Safety Administration, the Research and Special Programs Administration, the Saint Lawrence Seaway Development Corporation, the Surface Transportation Board and the Transportation Administrative Services Center. For more information on the DOT, access the http://www.dot.gov website.

DOT has established the Transportation Safety Institute (TSI) to support DOT's vital mission to ensure safety and security in the nation's transportation system through instruction to both those entrusted with enforcement and those obligated to compliance to safety standards. For more information on TSI, access the http://www.tsi.dot.gov website. DOT agencies also have training programs. For example, FAA has established the FAA Academy at http://www.academy.jccbi.gov which provides various sources for training. One is the Aircraft Certification Service website at http://av-info.faa.gov/software which contains information on training for safety-critical systems, and another is its computer-based training program at the http://faawbt.jccbi.gov website which contains self-study courses on software. The FAA also has self-study videos; one of which is 25819, Using the Software Job-Aid to Conduct Software Reviews.

1.2.4 The National Institutes of Standards and Technology (NIST)

The National Institutes of Standards and Technology is an agency of the U.S. Department of Commerce's Technology Administration. Established in 1901, NIST strengthens the U.S. economy and improves the quality of life by working with industry to develop and apply technology, measurements, and standards. Under the Information Technology Management Reform Act (Public Law 104-106), the Secretary of Commerce approves standards and guidelines that are developed by NIST for Federal computer systems. These standards and guidelines are issued by NIST as Federal Information Processing Standards (FIPS) for use government-wide. For more information on NIST, access the http://www.nist.gov website.

There is no formal training service provided by NIST. However, NIST provides a variety of tools and resources for software, one of which are links to Fire Modeling Programs. NIST's Information Technology Laboratory (ITL) concentrates on developing tests and test methods for information technologies that are still in the early stages of development, and once products are available, tests to allow developers and users to evaluate how products perform and assess their quality based on objective criteria. Another is a study which examines the contents of an SQA standard for nuclear applications, available at http://hissa.ncsl.nist.gov/publications/nistir4909/ website. The study includes recommendations for the documentation of software systems. Background information on the standard, documentation, and the review process is provided. The report includes an analysis of the applicability, content, and omissions of the standard and compares it with a general SQA standard produced by the Institute of Electronics and Electrical Engineers

(IEEE). Information is provided for the content of the different types of documentation. This report describes information for use in safety evaluation reviews. Many recommendations in this report are applicable for SQA in general.

1.2.5 National Aeronautical and Space Administration (NASA)

NASA is an independent agency established by the U.S. Congress in 1958 to conduct space missions and for national defense. It is a Federal research and engineering agency that accomplishes most of its space, aeronautics, science, and technology programs through Field Centers and contractors across the United States. It consists of the NASA Headquarters, nine Centers, the Jet Propulsion Laboratory (operated by the California Institute of Technology), and several ancillary installations and offices in the United States and abroad. Its mission is to advance and communicate scientific knowledge and understanding of the Earth, the solar system, and the universe; to advance human exploration, use, and development of space; and to research, develop, verify, and transfer advanced aeronautics and space technologies. For more information on NASA, access the http://www.nasa.gov or http://www.nasa.gov/search website.

NASA has established the Wallops Safety Office at http://www.wff.nasa.gov/ which provides a Safety Training Program, that includes a course on Software System Safety, and other resources such as videos. NASA has also developed an Information Technology program to enhance the safety and security of the National Airspace System through the development of technologies for systems control and operations, and flight critical software systems. Two significant projects in this program are the Intelligent System Controls and Operations (ISCO) project and the Software Integrity, Productivity and Security (SIPS) project. The program can be viewed on the http://www.nas.nasa.gov/IT/test/index.htm website. Also, the NASA Ames Research Center (ARC) is NASA's "Center of Excellence" for information sciences and technologies, and is available at the http://www.arc.nasa.gov website. Contained within ARC are the System Safety and Mission Assurance Office, and the Quality Management Program Office. Additionally, information on High Performance Computing and Communications is available at the http://hpcc.arc.nasa.gov website. Ames has developed a new Quality System and offers training on this process plus others, which can be viewed from the http://huminfo.arc.nasa.gov:80/ website.

1.2.6 Defense Threat Reduction Agency (DTRA)

DTRA was created to integrate and focus the capabilities of DOD which address the weapons of mass destruction (WMD) threat. DTRA safeguards the United States and its friends from WMD by reducing the present threat and preparing for the future threat. DTRA's work covers a broad spectrum of activities – shaping the international

environment to prevent the spread of WMD; responding to military requirements to help the United States deter, withstand, prevail against and recover from the use of such weapons; and preparing the warfighter to counter the full spectrum of future WMD threats. DTRA can be accessed on the http://www.dtra.mil website.

One of DTRA's major mission areas is Technology Development which focuses on several areas, three of which are the Scientific Computing Program, Radiation Test Facilities and Capabilities, and Hazard Prediction Assessment Capability (HPAC). The DTRA Scientific Computing Program is responsible for DOD's High Performance Computing Modernization Program (HPCMP), whose mission is to modernize the total high performance computational capability of DOD Science and Technology (S&T), Development Test and Evaluation (DT&E) and Ballistic Missile Defense Organization (BMDO). Use of DTRA scientific computing resources at DTRA, Los Alamos National Laboratory (LANL) and the High Performance Computing (HPC) sites are available to both contractor and government organizations who are performing research under contract with DTRA. Two products that are readily available are a brochure describing the Radiation Test Facilities and Capabilities and its resources, and HPAC software which predicts the effects of hazardous material releases into the atmosphere and its collateral effects on civilian and military populations. The HPAC software is available by license from the DTRA, to U.S. government entities, their contractors, and educational institutions for non-commercial research. DTRA has published several documents in nuclear radiation and safety software but they are not listed on the website. Training information was not available; however, it appears that DTRA expects staff to be trained before becoming part of one of their programs.

1.3 Industry Organizations and Training

For compliance with legislation to use consensus standards and facilitate management improvements, DOE practices are generally based on guidance from industry organizations and standards. Some of these organizations may provide training or seminars. The following sections focus on industry organizations and training for general software and safety software.

1.3.1 Software and Engineering Organizations and Training

Major industry organizations, who address issues on various software topics regarding information systems engineering, project management, and quality assurance, include the Software Engineering Institute (SEI), International Council on Systems Engineering (INCOSE), Electronic Industries Alliance (EIA), Institute of Electronics and Electrical Engineers (IEEE), the International Organization for Standardization (ISO), American Society of Mechanical Engineers (ASME), American National Standards Institute (ANSI),

American Nuclear Society (ANS), Society for Automotive Engineers (SAE), American Society for Quality (ASQ), Quality Assurance Institute (QAI), and Project Management Institute (PMI). DOE Federal and contractor organizations use standards and guidance from these organizations to accomplish missions. Some provide training.

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. Searches for software information such as "defense nuclear facilities safety and safety analysis software" can be made by accessing the http://www.sei.cmu.edu/about/website/search.html website.

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. Many Federal and contractor organizations are seeking improvement in their software projects by using the SEI Software CMM (SW-CMM). It is estimated that about 50 percent of software contractors nationwide are self-assessed at SW-CMM Level 2; i.e., they have the basic project management processes for project planning, project tracking and oversight, configuration management, requirements management, and quality assurance instituted in their organization. Besides various types of courses, the SEI conducts several symposiums during the year to discuss the models and other activities for maturing software staffs and project teams. For more information on SEI, access the http://www.sei.cmu.edu website.

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. Another is the Systems Engineering Management Methodology Working Group, whose purpose is to create, coordinate, and disseminate process definitions and methods for planning, organizing, integrating, and controlling the technical aspects of a project throughout a system's lifecycle. INCOSE has a publications library on its website, and conducts a symposium and workshop to discuss activities in international systems engineering. For more information on INCOSE, access the http://www.incose.org website.

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. Over 4,000 standards have been developed. Included in its resource listings are publications on system safety engineering and software. EIA conducts various forums, symposia, and conferences to discuss activities in systems engineering. For more information on EIA and EIA events, access the http://www.eia.org/ website.

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, and many other areas. 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. IEEE has issued several standards for software, SQA, and safety software. Two notable ones are IEEE 1228, Standard for Software Safety Plans, and IEEE 1044, Standard Classification for Software Anomalies. Additional information on IEEE standards can be viewed at the http://standards.ieee.org website. IEEE is also involved in the development of the Software Engineering Book of Knowledge (SWEBOK), which can be accessed at the http://www.swebok.org website. For more information on IEEE, access the http://www.ieee.org website.

The IEEE Conference on Software Engineering Education and Training offers direction and promotes innovation and collaboration and new instructional approaches to software engineering education and training. The Conference is devoted entirely to improvement in software engineering education and training. IEEE is establishing an IEEE Professional Development Institute to provide IEEE members and customers with a gateway to online educational resources and other educational products and services. These include short courses and tutorials by IEEE Technical Societies, IEEE Sections, and Partners (such as universities, companies, and other education providers.) IEEE also provides accreditation in electrical engineering and computer science. Information about the Institute and other IEEE educational services is available at the http://www.ieee.org/organizations/eab/education.htm website. There are two other noteworthy efforts by IEEE. One is the IEEE Software Engineering Standards Committee (SESC), which is involved in standards based training as part of an IEEE Computer Society effort (chaired by Paul Croll, pcroll@computer.org). The other is the IEEE Computer Society effort to develop a competency recognition program for software engineers (chaired by Stacy Saul, ssaul@computer.org).

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 published as International Standards. The ISO 9000 series of standards provides a framework for quality management and quality assurance, as well as other related ISO standards. The 9000 series are "management" standards rather than project-application standards. ISO does not provide training on its standards but does conduct seminars. Training on ISO standards is provided by ANSI. For more information on ISO and ISO standards, access the http://www.iso.ch website.

American Society of Mechanical Engineers (ASME). Founded in 1880 as the American Society of Engineers, today ASME International is a nonprofit educational and technical organization serving a worldwide membership. The ASME conducts one of the world's largest technical publishing operations, holds some 30 technical conferences and 200 professional development courses each year, and sets many industrial and manufacturing standards. Since 1884, when the first performance test codes were developed, ASME International has pioneered the development of codes, standards and conformity assessment programs. ASME maintains and distributes 600 codes and standards used around the world for the design, manufacturing and installation of mechanical devices. Two notable standards are NQA-1-1994, Quality Assurance Program

Requirements for Nuclear Facilities, and NQA-1-1997, Quality Assurance Requirements for Computer Software for Nuclear Facility Applications. For more information on ASME, access the http://www.asme.org/ website.

In addition to conducting forums, seminars, conferences, and workshops, ASME has created the ASME Virtual Campus to bring graduate online courses and distance learning to engineers and other technical professionals. ASME also has an accreditation and student development program. It offers training through an alliance with the International Institute for Learning, Inc., who provides training in project management and quality assurance. Information on these services is available on the website.

The American National Standards Institute (ANSI). ANSI has served in its capacity as administrator and coordinator of the United States private sector voluntary standardization system for more than 80 years. Founded in 1918, the Institute remains a private, nonprofit membership organization supported by a diverse constituency of private and public sector organizations. ANSI has as its primary goal the enhancement of global competitiveness of United States business and the American quality of life by promoting and facilitating voluntary consensus standards and conformity assessment systems and promoting their integrity. ANSI does not itself develop American National Standards; rather, it facilitates development by establishing consensus among qualified groups. ANSI-accredited developers support the development of national and, in many cases, international standards, addressing the critical trends of technological innovation, marketplace globalization and regulatory reform. ANSI has a website at http://www.nssn.org that allows searches for standards by title, designation, sponsoring organization, or key word. For more information on ANSI, access the http://web.ansi.org/ website.

ANSI provides education and training services, and develops and presents programs designed to teach companies and organizations how to be smarter, quicker, more efficient, and more effective as they participate in national, regional and international voluntary standardization activities. They will customize courses to unique needs. ANSI also provides an online database for searching for standards and technical training opportunities offered by the following organizations:

- American Association for Laboratory Accreditation (AALA)
- American National Standards Institute (ANSI)
- ASTM
- The International Society for Measurement and Control (ISA)
- National Institute for Standards and Technology (NIST)
- Society of Automotive Engineers (SAE)

ANSI provides accreditation for certification programs to ensure that the marketplace, including buyers, sellers, and public agencies can rely on the competence of ANSI accredited certification bodies for their activities related to products, processes, services, and personnel. The scope of the ANSI program extends to certifiers of products, processes, personnel, and services. Information on these services is available from the ANSI website.

American Nuclear Society (ANS). ANS is a not-for-profit, international, scientific and educational organization. It was established by a group of individuals who recognized the need to unify the professional activities within the diverse fields of nuclear science and technology. December 11, 1954, marks the Society's historic beginning at the National Academy of Sciences in Washington, D.C. ANS has since developed a multifarious membership composed of approximately 11,000 engineers, scientists, administrators, and educators representing 1,600 plus corporations, educational institutions, and government agencies. It is governed by three officers and a board of directors elected by the membership.

ANS creates only a portion of the standards for the nuclear industry, which can be viewed on the http://store.ans.org website. The NAS-10 standards address mathematics and computation, and include some computer programming. The ANS-8 standards address a Criticality Safety Committee. One notable standard used at DOE is ANSI/ANS-10.4-1987, Guidelines for the Verification and Validation of Scientific and Engineering Computer Programs for the Nuclear Industry. For more information on ANS, access the http://www.ans.org website.

ANS does not conduct training, but posts workshops in their Public Information section on their website. They also conduct two national meetings per year, and sponsor many topical meetings which concentrate on particular technical areas, and executive conferences which are held for industry leaders.

Society for Automotive Engineers (SAE). SAE provides technical information and expertise used in designing, building, maintaining, and operating self-propelled vehicles for use on land or sea, in air or space. Founded in 1905, nearly 80,000 engineers, business executives, educators, and students from more than 97 countries form a network of members who share information and exchange ideas for advancing the engineering of mobility systems. The SAE Cooperative Research Program helps facilitate projects that benefit the mobility industry as a whole. Also, technical committees are formed to write aerospace and automotive engineering standards, technical papers, books, and periodicals.

SAE maintains liaisons with a number of organizations to fully coordinate its standards and avoid duplication. The SAE Cooperative Engineering Program provides many standards each year that contain part and product qualification procedures. These procedures aid manufacturers in the production of quality products and save valuable engineering time. SAE publishes many new, revised, and reaffirmed standards each year in three categories: Ground Vehicle Standards (J-Reports); Aerospace Standards; and Aerospace Material Specifications (AMS). SAE Aerospace Standards are used extensively by the military services as well as by the private sector. Over 2,300 SAE Aerospace Material Specifications, covering a vast array of material and processes, are available to the aerospace engineer. Combine these with 2,100 more documents on a wide variety of subjects makes SAE the world's largest producer of non-government aerospace standards. For more about SAE, access the http://www.sae.org and http://www.normas.com websites.

SAE offers training through seminars, symposiums, workshops, forums, and self-study. It also offers the SAE Engineering Academy for newly hired engineers who need to quickly develop a particular skill set in order to become productive on the job. Information about the training is available through the SAE website.

Center for Chemical Process Safety. The Center for Chemical Process Safety (CCPS) was founded in 1985 now consists of 80 sponsoring members. CCPS is an industry-driven, non-profit professional organization affiliated with the American Institute of Chemical Engineers (AIChE). It is committed to developing engineering and management practices to prevent or mitigate the consequences of catastrophic events involving the release of chemicals and hydrocarbons that could harm employees, neighbors and the environment. Some areas of interest to CCPS sponsors include hazard and risk analysis, engineering design, operations and maintenance, information dissemination and process safety management. They offer an accreditation program and maintain a Process Safety Incident Database and a Process Equipment Reliability Database. Information about CCPS is available at the http://www.aiche.orgs/ccps/index.htm website.

In addition to various services and products, CCPS provides training through conferences and about 50 courses in professional and technical training, and will tailor and conduct classes at an organization's site. A catalog describing the courses is available on the website. They also have established the Safety and Chemical Engineering Education Program (SACHE) which is a cooperative effort between CCPS and engineering schools.

Nuclear Utilities Software Management Group (NUSMG). The NUSMG is a non-profit organization providing a forum for nuclear utilities to obtain consensus on software control issues. They have an online library, and provide training through workshops and courses in the NUSMG Training Program. This group has developed four

different one-day SQA courses for nuclear utility personnel, and has presented these to about 100 people in 12 to 15 sessions over the last year. Their website is available at http://www.nusmg.org.

1.3.2 Quality Organizations and Training

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. Training sponsored by these organizations was reviewed.

American Society for Quality (ASQ). Founded in 1946, ASQ advances individual and organizational performance excellence worldwide by providing opportunities for learning, quality improvement, and knowledge exchange. ASQ has more than 120,000 individual and 1,100 sustaining members. Since the establishment of its first certification program in 1966, ASQ has certified more than 80,000 quality practitioners as quality engineers, quality auditors, reliability engineers, quality technicians, mechanical inspectors, quality managers, and software quality engineers.

ASQ is charged with administering the standards committees on behalf of the American National Standards Institute (ANSI). The committees can be grouped within four broad technical disciplines: Quality Management, Environmental Management, Dependability, and Statistics; i.e., QEDS. As the secretariat for the ANSI Accredited Standards Committee (ASC) Z1 Committee on QEDS, ASQ provides direction on and builds consensus for national and international standards. ASQ plays a key role in developing the ISO 9000 series standards, which were originally adopted nationally as the Q90 series standards, and recently revised and redesignated as the Q9000 series standards. They do so through their involvement in the U.S. Technical Advisory Group for ISO Technical Committee 176, administered by ASQ on behalf of ANSI. (ANSI represents the U.S. within ISO.) ASQ is also the secretariat for ISO Technical Committee 69 Subcommittee 1 on Terminology and Symbols. In addition, ASQ administers the U.S. Technical Advisory Groups for several committees. For more information on ASQ, access the http://www.asq.org/ website.

ASQ sponsors a wide range of industry-specific conference topics throughout the year, including an Annual Quality Congress and Exposition (AQC). ASQ has a training and certification program. Training is provided through traditional classroom, e-learning, self-directed learning via CD-ROM, or at the organization's facility. Information on these services is available at the ASQ website.

Quality Assurance Institute (QAI). QAI was founded in 1980, and is an international organization of member companies in search of effective methods for defect detection/software quality control and defect prevention/software quality assurance. QAI's goal is to become the international standard of definition for professional status as an information services quality practitioner, and to provide leadership to the information services profession in improving quality, productivity, and effective solutions for process management. QAI provides leadership and state-of-the-art solutions in the form of consulting, education services, and assessments. It is exclusively dedicated to partnering with the enterprise-wide Information Quality profession for improving enterprise-wide information quality. For more information on QAI, access the http://www.qaiusa.com/ website.

QAI offers three professional level certifications; namely, Certified Quality Analyst (CQA) for competency in the principles and practices of quality assurance in the information technology profession; the Certified Software Test Engineer Program which is intended to establish standards for initial qualification and provide direction for the testing function; and the Certified SPICE Assessor Program for ISO/IEC TR 15504 conformant assessments. Besides the certification program, QAI sponsors seminars and conferences throughout the year. The seminars are posted in an Education Schedule which is available on the website.

Project Management Institute (PMI®). Since its founding in 1969, PMI® has become the organization of choice for project management professionalism. With over 70,000 members worldwide, PMI® is the leading nonprofit professional association in the area of project management. PMI® establishes project management standards, provides seminars, educational programs and professional certification. PMI®'s "A Guide to the Project Management Body of Knowledge (PMBOK® Guide)" was approved by ANSI as an American National Standard, ANSI/PMI 99-001-1999. For more information on PMI, access the http://www.pmi.org/ website.

PMI provides training through conferences, symposiums, and several seminars, listed in an online catalog. They also have a database of professional development programs offered by PMI® Registered Education Providers. In addition, the PMI® Education Department supports the development of standards for accrediting degrees in project management and approving curriculums for master certificates in project management. PMI® also conducts a certification program in project management. PMI®'s Project Management Professional (PMP) credential is the project management profession's most globally recognized and respected certification credential. Worldwide there are over 20,000 PMPs who provide project management services in 26 countries.

1.3.3 Software Safety Organizations and Training

Several organizations have been established to specifically address software system safety. Among these are the System Safety Society, the National Safety Council, and the International Safety Council. Additionally, in 1999, a Software Safety System Handbook was developed through a joint effort of Federal government staffs.

System Safety Society. Founded in 1964, the System Safety Society is composed of membership extending to over a dozen countries and a variety of professional occupations. It is a professional organization dedicated to the promotion of the system safety concepts at the local, national and international level to:

- Advance the state-of-the-art of system safety
- Contribute to a meaningful understanding of system safety
- Disseminate newly developed knowledge to all interested groups and individuals
- Further the development of the professionals engaged in system safety
- Improve the public understanding of the system safety discipline
- Improve the communication of the system safety movement and discipline to all levels of management, engineering, and other professional groups

Avoiding hazards has been a concern for some time; however, formalized efforts to incorporate activities specifically oriented toward hazard identification and control on a comprehensive and total lifecycle basis has occurred only in recent times. Safety publications endorsed by the System Safety Society include:

- MIL-STD-882, DOD Standard Practice for System Safety - released February 2000

- Software System Safety Handbook - A Technical and Managerial Team Approach - released December 1999

- MIL-STD-1472F, DOD Design Criteria Standard Human Engineering - released August 1999

- System Safety Analysis Handbook, 2nd edition, - released August 1999

They hold an annual conference and planning to provide products and services. For more information on the System Safety Society, access the http://www.system-safety.org website.

National Safety Council (NSC). Founded in 1913, the NSC has served as the premier source of safety and health information in the United States. The Council is a nonprofit, governmental, international public service organization dedicated to improving the safety, health and environmental well-being of all people. An Act of Congress on August 13,

1953, created the Council as a body incorporated under Federal law; i.e., Public Law 259 of the 83rd Congress formally established NSC as a federally chartered organization. The charter mandates that the Council be nonpolitical and not contribute to or otherwise assist any political party or candidate. The mission of the NSC is to educate and influence society to adopt safety, health and environmental policies, practices and procedures that prevent and mitigate human suffering and economic losses arising from preventable causes. The Council has been working for generations to protect lives and promote health with innovative programs.

NSC does not issue standards, but does sell some ANSI standards. Various services, resources, products, and certification programs are available. They conduct training through formal courses, online training, conferences, and seminars. For more information on the NSC, access the http://nsc.org/ website.

The International Safety Council (ISC). The ISC is the National Safety Council's global subsidiary. Established in 1913, ISC is a not-for-profit, nongovernmental, membership based organization committed to the mission of protecting life and promoting health. Over 17,000 members represent more than 70 countries around the world and include industry, labor, government, community groups and associations. They provide training (including online and onsite training), expertise, products and services, and certifications related to all areas of safety, health and the environment. For more information on the ISC, access the http://safety.webfirst.com/isc.htm website.

Joint Software System Safety Handbook. The development of this Handbook is a joint effort by the U.S. Army, Navy, Air Force, and Coast Guard Safety Centers, in cooperation with the FAA, NASA, defense industry contractors and academia. The research involved captures the "best practices" pertaining to software safety systems program management and safety critical software design. The Handbook consolidates these contributions into a single, user-friendly resource guide for use in the understanding of both the complete software safety systems and the contribution of each functional discipline in identifying, controlling, and managing software-related hazards within safety-critical components of hardware systems.

For more information on, or to download the Joint Software System Safety Handbook, access the System Safety Society at the http://www.system-safety.org website. Other sources of the Handbook or safety information are the Navy Surface Warfare Center, which can be accessed at the http://www.nswc.navy.mil/safety website, and the Air Force Safety Center at the http://www.usaf.com/orgs/12.htm website.

2.0 Training Analysis

In Technical Report 25, the Board addressed an apparent lack of a formal program for training Federal or contractor personnel who perform safety analysis or oversight functions. They concluded that issues of implementation and use of software partially resulted from a lack of training of safety analysts and instrumentation and control (I&C) personnel on the appropriate use of analytical codes for performing safety analysis and applying I&C software to assist in the control of DOE facility processes. Related to this concern is the degree of training by SQA staffs in the safety analysis and I&C systems.

The Board felt that DOE should consider the development of a qualification program for performing safety basis analyses of DOE facilities and activities (DNFSB Technical Report 25, section 4.1, page 4-2). The Board also suggested that DOE develop and institute an intensive training program, including best practices and other guidance for safety analysts (DNFSB Technical Report 25, section 4.3, page 4-3).

The independent evaluations and survey were conducted with these concerns in mind. This section addresses the findings, assessments, and gap analyses. Recommendations are provided.

2.1 Assessment of Independent Evaluation

Section 1.1 described the Departmental approach to training in general and in regards to safety/safety analysis and software/SQA. The high-level program and directives infrastructure for training appears to be in place. The guidance in the QA rule, DOE O 414.1A, and other guidance issued by EH which include provisions for safety training are facility-oriented but are expected to be interpreted to imply safety software training as well since software is considered a "work" process. A recent review found that DOE has not met commitments to ensure that DOE-STD-1135-99 is implemented by its contractors. After the SASG reviews the training infrastructure for safety software at the field sites, a determination should be made whether a Departmental directive is needed for safety software training in development, maintenance, and usage of such software.

The investigation revealed that there are several sources of training sponsored by DOE. Although some training is being provided on SQA and software usage by the field sites, there is no consensus set of training requirements. Further actions need to be taken to assess the adequacy of DOE's expectations and requirements for safety/safety analysis and software/SQA training, and to identify the areas that would yield the most benefit in improving personnel training and competency, particularly for safety analysis and I&C software.

Several of the Other Government organizations have training programs and have identified a set of consensus training requirements that can be used as benchmarks. Some of the websites provide contact names. Industry organizations are addressing safety software training issues and have developed courses that appear to be very appropriate for the DOE environment.

2.2 Assessment of Survey Results

A compilation of the survey is contained in Attachment 4. The following questions were asked in the survey, and the tentative analysis results of the answers follow each question.

SQA Questions

"II.C(1) – Is in-house SQA training provided for the code developers and maintainers? What is it?" ***Results***: Only three responded that there is formal training. The others stated that on-the-job training is provided.

"II.C(2) – Are there special SQA training needs for safety analysis and instrumentation and control (I&C) software? What is it?" ***Results***: The overall response is that on-the-job training is provided.

"IV.7 – Do you have a training program associated with these procedures [SQA procedures for I&C software]?" ***Results***: The overall response is that on-the-job training is provided.

"IV.8 – Are there qualification requirements for personnel who generate this class of software [I&C]?" ***Results***: The overall response is that there are no specific qualification requirements.

Safety Analysis and I&C Software Usage Questions

"II.B(1) – Indicate the documentation for and the manner in which safety analysts are trained in the appropriate use of computer codes." ***Results***: Training is provided in a variety of ways; e.g., on-the-job training, mentoring, partnering, through the group, self-study, or specialized or formal training on a case-by-case basis. The site's development or user manual is the usual teaching aide..

"II.B(3) – Do you require that safety analysts be trained in the use of specific computer codes used for the performance of hazard, accident, or consequence analysis?" ***Results***: Training is provided in a variety of ways; e.g., on-the-job training, mentoring, self-study, or formal setting.

"III.A(2) – Describe any training and documentation in the use of these identified codes [safety analysis]?" ***Results***: Training is provided in a variety of ways; e.g., on-the-job training, mentoring, self-study, or formal setting. No formal documentation is used.

"III.B(6) – Have your analysts received specific training in the use of these identified computer codes and is there documentation for the use of these codes [safety analysis]?" ***Results***: Training is provided in a variety of ways; e.g., on-the-job training, mentoring, self-study, or formal setting. Documentation may not be required.

Safety Analysis Questions

"II.A.(2) – Indicate the method(s) used to assure that safety personnel are trained in safety analysis procedures, good practices, and the process of performing safety analysis in regards to authorization basis." ***Results***: Training is provided in a variety of ways; e.g., on-the-job training, mentoring, self-study, or formal setting.

2.3 Gap Analysis of Survey Results and Independent Evaluation with DOE Training and Training Infrastructures

The OCIO has determined through an independent assessment that improvements need to be made in establishing a more adequate safety/safety analysis and software/SQA training infrastructure through the Departmental Training Program and the EH Training Program. In regards to safety software, more investigation needs to take place. Organizations and processes are in place for disseminating and making improvements to the Departmental Training Program and the EH Training Program. Auditing processes may need to be improved to get better communication of Departmental guidance for training requirements to the floor level.

Departmental websites have been established for the exchange of information on training opportunities. Attachment 1 lists the various DOE Federal and contractor websites which contain information on training sources.

2.4 Findings and Recommendations

It is the consensus of SQA and safety staffs that regular management attention from local DOE offices and its contractors is necessary to implement improvements in safety analysis and SQA. Proper contract requirements and implementing processes based on DOE rules, Orders, guides and reference standards must be established. In addition, assessment of proper implementation and training requirements must be performed by local DOE organizations.

2.4.1 Findings

Several findings of governance and responsibility became apparent in the review of Departmental standards. These findings influence the implementation of training requirements and qualifications since they establish protocols.

Finding No. 1: The Nuclear Safety Rule (10 CFR 830, Nuclear Safety Management) addresses the adequacy of "training and qualification" for nuclear facilities and activities and for non-nuclear hazardous facilities and activities, which could potentially impact the safety of nuclear operations.

Finding No. 2: SQA for safety software needs to be addressed within the context of the overall quality assurance program for DOE's defense nuclear facilities, especially considering the criteria in 10 CFR 830, Nuclear Safety Management.

Finding No. 3: The Technical Personnel Coordinating Committee, which evolved from DOE's response to DNFSB Recommendation 93-3 and 92-7, was established by DOE to facilitate intrasite and intersite communications, coordinate initiatives, share resources and lessons learned, and facilitate progress for safety training and accreditations of Federal and contractor staffs. The Implementation Plan has been completed and the infrastructure is in place for addressing the concerns in DNFSB Technical Report 25.

Finding No. 4: The DNFSB sent a letter to the Deputy Secretary on July 10, 2000, stating that ISM (includes QA integration) should be implemented by line management; i.e., each Program Secretarial Office (PSO), and not delegated to Environment, Safety and Health (EH) as it would be counter-productive. Because EH is not part of line management, the organization provides a better role as an independent assessor.

Finding No. 5: EH is the Office of Primary Interest (OPI) and owner of the QA rule (10 CFR 830.120); DOE O 414.1A, QUALITY ASSURANCE; and associated guides. Technical safety training requirements are contained in the EH directives.

Finding No. 6: The OCIO has primary responsibility for software (e.g., directives, training, processes, etc.) per the Clinger-Cohen Act and must set expectations for software management, engineering, and assurance, and other information management requirements per OMB Circular A-130 and the Paperwork Reduction Act (as well as other legislation). The DOE computing environment has become very diverse and complex so that the software cannot be considered an entity of its own, but part of a larger total systems context that includes the infrastructure upon which it is executed. DOE is highly dependent on software not just only for information generation but to ensure that the software reflects the processes and scenarios needed for conducting its missions and

businesses. Therefore, SQA can involve not only the review of the software but the environment in which it will be placed.

Finding No. 7: It is very beneficial for all software to undergo SQA, and of utmost importance that mission-critical, mission-essential, or high-risk code undergo SQA processes to ensure quality software is produced. SQA (as well as project management and software systems engineering) increases quality and saves time and money in the long term.

Finding No. 8: All Departmental Orders need to have the Secretary as the issuing authority for application to both DOE and NNSA.

2.4.2 Recommendations

As a result of the analysis of the data collected in the survey and the independent evaluation and the comparison of this information to the Departmental training infrastructure, the following recommendations are made.

Recommendation No. 1: DOE Directives. In general, DOE does not control nor establish specific training requirements for contractor personnel. There is a general requirement in QA orders (and other directives) that contractor personnel are trained to perform their jobs. Departmental directives pertinent to software/SQA and safety/safety analysis training are listed in Attachment 2. Issuance and implementation of a directive on SQA will be a major step towards ensuring that software training is addressed. As it becomes apparent that SQA is part of safety analysis and other related job functions, it is expected that appropriate training will be added to the contractor's requirements.

Recommend DOE program and project managers become familiar with DOE directives as they relate to training and qualifications for their projects and ensure their projects are in compliance with all applicable DOE directives and training programs. A memo from each LPSO to their organizations would be very conducive to ensuring this occurs.

Recommend the OCIO and EH conduct a more in-depth review of their directives for currency and application to software training and ways to ensure their implementation in regards to training and qualifications.

Recommendation No. 2: DOE Training Programs. Before a project begins, the training and qualifications of the project team that will be needed should be clearly defined. The DOE program manager and the DOE or contractor project manager should be aware of the international, national, Federal, and DOE information technology training requirements specified or recommended for a particular type of project. There are several

sources for determining these requirements as noted in this study. Program and project managers should select and apply the most appropriate training resources and sources that will enable their projects to be completed successfully and satisfy requirements. Departmental training programs and a sampling of available training pertinent to software/SQA and safety/safety analysis are listed in Attachments 1 and 3, respectively.

Recommend LPSOs affirm their support of Departmental, OCIO and EH training programs and opportunities. A memo from each LPSO reminding their staffs of these programs and encouraging participation would be conducive to ensuring DOE training requirements and qualifications are consensus-based and appropriate and current for DOE.

Recommend the OCIO and EH conduct benchmarking activities of their software training requirements, particularly for SQA and safety analysis, with other government organizations, and provide a list of software/SQA and safety/safety analysis training. The activities should include a definition of the goals of the training, how the training would be delivered, how the training would be evaluated against the goals, and recommendations for institutionalization or use as a benchmark.

Recommend that a proposal be submitted to the Departmental Training Program and Federal Technical Capabilities Board to include software-specific elements in their training programs and the DOE Technical Qualification Standards once the training and qualifications are defined.

Recommendation No. 3: Other Government and Industry Training Opportunities. Collaboration with and attendance at computer software engineering, project management, and quality assurance courses from related government and industry training sources is desirable. A consensus set of training requirements and qualifications is conducive to ensuring consistency of practice and pedigree of DOE software. Defined training requirements and qualifications for adoption Departmentwide should be submitted to the OCIO for consideration in a training directory. Qualifications for SQA specialists should map both experience and education to requirements. Website addresses for the government and industry organizations reviewed are contained in Attachment 1.

Recommend the OCIO review and solicit Departmental comments for a consensus set of training requirements and qualifications for those involved in software project management, engineering, and quality assurance.

Recommend EH review and solicit Departmental comments for a consensus set of training requirements and qualifications for those involved in safety software and those in safety and safety analysis which involve software.

Recommendation No. 4: Quality Training for Quality Software Products. Production and delivery of quality software products should be ensured. GAO has recommended that DOE have one training program applicable to all reporting entities, Federal and contractor. The Departmental Training Program has endeavored to bring all of the training offered by DOE under this program and to provide the needs of the Department for Federal and contractor staff training. Software quality training should be focused in two areas: (1) process-oriented SQA; i.e., reviews of the products and processes used throughout the lifecycle for assuring quality, and (2) product-oriented SQA; i.e., verification and validation and testing for assuring product quality.

Recommend the OCIO and EH collaborate with the Departmental Training Program to ensure their training programs are specified in the Departmental Training Program and accessible from its website.

Recommendation No. 5: Tool/Automation. Executive Order 13111 encourages "using technology to improve training opportunities for Federal Government Employees" to enable any time, any where learning; and Federal organizations should explore programs, initiatives, and policies to better support lifelong learning through the use of technology.

Recommend that LPSOs consider and encourage the usage of new technologies, such as the DOE Online Learning Center (ONLL), which would be conducive to ensuring SQA knowledge is acquired.

Recommendation No. 6: Link Organizations and Websites and Improve Line Management. It appears that DOE has an adequate Federal and contractor training infrastructure. However, there seems to be a lack of interaction among these organizations and staffs. Contractor organizations such as SQAS, DOE INCOSE, and EFCOG SAWG need to be better aligned with the OCIO, QAWG, and SASG for better communication and dissemination of software and safety training information. The QAWG has revised its charter and developed an organizational matrix as guidance for improving this linkage. Contractors should be included in the Departmental Training Program committees.

Recommend that the various Federal and contractor organizations link themselves through their websites and the websites established by the Program Offices and field sites for software and safety for the purpose of improving communications.

Recommend that better communication lines are defined for line management organizations to ensure that everyone can be apprised of issues, concerns, training opportunities, etc.

Recommendation No. 7: Followup Study. A more in-depth study of training for safety analysis and I&C software at defense nuclear facilities needs to be conducted. The survey provided some high-level information, but more details are needed. The Safety Analysis Software Group (SASG) has been formed to address training for software used in safety analysis and I&C at defense nuclear facilities.

Recommend LPSOs endorse and support the SASG and that the SASG share SQA training requirements and qualifications for safety software with the OCIO, QAWG, EFCOG, and SQAS. Planned deliverables of the SASG are a report of their in-depth study, including training opportunities, and possibly a toolbox of codes and consensus set of standards.

Recommend the SASG answer the following questions: What improvements can be made? What are the appropriate types and levels of software (SQA and safety software) training commensurate to the requirements of the safety analysis and I&C functions performed by the Department? What are the goals of training, how will the training be delivered, and how will the training be evaluated against the goals? Are DOE directives and standards adequate? Is there an adequate infrastructure for disseminating and promoting training? Is there adequate interaction with government and industry organizations? Are any joint ventures needed? Are training requirements and qualifications adequately covered in contracts? What improvements are needed in safety software management?

3.0 Institutionalization and Follow-through

In addition to the actions recommended in Section 2.4.2, there are various ways to institutionalize and ensure continuation of the recommendations. It is important to institutionalize and provide follow-through to ensure improvements occur.

3.1 Promotion and Awareness

DOE governance groups can be a source for providing promotion and awareness of the need to have quality software and training. These groups include the Executive Committee for Information Management (ECIM), the DOE CIO Council, the Quality Assurance Working Group (QAWG), and potentially the Safety Analysis Software Group (SASG). The OCIO and EH should take advantage to bring software training issues and concerns to these groups.

Contractor groups such as the Software Quality Assurance Subcommittee (SQAS) and the Energy Facilities Contractor Group (EFCOG) Safety Analysis Working Group (SAWG) can be very instrumental in institutionalizing software quality and safety management training. The OCIO and EH should form closer working relationships with these groups.

3.2 Web Linkages

Most of the organizations above in Section 3.1 have established websites. All of these should be linked, which would be conducive to ensuring better communication and sharing.

3.3 Update and Adoption Process

Both the OCIO and EH have training programs and processes that provide for DOE participation in these programs to update or adopt new training requirements. These programs can and are very conducive for ensuring improvements are made in the way DOE provides training. A better integration with the Departmental Training Program for information sharing should be considered by both organizations, such as a direct link from the Departmental Training Program website to the OCIO and EH training websites.

3.4 Auditing Processes

DOE Federal and contractor organization auditing processes can be used to ensure software and safety standards are reviewed, where applicable. This would help to promote, keep current, and continually provide an awareness of the importance of standards.

The following is a listing of the websites for the organizations discussed in this study report.

LISTING OF TRAINING ORGANIZATIONS		
DOE Websites		
CTED	Clearinghouse for Training, Education, and Development	http://cted.inel.gov/cted
CHRIS	Corporate Human Resources Information System	http://chris.inel.gov
CCTF	Cross-Cutting Training Forum	http://cted.inel.gov/cted
DOE Safety	Departmental Safety Training	http://www.pnl.gov/esbs
DOE Training	Departmental Training Program	http://cted.inel.gov/cted
Explorer	Directives System	http://www.explorer.doe.gov:1776/htmls/directives.html
FTCP	Federal Technical Capability Panel	http://tis.eh.doe.gov/
Hammer	Hammer Training Program	http://www.hammertraining.com
ISM	Integrated Safety Management Training	http://tis.eh.doe.gov
NNSI	Nonproliferation and National Security Institute	http://www.nnsi.doe.gov
ONLL	Online Learning Center	http://cted.inel.gov/cted
Science	Good Practices Guides	http://www.er.doe.gov/ once on the site add production/er-80/er-82/gpguides.html
QAWG	Quality Assurance Working Group	http://twilight.saic.com/qawg
QSM	Quality and Safety Management Special Interest Group Training Resource and Data Exchange (TRADE)	http://www.orau.gov/qsm
EH	Technical Qualifications Program	http://cted.inel.gov/cted/qualstd.html
EH	Technical Training Program	http://tis.eh.doe.gov/training/resources/resources.htm
TDMC	Training and Development Management Council	http://cted.inel.gov/cted

LISTING OF TRAINING ORGANIZATIONS		
Contractor Websites		
EFCOG/SAWG	Energy Facilities Contracting Group/Safety Analysis Working Group	http://www.efcog.org/ http://www.sawg2000.org
ORISE	Oak Ridge Institute for Science and Education	http://www.orau.gov/orise.htm
SQAS	Software Quality Assurance Subcommittee	http://cio.doe.gov/sqas
NWC	Nuclear Weapons Complex Training	http://prp.lanl.gov:8686/
Other Government Websites		
Air Force	Air Force Safety Center	http://www.usaf.com/orgs/12.htm
DISA	Defense Information Systems Agency	http://www.disa.mil
DISA	Defense Technical Information Center	http://www.dtic.mil
DTRA	Defense Threat Reduction Agency	http://www.dtra.mil
DOD	Department of Defense	http://www.defenselink.mil
DOD	DOD	http://firstgov.gov
DOT	Department of Transportation	http://www.dot.gov
DOT/TS	DOT Transportation Safety Institute	http://www.tsi.dot.gov
DOT/FAA	FAA Academy	http://www.academy.jccbi.gov
DOT/FAA	FAA Aircraft Certification Program	http://av-info.faa-gov/software
DOT/FAA	FAA Computer-Based Training	http://faawbt.jccbi.gov
FIATC	Federal Inter-Agency Training Council	http://www.docal.gov/gtd/etc.htm
JSS	Joint Services Schools	http://fedgate.org/fg-jss.htm
Joint SSSH	Joint Software System Safety Handbook	http://www.system-safety.org
NASA	National Aeronautical and Space Administration	http://www.nasa.gov
NASA	National Acronautical and Space Administration Search	http://www.nasa.gov/search
NASA/Ames	NASA Ames	http://www.arc.nasa.gov

LISTING OF TRAINING ORGANIZATIONS		
NASA/Ames	NASA High Performance	http://hpcc.arc.nasa.gov
NASA/Ames	NASA Ames Quality System	http://huminfo.arc.nasa.gov:80
NASA	NASA ISCO and SIPS	http://www.nas.nasa.gov/IT/test/index.htm
NASA	NASA Wallops Safety Office	http://www.wff.nasa.gov
NIST	National Institutes of Standards and Technology	http://www.nist.gov
NIST/SQA	National Institutes of Standards and Technology SQA Standard	http://hissa.ncsl.nist.gov/publications/nistir4989/
Navy/NSWC	Navy Surface Warfare Center	http://www.nswc.navy.mil/safety
NRC	Nuclear Regulatory Commission	http://www.nrc.gov
Industry Websites		
ANSI	American National Standards Institute	http://www.ansi.org
ANSI	American National Standards Institute Standards	http://www.nssn.org
ANS	American Nuclear Society	http://www.ans.org
ANS	American Nuclear Society Standards	http://store.ans.org
ASME	American Society of Mechanical Engineers	http://www.asme.org
ASQ	American Society for Quality	http://www.asq.org
CCPS	Center for Chemical Process Safety	http://www.aiche.orgs/ccps/index.htm
EIA	Electronic Industries Alliance	http://www.eia.org
IEEE	The Institute of Electrical and Electronics Engineers	http://www.ieee.org
IEEE/Training	IEEE Computer Society Standards-Based Training	pcroll@computer.org
IEEE/Training	IEEE Computer Society Competency Recognition Program	ssaul@computer.org
IEEE Education	IEEE Education Services	http://www.ieee.org/organizations/eab/education.htm
IEEE Standards	IEEE Standards	http://standards.ieee.org
IEEE/SWEBOK	IEEE Software Engineering Book of Knowledge	http://www.swebok.org
INCOSE	International Council on Systems Engineering	http://www.incose.org

LISTING OF TRAINING ORGANIZATIONS		
ISO	International Organization for Standardization	http://www.iso.ch
ISC	International Safety Council	http://safety.webfirst.com/isc.htm
NSC	National Safety Council	http://nsc.org/
NUSMG	Nuclear Utilities Software Management Group	http://www.nusmg.org
PMI	The Project Management Institute	http://www.pmi.org
QAI	The Quality Assurance Institute	http://www.qaiusa.com
SAE	Society for Automotive Engineers	http://www.sae.org or http://www.normas.com
SEI	Software Engineering Institute	http://www.sei.cmu.edu
SEI	Software Engineering Institute Search	http://www.sei.cmu.edu/about/website/search.html
SSS	System Safety Society	http://www.system-safety.org

Note: Check http://cio.doe.gov/smp (soon to http://cio.doe.gov/sqse) or http://cio.doe.gov/sqas or http://cio.doe.gov/asci for other useful website links not reviewed for this report.

The following is a listing of the training directives discussed in this study report.

LISTING OF DEPARTMENTAL TRAINING DIRECTIVES AND STANDARDS		
DOE Training Policies, Orders, Manuals, Standards		
DOE O 350.1	CONTRACTOR HUMAN RESOURCE MANAGEMENT PROGRAMS	DOE O 350.1 applies to contractor training programs. It requires the use of a systematic approach to develop training. Change 2 (draft), (a) establishes DOE responsibilities, requirements, and cost allowability criteria for the management and oversight of contractor Human Resource (HR) Management programs, (b) ensures that DOE contractors manage their HR programs to support the DOE mission, promote work force excellence, champion work force diversity, achieve effective cost management performance, and comply with applicable laws and regulations, © implements consistent requirements that allow contractors flexibility in determining how to meet the requirements, and (d) ensures that all elements of cash and non-cash compensation are considered in the design and implementation of an appropriate total compensation philosophy, but are not used as a means to deflect needed cost reductions in either or both. A re-write of various chapters of DOE O 350.1 in response to GAO recommendations and a Secretarial letter entitled "Effectively Managing Training Resources", dated March 4, 1999, is nearing completion and is expected to be forwarded to Directives for beginning the review process. The contact for the rewrite is John Edmondson, MA-53).
DOE O 360.1A	FEDERAL EMPLOYEE TRAINING	DOE O 360.1A applies to Federal personnel and was issued to plan and establish requirements and assign responsibilities for DOE Federal employee training, education, and development under the Government Employees Training Act of 1958, as amended, to improve workforce performance related to the mission and strategic objectives of DOE through a cyclical program of training planning, needs analysis and assessment, design, development, implementation, and evaluation.
DOE M 360.1A-1	FEDERAL EMPLOYEE TRAINING MANUAL	DOE M 360.1A-1 provides detailed requirements to supplement DOE O 360.1A, FEDERAL EMPLOYEE TRAINING. The information is intended to assist in improving Federal workforce performance through training, academic and other education programs, developmental assignments, workforce development programs, which may use a range of personnel and training authorities, and other learning-related activities.

LISTING OF DEPARTMENTAL TRAINING DIRECTIVES AND STANDARDS		
DOE Training Policies, Orders, Manuals, Standards		
DOE P 360.X	POLICY FOR A CORPORATE APPROACH TO TRAINING AND DEVELOPMENT FOR THE DOE COMPLEX	DOE P 360.X provides a framework for the corporate approach to training and development for the entire DOE complex, including contractor training.
DOE Safety and Safety Analysis Training Policies, Orders, Manuals, Standards		
DOE O 5480.20A	PERSONNEL QUALIFICATIONS AND TRAINING REQUIREMENTS FOR DOE NUCLEAR FACILITIES	DOE O 5480.20A assigns responsibility to EH to develop Department-wide training requirements.
DOE P 426.1	FEDERAL TECHNICAL CAPABILITY FOR DEFENSE NUCLEAR FACILITIES	DOE P 426.1 establishes the Federal Technical Capability Program to provide for the recruitment, deployment, development, and retention of Federal personnel with the demonstrated technical capability to safely accomplish the Department's missions and responsibilities. It establishes general training requirements for DOE personnel involved in facility operations and safety oversight.
DOE G 426.1-1	RECRUITING, HIRING, AND RETAINING HIGH-QUALITY TECHNICAL STAFF	DOE G 426.1-1, provides DOE managers with information on available administrative flexibilities that can be utilized in day-to-day HR management activities-especially those bearing on the recruitment and retention of high-quality technical staff.
DOE-STD-3009-94	PREPARATION GUIDE FOR US DEPARTMENT OF ENERGY NON-REACTOR NUCLEAR FACILITY SAFETY ANALYSIS REPORTS	DOE-STD-3009-94,, establishes guidance for consistency with DOE O 5480.23 requirements and its safety guide and describes a safety analysis report (SAR) preparation method for DOE. The standard includes the following requirement in section 3.4.1 "Briefly summarize and reference detailed information on algorithms, computational and analytical bases, and software quality assurance measures."

LISTING OF DEPARTMENTAL TRAINING DIRECTIVES AND STANDARDS		
DOE Training Policies, Orders, Manuals, Standards		
DOE-STD-1135-99	GUIDANCE FOR NUCLEAR CRITICALITY SAFETY ENGINEER TRAINING AND QUALIFICATION	DOE-STD-1135-99 describes the requirements for training and qualification of contractor Nuclear Criticality Safety (NCS) engineers in the DOE complex to facilitate hiring and maintaining of trained and qualified NCS staff. The standard briefly addresses SQA for criticality codes in section IV.5.0 "Evaluators should use configuration controlled, verified, and validated software and data sets"; and should be able to "Describe the importance of validation of computer codes and how it is accomplished." (A recent review found that DOE has not met commitments to ensure that this standard is implemented by its contractors.)
DOE-STD-1063-2000	FACILITY REPRESENTATIVES	DOE-STD-1063-2000 defines the duties, responsibilities, and qualifications for DOE Facility Representatives, based on facility hazard classification; risks to workers, the public, and the environment; and the operational activity level. The standard addresses selection, qualification, and training for facility representatives. It does not list specific topics to be included in training and qualification, but does discuss a Needs Analysis process to determine requirements for specific Facility Representatives.

LISTING OF DEPARTMENTAL TRAINING DIRECTIVES AND STANDARDS		
DOE Training Policies, Orders, Manuals, Standards		
DOE Software and Quality Assurance Policies, Orders, Manuals, Standards		
DOE O 200.1	INFORMATION MANAGEMENT	Was canceled in FY 2000. It contained no explicit requirements for software training, but did reference DOE G 200.1-1, SOFTWARE ENGINEERING METHODOLOGY. DOE O 1330.1D, COMPUTER SOFTWARE MANAGEMENT, (superseded by DOE O 200.1) contained more explicit requirements for software training. A replacement Order is under development for DOE O 200.1.
DOE N 203.1	SOFTWARE QUALITY ASSURANCE	Specifies the requirements for training in an SQA program. The Notice references DOE directives and industry standards applicable to safety or safety software. This Notice will be made into an Order.
DOE G 200.1-1	SOFTWARE ENGINEERING METHODOLOGY	Contains guidance in regards to the application of training on software projects. The Guide can and should be supplemented by site guidance to meet local needs.
DOE O 414.1A	QUALITY ASSURANCE	States the requirements for DOE elements and contractors to develop Quality Assurance Programs (QAPs). The Order directs organizations to include training in their QAPs.

Software Courses					
Title	Offeror	Cost	Phone	E-mail	Web Site
•Building Software Quality Skills •Information Quality Improvement •Software Metrics •Software Quality Engineering	American Society for Quality		800-248-1946 414-272-8575		http://www.asq.org/products/courses/fall/falltoc.html
•Keys to Successful Software Development •Software Testing: Building Infrastructure, Due Diligence, and OO Software •Successful Software Project Management •Design and Application of Real-Time Systems •Designing and Analyzing Object-Oriented Systems •Object-Oriented Analysis and Design •Real-Time Systems: An Engineer's Guided Tour	IEEE Education Online			a.trembly@iecc.org	http://www.iecc.org/organizations/eab/compeng/compeng-intro.htm
•Software Inspection •Product and Product-Related Configuration Management •Constraints on the use of Software in High Consequence Systems •Software Measurement •Specification-based Testing	Sandia National Laboratories, Albuquerque		505-845-9734	patrell@sandia.gov	
•Implementing Goal-Driven Software Measurement •Introduction to the Capability Maturity Model for Software (SW-CMM) •Statistical Process Control (SPC) for Software •Defining Software Processes •Computer Security Incident handling for Technical Staff (Advanced) •Managing Software Development with Metrics	Software Engineering Institute (SEI)		412-268-5800	customer-relations@sei.cmu.edu	http://www.sei.cmu.edu/topics/products

Survey on Software Quality Assurance (SQA) Practices, Processes, and Procedures Impacting Safety Analysis and Instrumentation and Control (I&C) Software Information Request for Response to Defense Nuclear Facilities Safety Board (DNFSB) Technical Report 25

Note: The response to the survey should not include non-nuclear facilities since the DNFSB issues are exclusively with nuclear facilities. The survey, however, does include hazardous chemicals present at nuclear facilities. The survey is directed at contractors; however, DOE Federal organizations may complete the survey as their input might provide additional insight.

Survey Targets: LLNL, LANL, SNL, SRS, Pantex, Rocky Flats, Y-12, INEEL, Nevada Test Site, Hanford (including ORP), WIPP, and ORNL. Only response from ORNL is the Y-12 survey. The Nevada Test Site stated they had no nuclear facilities. Although not a major target, YMP submitted a survey.

II. SAFETY ANALYSIS AND SOFTWARE APPLICATION USER TRAINING		
A. Safety Analysis – Authorization Basis		
(2) Indicate the method(s) used to assure that safety personnel are trained in safety analysis procedures, good practices, and the process of performing safety analysis in regards to authorization basis.	LLNL	HCD/ABS, CSG and HWM--uses a combination of on-the-job training, mentoring, and peer review to assure the quality of documents prepared by its staff. HCD personnel also act as independent reviews for SARs prepared by the nuclear facility staff.
	LANL	Current training is done individually by group. Inside each group training is done as courses become available (such as EFCOG sponsored training, DOE training, etc.); currently, no site wide training plan is in place to provide an institutional expectation on training. A training plan is under development and should be in place in early 2001.
	SNL	•Education: Personnel with advanced degrees in nuclear engineering or related fields are chosen to perform analysis for the reactor characteristics, key operating parameters, and accident analysis. This ensures the correct calculation approaches and methods are used in the analysis as a major thrust of nuclear engineering education is design for safety. •Work Experience: Personnel chosen to lead the safety analysis effort have previous experience on a team performing safety analysis for SARs. Additional experience performing safety evaluations and analyses for specific experiments or operations is a preferred but not required as a qualifier. •Training: If no available personnel have the requisite experience in performing safety analysis for SARs, the personnel chosen will receive training on DOE-STD-3009-94 requirements. In general, self-study of the DOE Orders, standards, and previously written SARs is the method of training used. Other training in specific computer codes may be required for a specific SAR as determined by SNL management for the SAR preparation.
	SRS	Each functional group's engineers are required to read E7, 1Q, 11Q, Site-specific SAR Preparation Guide (Paddleford et al. WSRC report). They are also responsible for completing reading on desktop guides specific to each group, instructing them on Inputs, Assumptions, and Basic Approach for safety analysis. Formal test-out is not required, nor is required for these reading programs. Most of the test-out will occur through the proceduralized Engineering Calculation technical review on specific analyses.

II. SAFETY ANALYSIS AND SOFTWARE APPLICATION USER TRAINING		
	Pantex	DOE STD-3009 short course and other training on DOE authorization basis process, USQ training, Hazards Analysis short course, and industry standard blast design short courses. MHC has also developed an authorization basis manual and several plant standards to delineate the procedures and process for authorization basis development.
	Rocky Flats	Again, each Project sets the standards and defines the usage appropriate to the specific situation which exists in each building. The personnel are given hands-on training both in an initial session when they begin the work, and in annual refresher courses. At these sessions they are provided with a user manual, which is updated as appropriate.
	Y-12	•Facility Safety: A training program, Y90-027, exists within the Plant. This training program is assessed frequently. Individual training is assessed when the work processes are assessed. All technical members of the Facility Safety Organization have received formal training on safety analysis (e.g., training on the implementation of DOE-STD-3009-94. All safety analysis calculations undergo a minimum of two reviews, an independent review by a checker, and a review by the preparer's supervisor. If a need for additional training is identified during these reviews, appropriate training is initiated. •Nuclear Criticality Safety: As outlined in Y/DD-694, NCSD is committed to developing and maintaining a staff of highly qualified personnel to meet the current and anticipated needs in NCS. This is accomplished through the Qualification Program designed to address NCSD technical and managerial qualifications as required by Y-12 Training Implementation Matrix (TIM). The Qualification Program comprises thirteen tasks and three duty assignments. A selection of duty assignments is identified with each Qualification Program customized to meet specific objectives of the Division.
	INEEL	Safety analysts are trained to perform their functions by a combination of formal training classes, self-study, and working under the mentorship of experienced analysts. A Safety Analyst Training and Qualification Program has been established at the INEEL in recognition of the ISMS principle of ensuring competence commensurate with responsibilities. An INEEL Safety Analyst Training Standard (STD-1107) has been developed that describes the training and qualification program and lists the required skills and training for qualified analysts, depending on the specific job requirements. The respective safety analysis group supervisor/manager is responsible for evaluating the training completed and the skills and abilities acquired and demonstrated by the analysts in determining their qualification level.
	YMP/ TESS	N/A. Project is still in Site Characterization phase.

II. SAFETY ANALYSIS AND SOFTWARE APPLICATION USER TRAINING		
	Hanford/ RL	•Fluor Hanford--Safety analysis training is conducted primarily with on the job training and very occasionally with off-site training. This training is supplemented by: mentoring by experienced analysts and/or supervision in the use of safety analysis procedures; review of recently approved safety analysis reports; and application of DOE complex lessons learned and good practices. Competence is assessed through observation and peer technical reviews of consequence analyses by HEDOP approved reviewers. HEDOP, the Hanford Environmental Dose Oversight Panel, was established by DOE-RL to provide oversight for and consistency in the use of accident analysis and dose consequence methodologies and codes. Experts from DOE and the Hanford contractors form the panel. FFS uses FFS Practice 134.290.1124, *Training and Qualification Program for Safety Analysts* to provide for the training of its analysts. •Bechtel Hanford--ERC position requirements are specified consistent with the level of expertise required. Personnel selection policies are outlined in BHI-HR-01 procedure #4.2. The ERC training program is outlined in BHI-MA-02 procedure #5.2 and BHI-HR-02 procedure #1.1. Personnel who are performing safety analyses are qualified through prior education and experience with specialized skills addressed through on-the-job training. All personnel performing safety analyses are trained in the Design Engineering procedures and guides that define the ERC safety analysis process and the methodologies to be used. The training consists of procedure reading and comprehension testing. •PNNL Hanford–Facility Operations has an extensive training program to support the safety basis including the authorization basis. This training includes; USQ Evaluator, SAR/TSR training for access to the facility, SAR/TSR training for management, and other training as identified. Two of the responsibilities of a Technical Group Manager are to "Deliver appropriately trained and motivated staff" and "Ensure quality of products/services delivered". The method(s) they use are the Staff Development and Review Process (http://sbms.pnl.gov/standard/4d/4d00t010.htm) coupled with the Training and Qualification for Staff (http://sbms.pnl.gov/standard/1e/1e00t010.htm). The technical group manager of the Materials & Engineering Analysis group is responsible for assuring the technical staff are trained in procedures, good practices and the process of performing criticality and shielding analysis used for safety analysis in regards to the authorization basis. This judgment of their technical qualifications is based on education (both degree and formal additional safety course work), relevant work experience and on the job training.
	Hanford/ ORP	•Tank Farm–CHG uses a qualification card approach. Safety analysts and engineers allowed to sign off on safety analyses as Cognizant Engineers are required to complete the Nuclear Safety & Licensing Cognizant Engineer qualification Card that documents their relevant education, experience, and training. In addition, Nuclear Safety & Licensing quality and Technical Peer Reviews are required for authorization basis changes, and Technical Peer Reviews are required for Calculation Notes. These reviews serve as continuing verification that safety analyses are being performed by knowledgeable individuals. •Tank Waste–Procedures for selection of project personnel K21P010 and training of project personnel K20C009 must be followed. Periodic management assessments and surveillance are conducted to evaluate the effectiveness of safety analysis process.
	WIPP	Experience, Formal training, Informal (on-the-job) training. Peer review of analysis and textual products.

II. SAFETY ANALYSIS AND SOFTWARE APPLICATION USER TRAINING		
B. Usage of Software for Safety Analysis		
(1) Indicate the documentation for and the manner in which safety analysts are trained in the appropriate use of computer codes.	LLNL	HCD/ABS, CSG and HWM--A combination of experienced personnel, on-the-job training, mentoring, and peer review is used. This training is not documented.
	LANL	Currently two methods are used. First, training of analyst on appropriate computer software is done individually by group. Groups utilize outside training when available (such as manufacture training, DOE sponsored training, or FCOG training). Secondly, groups use a mentor approach to training. This involves having inexperienced staff mentor under an individual who has proficiency in a given code application. Only after the inexperienced staff has been judged to have mastered a particular code application are they allowed to produce stand alone analysis.
	SNL	•Education: Formal course work in Nuclear Engineering includes appropriate use of calculational methods for a particular type of analysis and use of some common industry-wide codes such as MCNP. This education is documented in the degree and class descriptions for the individual. •Self-Study: Self-study and sample (or benchmark) problem code calculation with correct results. Self-study is augmented by discussion and interaction with other experienced users of the code. This self-study is undocumented except for internal SNL department activity reports and/or personnel performance evaluations, which can address such capability and qualification topics. •Specialized Training: Specialized training and education courses are chosen on a case-by-case basis if the required education is not available and self-study is not deemed an acceptable alternative by SNL management. Specialized training is documented by course completion certificates in personnel records.
	SRS	•Each functional group has procedural or desktop guidance. Analysts must understand and signoff on these materials before performing their respective analysis. In addition to the group-specific training, the analysts must understand and are responsible for following pertinent sections of E7, 1Q, 11 Q, AB Steering committee documents, and the Integrated Work Process Manual. •Computer code training is handled through pairing new and less experienced engineers with more senior colleagues. Learning is on-the-job, but always peer-reviewed.
	Pantex	Training is documented in the MHC Training Matrix for Nuclear Criticality Safety (NCS) analysts. Training for NCS analysis includes professional off-site courses, and practical hands-on training on-the-job. Blast prediction, building debris, and dynamic structure response is on-the-job training and industry short courses, when available. Finite Element Modeling is provided through the vendor. For dispersion modeling, training is documented on the following forms: PX-2496, *Training Program Description for Dispersion Modeling Analysts;* PX-2498A, *Table Top Job Analysis;* and PX-4090, *Individual Training Plan.* Emergency Management personnel attend training courses at Process Safety Institute (PSI) and Harvard School of Public Health.
	Rocky Flats	The personnel are given hands-on training both in an initial session when they begin the work, and in annual refresher courses. At these sessions they are provided with a user manual, which is updated as appropriate.
	Y-12	•Facility Safety: Each organization is responsible for assuring that their personnel are properly trained. Training ranges from self-paced, individual training, to mentoring by experienced practitioners of the codes, to formal training. •Nuclear Criticality Safety: Task 4 and 5 of the NCSD Qualification Program addresses the performance and the review of NCS computations, respectively. The Task 4 NCS Computation qualification requires demonstration of proficiency in the use of the

II. SAFETY ANALYSIS AND SOFTWARE APPLICATION USER TRAINING		
	INEEL	Training on use of computer software for safety analysis is performed either in formal classroom settings or by self-study of software manuals and practice under the mentorship of experienced analysts. The setting is determined by the number of analysts that require a particular type of training. Classroom training is documented by rosters and passing a test, if applicable. Successful acquisition of a skill as demonstrated by job performance is evaluated and documented by the responsible supervisor/manager.
	YMP/ TESS	For commercial software, the software vendor provides training. For non-commercial software, informal training is provided to new staff by existing staff.
	Hanford/ RL	•Fluor Hanford--In general, FH and its subcontractors are responsible for ensuring that employees receive indoctrination and training according to the scope, complexity, and nature of their duties and administering training record documentation. Code specific training is conducted primarily as on the job training and may occasionally involve off-site training. Competence to use a particular code is assessed through observation and technical reviews. However, there are no explicit requirements for documentation of code-specific training. •Bechtel Hanford--As noted in the response to question II.A-2 on training for procedures, practices, and processes in regards to authorization basis, safety analysis personnel are trained in the ERC procedures that govern the use of computer software. This training consists of procedure reading. Completion of this training is documented through the individuals reading list and is part of his training record. Training in the use of specific computer tools consists of reading the program documentation and working with experienced user's of the program. This on-the-job training is not formally documented. •PNNL Hanford--The safety analysis is done using GENII version 1.485. Staff members who use the GENII received one-on-one with code developer. Staff using SCALE receive formal course training from Oak Ridge and on-the-job training from experienced users. Staff using MCNP receive formal course training from Los Alamos, and other experienced developers, as well as on-the-job training from experienced users. Computer code modeling using CFAST Version 2.0.1 was applied by subcontracted personnel with specific expertise in the application of the code.
	Hanford/ ORP	•Tank Farm–Training in appropriate use of computer software is generally performed as on-the-job training and with feedback from technical reviewers. Some offsite training is used when it is available. CHG managers are responsible for ensuring their employees' technical proficiency. •Tank Waste–Safety analysts are trained in project procedures that govern the performance, documentation and review of calculations in support of safety analysis. These procedures cover the appropriate use of computer software for the calculations. Evidence of current training in these procedures is kept by the project training organization. Relevant procedures are: K70P505, *Accident Analysis*; K70C505, *Code of Practice for the Accident Analysis Process*; K70C518, *Code of Practice for Engineering Calculations*; K70C515, *Code of Practice for Computer Program Use*
	WIPP	Formal training: Class completion certificate; Informal training (OJT): No documentation.

II. SAFETY ANALYSIS AND SOFTWARE APPLICATION USER TRAINING		
(3) Do you require that safety analysts be trained in the use of specific computer codes used for the performance of hazard, accident, or consequence analysis?	LLNL	HCD/ABS, CSG and HWM use a combination of on-the-job training, mentoring, and peer review to assure the quality of documents prepared by its staff. HCD personnel also act as independent reviewers for SARs prepared by the nuclear facility support staff.
	LANL	No formal training is required at this time. However, training and certification are being examined and with a decision expected in early 2001.
	SNL	Specifically no, although some training may have been given or obtained by the analyst in specific cases. (See the answer to questions II.A.2 and II.B.1)
	SRS	Specific training is provided for complying with E7 procedures for safety analysis. AB Documentation analysis specifics are informally trained on respective tasks in hazard, accident, and consequence analysis through a reading and sign-off program. However, this is not a qualification procedure, but more of a familiarization process.
	Pantex	All NCS analysts are trained in the use of criticality safety software. Dispersion analysts attend professional off-site training courses and are mentored by senior employees. Untrained personnel performing analyses work under the direct supervision and review of an engineer trained in the proper use of the computer code.
	Rocky Flats	Yes, please see notes on analyst training above.
	Y-12	•General: Yes. Training is described, controlled, and maintained through the implementation of the Y-12 Plant training program. •Civil and Structural Engineering: Informal training available to use the GTSTRUDL computer code. •Nuclear Criticality Safety: The Task 4 NCS Computation qualification is code specific. The analyst is required to demonstrate proficiency in the use of the subject code used in the performance of nuclear criticality safety analyses.
	INEEL	•In the hazard and accident analyses for non-reactor nuclear facilities, the only computer codes normally used are dose consequence calculation codes. As described above in item II.A.2, safety analysts are required to be trained and qualified to perform this work. However, as stated in item II.B.1 above, this training may involve self-study of code manuals and practice under an experienced mentor. •Training is also required for performing computer code calculations in support of ATR Facility safety analysis, though it is normally accomplished through self-study of code manuals and practice under an experienced mentor, since the number of analysts required for this function is fairly small.
	YMP/ TESS	No

II. SAFETY ANALYSIS AND SOFTWARE APPLICATION USER TRAINING		
	Hanford/ RL	•Fluor Hanford--FH procedure HNF-PRO-309, *Computer Software Quality Assurance Requirements,* requires that personnel using software are qualified by meeting position description documented education and experience requirements which are dependent on the scope, complexity and nature of work. These qualification requirements are for software significant to occupational, environmental, onsite or offsite safety, and quality-affecting functions. •Bechtel Hanford--No. There is no procedural requirement to formally train safety analysts in the use of specific computer codes. ERC relies on the analyst's experience, as required by position requirements, and informal on-the-job training. Qualified personnel are hired/placed based on position requirements including any specific computer skills. Training in use of specific software for analyses, as listed above, is on an individualized basis under the direction of experienced analysts. There are no records of such individualized training. •PNNL Hanford--Training of the analyst is provided by the analyst's organization as necessary to support the requested safety analysis service to Facility Operations. For shielding and criticality analysis, the only example of consequence analysis was based on referenced data, not by a specific code. For shielding and criticality analysis, the codes mentioned above, MCNP and SCALE are used to assess both the normal operations, and off-normal or accident scenarios. The training for those codes is described above. Training in the use of GENII version 1.485 is received one-on-one with the code developer.
	Hanford/ ORP	•Tank Farm–CHG managers are responsible for ensuring their employees' technical proficiency, which includes use of computer codes as applicable. However, there are no specific requirements for training on safety analysis computer codes. •Tank Waste–K70C515, *Code of Practice for Computer Program Use*, requires that all computer codes with "Important to Safety" application, as determined by the engineering manager and the Environmental, Safety, & Health manager, have specific training requirements for users in those applications. The training requirements are developed by the Project Program Sponsor. At present, two codes with potential for use in safety analysis are listed, Microshield and MCNP. The training requirements for both are specified thus: "None: the users' manual and program interface are sufficient for Health Physics and Engineering Professionals to effectively use the program." Additional codes for use in the safety analysis supporting the Preliminary Safety analysis report are being identified and will undoubtedly be added to the list. Training requirements for those codes will specify demonstrated familiarity with the technical aspects of the code, previous experience in use of the code or initial used under supervision of an experienced user, or formal classroom training requirements.
	WIPP	GXQ 4.0 is used for consequence analysis. Report is peer reviewed by at least an equally trained, competent person.

II. SAFETY ANALYSIS AND SOFTWARE APPLICATION USER TRAINING		
C. Software Quality Assurance (SQA) Training		
(1) Is in-house SQA training provided for the code developers and maintainers? What is it?	LLNL	No
	LANL	In-house SQA training is done individually by group. Training varies by code development program.
	SNL	Yes, training on RREP 3-2, Computer Software Control, is administered to personnel as a reading requirement. By following the requirements in RREP 3-2, personnel learn Software QA concepts.
	SRS	There are 1Q and E7 procedures to be followed, but no formal training program per se.
	Pantex	No formal SQA training is provided. The Software Quality Life Cycle Plant standard is supplemented by a Guidelines manual which provides examples of all of the required documentation and review/approval forms. Additionally, Internal Operating Procedure IP-E8602 provides instructions for validation of nuclear criticality safety computer programs.
	Rocky Flats	Yes. Training consists of covering the requirements for SQA in the CSMM and in the tools and techniques called for in the SEI Level 3 certification.
	Y-12	•General: Training exists for the overall software control process described in the Y80 Series procedures. This training will be revised as part of the overall revisions to the Y80 Series procedures. •Nuclear Criticality Safety: In-house SQA training is provided through notification of plant 80 Series procedures via the required reading program.
	INEEL	No such training is currently provided in a classroom setting. On-line web-based training courses are provided for the CM Program. The knowledge of specific requirements of software CM is gained normally through required reading and self-study, as verified by responsible management.
	YMP/ TESS	In-house training is provided to the requirements of AP-SI.1Q, Software Management. This training is mandatory for all developers and maintainers of software used in support of the License Application and the Safety Case.

II. SAFETY ANALYSIS AND SOFTWARE APPLICATION USER TRAINING		
	Hanford/ RL	•Fluor Hanford--There is no formal training program for FH SQA requirements and processes; however, FH requires code developers to utilize a subcontractor, Lockheed Martin Services, Inc., whenever developing or changing codes. Lockheed Martin Services, Inc. has been contracted to provide IRM services to the PHMC. Lockheed Martin Services has a level-3 certification for Processes and Practices Institutionalized at the corporate level from Carnegie Mellon Software Engineering Institution Capability Maturity Model. They are expected to maintain qualified software technical expertise. Individual organizations have developed on the job training for selected technical staff on SQA. Examples are the FFS practice, 134.200.0960, *Control of Engineering Software*, and the Spent Nuclear Fuel Project On the Job Familiarization, OJF-019-M-00, *Software Configuration Management.* •Bechtel Hanford--In-house training is provided for software engineers and personnel that may use or procure computer software; this includes SQA training. However, the ERC has not developed any safety analysis software and does not control the source code for the safety analysis software currently in use. The aspect of the SQA training applicable to the safety analysis software used by the ERC involves the specification and procurement of commercially available safety analysis software. •PNNL Hanford--For software maintenance referenced in PNL-MA-875 " Computer Code Maintenance Software Quality Assurance Manual", staff receive on the job training from the M&EA group manager and other experienced Computer Code QA engineers.
	Hanford/ ORP	•Tank Farm–CHG does not develop computer codes. •Tank Waste–Currently, we do not develop codes for safety analysis. Users and maintainers are trained in the Quality Assurance Program and project procedures.
	WIPP	OJT training for the developer.
(2) Are there special SQA training needs for safety analysis and instrumentation and control (I&C) software? What is it?	LLNL	No
	LANL	Need exists, currently no training is provided.
	SNL	No
	SRS	No. All personnel working on I&C software are trained on the procedures as part of the standard training program.
	Pantex	There are no special needs.
	Rocky Flats	No. Don't have any in-house developed I&C software.
	Y-12	•General: There in not training specific SQA training in these area. Training for these types of software is incorporated in the overall Y80 Series training, since the Y80 Series does not differentiate these types of systems. Within the Y80 Series, software is classified for graded approach purposes, and the formality and rigor required for a given system is based on this graded approach. •Nuclear Criticality Safety: NCSD activities involve the use of safety analysis software but not I&C software. There are no special needs.

II. SAFETY ANALYSIS AND SOFTWARE APPLICATION USER TRAINING		
	INEEL	Current training methods used for safety analysis software applications at INEEL are considered adequate. Formal classes are provided for applications having a large number of users, such as RSAC-5. For applications with a small number of users, self-study and one-on-one mentorship by experienced users is effective.
	YMP/ TESS	No
	Hanford/ RL	•Fluor Hanford--There are no special needs regarding SQA training. •Bechtel Hanford--No. The ERC has identified no special SQA training needs for safety analysis. The ERC work scope does not include safety I&C. •PNNL Hanford–No software is used for I&C Safety Critical Applications.
	Hanford/ ORP	•Tank Farm–Yes, but training is limited to I&C operations on computer control system firmware such as for the Tank AZ-101 mixer pump, Tank C-106 transfers, and the 702-AZ ventilation system. The technicians setting parameters on these systems do not have access to the source code. Any source code changes would be governed by RPP-PRO-309, *Computer Software Quality Assurance Requirements.* •Tank Waste–There are no special SQA training needs for safety analysis or I&C software.
	WIPP	N/A

III. Software Applications Used in the Performance of Safety Analysis		
A. Safety Analysis		
(2) Describe any training and documentation in the use of these identified codes	LLNL	HCD/ABS and HWM-- OJT, mentoring, peer review
	LANL	Training is done individually by group.
	SNL	See Previous Answers (i.e., II.A.2, II.B.1 and 3, II.C.1 and 2).
	SRS	Training is often self-paced with procurement of a code, and assignment to an engineer as a lead. Typical documentation required is User Manual and Model Description; other documentation is sometimes required. Specific training can be at the code developer's , at WSMS offices, or through the Annual Safety Analysis Workshop.
	Pantex	Occupational Safety & Health analysts receive in-house and vendor training. Blast prediction, building debris and dynamic structure response is on-the-job training and industry short courses, when available. Finite Element Modeling is provided through the vendor. See II.B.1 of this survey regarding Criticality Safety training and documentation. Emergency Management analysts attend "Consequence Analysis Methods" training provided by PSI, and "Atmospheric Science and Radiation Releases" training provided by the Harvard School of Public Health.
	Rocky Flats	See answers to training questions in previous sections (i.e., II.A.2, II.B.1 and 3, II.C.1 and 2).
	Y-12	•Facility Safety: Training on the use of these computer ranges from self-paced, individual training, to mentoring by experienced practitioners of the codes, to formal training. All of the codes have formal documentation, which include theoretical information and user's manual type information. •Nuclear Criticality Safety: Users attend a week-long course on code usage an must complete Task 4 of the Training and Qualification program before work is legitimate for quality assurance purposes. •Emergency Management: Formal training programs on CHARM have been provided by the Radian Corporation. Accompanying the training are detailed user manuals. Technical assistance is also available as needed from Radian. NARAC has also provided a formal training program through Lawrence Livermore Laboratory along with user manuals and technical assistance. HOTSPOT and EPI code models are less sophisticated and utilize less formal individual training and user manuals.
	INEEL	Formal training classes are provided on the use of RSAC-5 by the code developer. Due to the limited number of people using the rest of these codes, training is provided by self-study of code manuals and mentorship by experienced users.
	YMP/TESS	Experienced members of staff attend vendor-provided software training. Informal training in the codes is provided in-house to new staff by qualified members of staff. Software vendors provide documentation. AP-SI.1Q training is mandatory for users of these codes.

III. Software Applications Used in the Performance of Safety Analysis		
	Hanford/RL	•Fluor Hanford--In general, FH and its subcontractors are responsible for ensuring that employees receive indoctrination and training according to the scope, complexity, and nature of their duties and administering training record documentation. Code specific training is conducted primarily as on the job training and may occasionally involve off-site training. Competence to use a particular code is assessed through observation and technical reviews. However, there are no explicit requirements for documentation of code-specific training. •Bechtel Hanford--Training is provided on an individualized basis under the guidance of an experienced analyst. The training involves reading the software documentation and interaction with the experienced user as necessary. This training is not formally documented. The calculation review and approval process also serves as a check on the competency of personnel using a particular software package. •PNNL Hanford–This information is provided in detail in Sections I and II.
	Hanford/ORP	•Tank Farm–CHG management is responsible for (a) ensuring that employees receive indoctrination and training according to the scope, complexity, and nature of their duties and (b) maintaining training documentation. Training in the use of computer codes is primarily performed as on-the-job training and sometimes as offsite training. There are no requirements for code-specific training. Appropriate use of codes is verified during required Technical Peer Reviews of safety analysis performed with the codes. User manuals, code descriptions, and/or code test documentation is available for all codes listed. •Tank Waste–HADCRT–classroom training for safety analysts; user manual and verification and validation documentation provided by Fauske and Associated, Inc. GXQ–users for RPP-WTP have previous training and experience in atmospheric dispersion theory in general and with using the code in particular. User documentation, and verification and validation documentation is on hand. MICROSHIELD–calculations for direct radiation doses will be done by members of the radiological safety group who are experienced in the use of MICROSHIELD. User documentation, and verification and validation documentation is on hand.
	WIPP	Informal OJT training; no documentation.

B. Accident Phenomenology and Consequence Analysis		
(6) Have your analysts received specific training in the use of these identified computer codes and is there documentation for the use of these codes?	LLNL	•HCD/ABS and HWM--They are trained but the training is not documented. •CSG–Nuclear criticality safety engineers are qualified for many criticality safety areas including criticality safety computer codes.
	LANL	Training is done individually by group, (For example, some training has occurred for the use of MACCS2 and FLOW-3D). Most analysts are mentored in other code applications. Documentation is limited to user manuals.
	SNL	Specific training and documentation for these codes above – See answer to question II.A.2, II.B.1, and III.A.2.

III. Software Applications Used in the Performance of Safety Analysis		
	SRS	•Occasionally, training on the computer models will be brought in, or the analysts will be sent to the EFCOG Safety Analysis Workshop for hands-on training on a specific computer code. Training was held onsite for MACCS, and a JBFA Consequence Analysis course. Otherwise, any indoctrination on a computer model is based on user-initiated procurement of a computer model, and self-study on the particular code. •For some proprietary models, WSRC/WSMS usually obtains a training agreement for a set number of analysts. A recent example of this arrangement was training on the CFD code, FLUENT.
	Pantex	In general, mentoring and off-site training are provided for analysts. Blast analysts have been trained in the proper use of the above listed computer codes for blast prediction, building debris prediction, and finite element modeling. Dispersion analysts maintain users manuals for all codes. Emergency Management analysts attend ERO Course #52.34 for HOTSPOT and ERO Course #52.36 for ARAC. There is no course for EPI code.
	Rocky Flats	Yes
	Y-12	•Facility Safety: FAST 3.1 from the National Institute of Standards and Technology (NIST) HASS 7.2 from HRS Systems, Inc. PIPE2000 from the University of Kentucky HGSYSTEM from Shell Research Limited HEATING M.C./PATHAN and M.C./THERMAL •Nuclear Criticality Safety: Yes •Emergency Management: Yes. Formal training programs have been provided for CHARM and NARAC. Informal training has occurred for HOTSPOT and EPI code.
	INEEL	Safety analysts receive formal training or one-on-one mentorship training on use of computer codes in safety analysis. Until recently there has been no documentation of this training. However, at present the acquisition of computer code usage skills by safety analysts is documented in accordance with the INEEL Safety Analyst Training Standard (STD-1107).
	YMP/ TESS	No specific formal training is provided. Software vendors provide training on commercial software packages. Qualified staff performs in-house training. Software vendors provide documentation for commercial software.

III. Software Applications Used in the Performance of Safety Analysis		
	Hanford /RL	•Fluor Hanford--There is in general, no specific training except familiarization and on the job training. Documentation for the use of the codes is contained in the particular reports that are generated as a result of an analysis. In general, FH and its subcontractors are responsible for ensuring that employees receive indoctrination and training according to the scope, complexity, and nature of their duties and administering training record documentation. Code specific training is conducted primarily as on the job training and may occasionally involve off-site training. Competence to use a particular code is assessed through observation and technical reviews. However, there are no explicit requirements for documentation of code-specific training. •Bechtel Hanford--Software documentation requirements are specified in the procedures identified in the response to I-1. Training is provided on an individualized basis under the guidance of an experienced analyst. The training involves reading the software documentation and interaction with an experienced user as necessary. This training is not formally documented. The calculation review and approval process also serves as a check on the competency of personnel using a particular software package. •PNNL Hanford–This information is provided in detail in Sections I and II.
	Hanford /ORP	•Tank Farm–*Criticality Codes*: The criticality specialist qualified to run the codes received specific training via the internal training department and the RSICC, as needed. The codes are documented via RSICC. *Other Codes*: Training in use of computer software is generally performed as on-the-job training and with feedback from technical reviewers. Some offsite training is used when it is available. CHG managers are responsible for ensuring their employees' technical proficiency. User manuals, code descriptions, and/or code documentation is available for all codes listed. •Tank Waste–In general, no specific training is provided for the use of the computer codes. However, one of the criteria for hiring and assigning project personnel to safety-related applications is familiarity and experience with critical software such as MCNP and MICROSHIELD. In addition, on the job training under the supervision of an experienced engineer is used to ensure that job proficiency is maintained.
	WIPP	No. Informal OJT is the training method employed.

IV. COMPUTER SOFTWARE USED FOR I&C IN SAFETY CRITICAL APPLICATIONS	
7. Do you have a training program associated with these procedures?	
LLNL	Only one individual works with the software development. There is a facility workspace-specific training requirement for users.
LANL	No
SNL	Yes but it is just a familiarization (through reading) program that is invoked periodically depending upon the changes in the program.
SRS	Yes, we have required reading as well as informal on-the-job training within the work group
Pantex	No formal SQA training is provided. The Software Quality Life Cycle Plant standard is supplemented by a Guidelines manual which provides examples of all of the required documentation and review/approval forms. Additionally, Internal Operating Procedure IP-E8602 provides instructions for validation of nuclear criticality safety computer programs.
Rocky Flats	N/A
Y-12	•General: Yes. The training program will be revised in accordance with the upcoming issuance of revised Y80 Series procedures. •Fire Systems Management: N/A
INEEL	Not for software CM in general. Training on the NWCF DCS is provided by the system vendor. Training on NWCF-specific aspects of the system software is by self-study of system manuals and mentorship by system experts.
YMP/TESS	N/A
Hanford/RL	•Fluor Hanford--There is no formal training program for the company procedures. The FH procedures have a routing/communication process for distributing procedures and changes. The projects establish their own training programs for their implementing procedures. As noted in question II.C.1 above regarding in-house SQA training, Lockheed Martin Services, Inc. has been contracted to provide certified software technical experts to FH and the projects. The use of these experts is required by FH procedures. •Bechtel Hanford–N/A •PNNL Hanford–N/A
Hanford/ORP	•Tank Farm–There is no formal training program for these procedures. •Tank Waste--N/A
WIPP	N/A

IV. COMPUTER SOFTWARE USED FOR I&C IN SAFETY CRITICAL APPLICATIONS	
8. Are there qualification requirements for personnel who generate this class of software?	
LLNL	Only one individual works with the software development.
LANL	Yes, but the requirements are quite general in nature and are subject to the interpretation of line management.
SNL	Not formally administrated.
SRS	Yes, all positions have job descriptions which define required technical capabilities, and are used both for hiring and for job assignments.
Pantex	No
Rocky Flats	N/A
Y-12	•General: Not specifically. The I & C software is not singled-out as a specific type of software in the Y80 Series. •Fire Systems Management: N/A
INEEL	No
YMP/TESS	N/A
Hanford/RL	•Fluor Hanford--Yes, in HNF-PRO-309, *Computer Software Quality Assurance Requirements.* •Bechtel Hanford–N/A •PNNL Hanford–N/A
Hanford/ORP	•Tank Farm–Yes, identified in HNF-PRO-309 •Tank Waste--N/A
WIPP	N/A

DOE Training & Development Management Infrastructure

" Effectively Managing Scarce Training & Development Resources"

ORGANIZATION	MEMBERSHIP & FOCUS/OUTPUT	PARTNERS
PRIMARY LEAD **Training & Development Management Council** (Federal; Reports to the Deputy Secretary of Energy) Communication Mode: Electronic/E-mail, Meetings	**Membership (32 Organizations):** Senior HQ Resource Managers and Field Assistant Managers for Administration, or equivalent. **Focus:** Direction, guidance, and decisions on Department of Energy Corporate Approach to Training and alignment of training with DOE priority missions (technical and non-technical). **Output:** Advice to Secretary, Direction/Guidance to Training & Development Community	**Energy Facility Contractors Organization Group** (Contractor) **Membership**: Chief Executive Officers of DOE Management &Operating Contractor organizations. This is a fee for membership organization. **Focus:** Management and Operation of DOE Facilities **Output:** Exchange of best-practices, lessons-learned, workshops, written reports, consensus standards, etc. as desired by DOE Program Offices. Communication Mode: Annual Meeting/Conference Calls

DOE Training & Development Management Infrastructure

" Effectively Managing Scarce Training & Development Resources"

ORGANIZATION	MEMBERSHIP & FOCUS/OUTPUT	PARTNERS
WORKING GROUP **TDMC Executive Committee** (Federal; Reports To TDMC) Communication Mode: Electronic/E-mail, Bi-Monthly Meetings	**Membership:** Senior HQ Resource Managers and Field Assistant Managers for Administration, or equivalent. NOTE: This is a small working group of 15 TDMC members **Focus:** Implementation of TDMC Direction/Guidance; Research, Analysis and Development of Solutions to T&D Issues **Output:** Options for total TDMC Consideration; Direction/Guidance to Training & Development Community	**Training Resources and Data Exchange** (TRADE; Contractor Organization Addressing Training for the EFCOG) **Membership:** Training Managers of DOE Management & Operating Contractor organizations. Participation is voluntary. **Focus:** An organization established by DOE to achieve partnering & sharing of resources amongst DOE contractor organizations. **Output:** Training, Guidance Documents, Standards Development, other products and services as desired by the DOE and M&O contractor community. Communication Mode: Electronic/e-mail, Annual Meeting, teleconferences, ad hoc face-to-face meetings

DOE Training & Development Management Infrastructure

" Effectively Managing Scarce Training & Development Resources"

ORGANIZATION	MEMBERSHIP & FOCUS/OUTPUT	PARTNERS
STAFF GROUPS **Training & Development Coordinating Group** (Disbanded but members meet informally via teleconference; Federal; Reports To TDMC) **Technical Personnel Coordinating Committee*** (Federal; Reports To FTCP/TDMC) *TPCC members are also members of the larger TDCG. Communication Mode: Electronic/E-mail, Monthly Teleconference; Ad Hoc Face-to-face Meetings	**Membership:** Field Office Training Managers, DOE Program Office Training Managers or Training Coordinators. Working staff to the Training and Development Management Council. **Membership:** Field Office Training Managers, DOE Program Office Training Managers or Training Coordinators with responsibility for technical training for the defense nuclear facilities workforce. Working Staff to Federal Technical Capability Panel. **Focus:** Research, Analysis and Development of Solutions to both technical and non-technical T&D Issues; Completion/Implementation of TDMC Task Assignments **Output:** Dev. Of Options for TDMC Consideration, e.g. FY-2001 training priorities, technical capability issues; Dev. of Guidance Documents for Training & Development Community	**TRADE Special Interest Groups**: Advanced Training Technologies, DOE Federal Trainers, Performance-Based Management, Occurrence Reporting, Emergency Management Issues, Industrial Hygiene/Industrial Safety, Quality Management, Security Education **Membership:** Employees of Federal/Contractor training orgs or other orgs. interested in working on these specific training or other topic areas. Participation is voluntary. **Focus:** Facilitate work efforts on specific topics, e.g. Advance Training Technologies, to promote/facilitate networking across the DOE complex (Federal and contractor) **Output**: Training, Guidance Documents, and other products and services desired by the specific interest group customers. Communication Mode: Electronic/e-mail, Annual Meeting, teleconferences, ad hoc face-to-face meetings

DOE Training & Development Management Infrastructure

" Effectively Managing Scarce Training & Development Resources"

ORGANIZATION	MEMBERSHIP & FOCUS/OUTPUT	PARTNERS
OTHER **Federal Technical Capability Panel** (FTCP) . Communication Mode: Electronic, Videoconferences, Teleconferences, Quarterly Meetings	**Membership:** Senior Field and Headquarters line managers (Agents) **Focus:** Assures the Department of Energy defense nuclear facilities technical workforce capability and competence (recruitment, staffing, training and other issues). **Output:** Federal Technical Capability Action Plan, Annual Report to the Secretary of Energy, Advice to Secretary	**DOE Training Groups*** **Membership:** Training Coordinators for DOE Headquarters & Field Training and Development organizations * Individuals May Also be TDCG Representative for their Organization **Focus:** Research, Analysis and Development of Solutions to their organization's T&D Issues; Administration of their organizations Trg. & Dev. Plan; Administrative Trg. & Dev. Actions. **Output:** Dev. Of Options for TDCG/TDMC Consideration; Guidance Documents for Training & Development Community Communication Mode: Electronic/E-mail, Quarterly Face-to-face Meetings **Office of Personnel Management's Human Resource Development Council** **Training Technology Group Implementation Group** (Addresses implementation of E.O. 13111) **Training Officer's Conference (TOC/Ft. McNair)**

DOE Training & Development Management Infrastructure

" Effectively Managing Scarce Training & Development Resources"

ORGANIZATION	MEMBERSHIP & FOCUS/OUTPUT	PARTNERS
CORPORATE SYSTEMS **Corporate Human Resources Information System**: – Training Administration – Manage Competencies **Cross-cutting Training Forum** **Online Learning Center (formerly Technology-Supported Learning)** Other local Training Data Systems	**Membership:** Teams working on particular systems issues. Teams may be comprised of both Federal and contractor employees. **Membership:** Teams working on particular systems issues. Teams may be comprised of both Federal and contractor employees. **Membership:** Teams working on particular systems issues. Teams may be comprised of both Federal and contractor employees	**PeopleSoft;** Other Local Training Data Systems (See data compiled as a request thread in the Cross-cutting Training Forum) **Membership:** Teams working on particular systems issues. Teams may be comprised of both Federal and contractor employees.

Training and Development Management Council Membership

TDMC Membership List including Contractors as of 9/6/00; shaded blocks indicate Executive Committee members

Organization	Positional Membership	Telephone	Internet Address
MA	Director, Management & Administration (David Klaus) **Chair**	202-586-8010	David.Klaus@hq.doe.gov
MA	Office of Training and Human Resource Development (Jerome Butler) **Executive Secretary**	202-426-1506	Jerome.Butler@hq.doe.gov
CI	Director, Administration & Resource Management Division (Laura Brown)	202-586-5524	Laura.Brown@hq.doe.gov
CR	Director, Office of Chief Finanical Officer (James Campbell, Deputy Controller)	202-586-4171	James.Campbell@hq.doe.gov
DP	Deputy Assistant Secretary for Program Support (Jim Landers) & (Anne Khoury, LANL)	202-586-7126	James.Landers@dp.doe.gov
ED	Director, Office of Minority Economic Impact and Diversity (James B. Lewis)	202-586-8383	James.Lewis@hq.doe.gov
EE	Director, Office of Management & Operations (Barbara Mandley)	202-586-5104	barbara.mandley@hq.doe.gov
EI	Director, Office of Resource Management (Steve Durbin)	202-586-3521	SDurbin@eia.goe.gov
EH	Deputy Assistant Secretary for Planning & Administration (Geoffrey Judge)	202-586-9024	Geoffrey.judge@hq.doe.gov
EM	Deputy Assistant Secretary for Management & Evaluation (Barry Clark)	202-586-1665	Barry.Clark@em.doe.gov

Training and Development Management Council Membership

TDMC Membership List including Contractors as of 9/6/00; shaded blocks indicate Executive Committee members

Organization	Positional Membership	Telephone	Internet Address
FE	Deputy Assistant Secretary for Petroleum Reserves (Richard Furiga)	202-586-4410	Richard.Furiga@hq.doe.gov
GC	Deputy Assistant General Counsel for General Law (Susan Beard (Acting)	202-586-8618	Susan.Beard@hq.doe.gov
HG	Deputy Director of Financial Analysis, Office of Financial Analysis (Richard Tedrow)	202-426-1659	Richard.Tedrow@hq.doe.gov
IG	Administrative Officer, Office of Resource Management (Denise Smith)	202-586-1925	Denise.Smith@hq.doe.gov
NE	Associate Director, Office of Management, Planning & Analysis (John Stamos)	301-903-3023	John.Stamos@hq.doe.gov
RW	Director, Office of Acceptance, Transportation and Integration (Jeffery R. Williams)	202-586-9620	Jeff.Williams@rw.doe.gov
SC	Associate Director, Office of Resource Management (John Rodney Clark)	301-903-4944	John.Clark@science.doe.gov
CIO	Chief Information Officer (Ronald Shores)	202-586-0041	Ronald.Shores@hq.gov
SO	Director, Office of Resource Management (Ronald Shores)	202-586-0041	Ronald.Shores@hq.doe.gov

Training and Development Management Council Membership

TDMC Membership List including Contractors as of 9/6/00; shaded blocks indicate Executive Committee members

Organization	Positional Membership	Telephone	Internet Address
WT	Acting Director, Office of Worker and Community Transition (Gary King)	202-586-7550	Gary.King@hq.doe.gov
ALO	Assistant Manager, Office of Management & Administration (Patty Wagner) & (Everett Poore, Mason & Hanger- Pantex/AL)	505-845-6036	pwagner@doeal.gov epoore@pantex.com
BPA	Chief Operating Officer (Steve Hickok)	503-230-5103	sghickok@bpa.gov
CHO	Group Manager, Technical & Administrative Services Group (Dr. Carson L. Nealy)	630-252-2002	carson.nealy@ch.doe.gov
FETC	Associate Director for Administration, Office of Program Support and Site Operations (Norman Howton)	304-285-4229	NHOWTO@FETC.doe.gov
IDO	(Acting TDMC Representative Supervisory Program Manager, Human Resource Division) (Carol Henning)	208-526-8042	HENNINCS@id.doe.gov
NVO	Assistant Manager for Business & Financial Services (David Marks) & (Chuck Meyer, Bechtel, NV)	702-295-3126 702-295-0569	marksd@nv.doe.gov
OAK	Field Chief, Financial Office & Business Management (James S. Hirahara) & (Jim Wells, LLNL)	510-637-1503	james.hirahara@oak.doe.gov 'wells9(a)llnl.gov'

Training and Development Management Council Membership

TDMC Membership List including Contractors as of 9/6/00; shaded blocks indicate Executive Committee members

Organization	Positional Membership	Telephone	Internet Address
ORO	Assistant Manager for Administration (Dan Wilken)	423-576-9603	wilkendh@oro.doe.gov
RFO	Director, OBS Training and Information Management Group (George Cannode)	303-966-3136	george.cannode@rfets.gov
RLO	Deputy Manager for Business Services (Robert Rosselli) & (Pat Gardner, Fluor Daniel/Hanford)	509-376-6880	robert_M_Rosselli@RL.gov
SPRO	Program Manager, Office of the Assistant Project Manager, Technical Assurance (Charles "Chuck" Dobson)	504-734-4274	Charles.Dobson@spr.doe.gov
SRO	Asst. Manager for Business & Logistics (Brent Armstrong) & (Kathy Hatcher, WSRC)	803-725-2933 803-208-2017	brent.armstrong@srs.gov kathy.hatcher@srs.gov
SWPA	Program Manager, Office of Corporate Services (Chief Financial Officer) (George Grisaffe)	918-595-6628	grisaffe@swpa.gov
WAPA	Acting Administrative Officer (Robin Johnson)	720-962-7070	rrjohnsn@wapa.gov

Training and Development Management Council Membership TDMC Membership List including Contractors as of 9/6/00; shaded blocks indicate Executive Committee members			
Organization	**Positional Membership**	**Telephone**	**Internet Address**
Advisors to the Training and Development Management Council			
MA-3	Office of Human Resources Management (Timothy Dirks)	202-586-5610	Tim.Dirks@hq.doe.gov
MA-5	Office of Procurement and Assistance Management (Richard H. Hopf)	202-586-8613	Richard.Hopf@hq.doe.gov
MA-6	Office of Performance Excellence (Edward T. Allard, III)	202-426-1324	Edward.Allard@hq.doe.gov
TRADE	Chairman, Training Resources and Data Exchange Executive Committee (Elizabeth Carroll)		CarrollE@orau.gov

TRAINING AND DEVELOPMENT COORDINATING GROUP MEMBERSHIP

Advisors to the Training and Development Management Council (disbanded but members meet informally)

ORG.	NAME	PHONE#	FAX#	INET#
CHAIR	Butler, Jerome	(202) 426-1506	(202) 426-1480	jerome.butler@hq.doe.gov
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TRAINING AND DEVELOPMENT COORDINATING GROUP MEMBERSHIP

Advisors to the Training and Development Management Council (disbanded but members meet informally)

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EE	Mandley, Barbara	202-586-5104		barbara.mandley@hq.doe.gov
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IG-11	Smith, Denise	(202) 586-1925	(202) 586-7851	denise.smith@hq.doe.gov
NE-10	Coates, Peggy	(301) 903-5559	(301) 903-5745	peggy.coates@hq.doe.gov
NN-10	Harris, Celeste	(202) 586-2464	(202) 586-5433	celeste.harris@hq.doe.gov
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SC-62	Vallette, Myrna	(301) 903-3444	(301) 903-8583	myrna.vallette@science.doe.gov
WT-1	Waters, Brenda	(202) 586-3559	(202) 586-1540	Brenda.Waters@hq.doe.gov

SEPARATION

PAGE

The Deputy Secretary of Energy
Washington, DC 20585
October 2, 2000

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MEMORANDUM FOR JOHN A. GORDON, UNDER SECRETARY
NUCLEAR SECURITY

CAROLYN L. HUNTOON, ASSISTANT SECRETARY FOR
ENVIRONMENTAL MANAGEMENT

DAVID M. MICHAELS, ASSISTANT SECRETARY FOR
ENVIRONMENT, SAFETY AND HEALTH

FROM: T. J. GLAUTHIER

SUBJECT: Establishment of Safety Analysis Software Group

As a part of the action plan in responding to the Defense Nuclear Facilities Safety Board (DNFSB), Technical Report No. 25, "*Quality Assurance for Safety-Related Software at Department of Energy (DOE) Defense Nuclear Facilities*," dated January 20, 2000, the response team, led by the Chief Information Officer, has recommended that an initial team of experts, the Safety Analysis Software Group (SASG), be formed. The SASG would be responsible to analyze data that the Department will be receiving in response to a survey on the safety related codes and software quality which was distributed to DOE Defense Nuclear Facilities recently (survey attached).

More specifically, the SASG would determine what safety analysis and instrumentation and control (I&C) software will need to be fixed or replaced, establish a plan and cost estimate for the remedial work and provide recommendations regarding a permanent mechanism to manage this software in the future. In addition the SASG will coordinate with the Nuclear Regulatory commission on code assessment, as appropriate.

The Under Secretary for Nuclear Security is requested to designate a member of his staff as the SASG Lead and the Assistant Secretaries for EM and EH are asked to designate one SASG member each, staff or contractor, to represent each organization as soon as possible or not later than October 16, 2000. Names of designees should be provided to Brenda Coblentz of the Office of the CIO. Designees should have the authority and ability to assemble the appropriate experts from their respective program and field elements to rapidly complete the analysis and recommendations. The final determination of the SASG membership will be made by the NNSA lead based on the qualification and availability of the recommended experts. The first deliverable that requires the SASG involvement to address some of the DNFSB issues is due by December 15, 2000.

For any questions, please feel free to contact Brenda Coblentz of the CIO's staff on 301-903-4632 or via email at brenda.coblentz@hq.doe.gov.

Attachments

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