U.S. DEPARTMENT OF ENERGY

OFFICE OF ENVIRONMENTAL MANAGEMENT

Guidance Document for Integrating Quality Assurance

During the

Design and Construction Life Cycle

September 2011

FOREWORD

This Department of Energy (DOE) Environmental Management (EM) guidance document is approved for use by all DOE EM organizational units and contractors performing work for EM.

A project's Quality Assurance Program assigns responsibilities and authorities, defines policies and requirements, and provides for the performance and assessment of work that provides confidence that required level of quality is achieved, commensurate with the various project requirements.

This guidance document offers for evaluation, by project personnel from EM and contractor organizations, activities and approaches to be considered as projects establish QA requirements to be used throughout the lifecycle of the project.

The need for this was recognized by the EM Quality Assurance Corporate Board as the membership was questioned regarding gaps in existing program support literature to be used on EM projects.

This guidance document should be considered throughout the lifecycle of project related activity and applied in a manner that fits the specific conditions applicable to the project and is intended to complement other guidance such as that found in DOE G 413.3-2, Quality Assurance Guide for Project Management.

Existence of a guidance document does not mandate its use. However, it is the expectation of senior EM management that this guide should be considered for implementation locally as conditions warrant. This guide details considerations that should be evaluated in establishing Quality Assurance Programs on EM Projects in fulfilling the requirements of 10 CFR 830 and DOE Order 414.1D, Quality Assurance. This guidance does not modify or create any new requirements; instead, it explains how to satisfy existing requirements. As such, no contract requirements are altered by use of the guide.

Within this guidance document, any use of the term "shall" designates requirements contained in 10 CFR 830 or DOE Order 414.1D, Quality Assurance, DOE Order 413.3B, Program and Project Management for the Acquisition of Capital Assets, and "should" designates recommendations to meet EM expectations. Compliance with the standard is achieved by adherence to its requirements and consideration of its recommendations.

ACRONYMS

A/E	Architect/Engineering firm, external entity providing of professional design service support
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ASL	Approved Supplier List
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society of Testing Materials
CD	Critical Decision
CFR	Code of Federal Regulations
CGD	Commercial Grade Dedication
CMTR	Certified Material Test Report
CoC	Certificate of Conformance
CRA	Contractor Readiness Assessment
DOE	US Department of Energy
DSA	Documented Safety Analysis
EFCOG	Energy Facility Contractors Group
EM	Environmental Management
EPC	Engineering, Procuring and Constructing Contractor
FPD	Federal Project Director
HVAC	Heating, Ventilation and Air Conditioning
M&O/I	Managing and Operating/Integrating Contractor
M&TE	Material and Test Equipment
MSA	Management Self-Assessment
NCA-xxxx	Series of ASME Requirements, a subsection to Section III of the Boiler and Pressure Vessel Code
NDE	Nondestructive Examination
NQA-1	Nuclear Quality Assurance-1, ASME's Quality Assurance national consensus code for nuclear activities
O&M	Operating and Maintaining
ORR	Operational Readiness Review
QA	Quality Assurance
QC	Quality Control
QSL	Qualified Supplier List
RT	Radiographic (volumetric) Examination
S/CI	Suspect/Counterfeit Items
SC	Safety Class
SS	Safety Significant
SSC	Systems, Structures and Components
TSR	Technical Safety Requirements
UT	Ultrasonic (volumetric) Examination

1. INTRODUCTION

This document will examine the roles and responsibilities of the Quality Assurance (QA) organization during the life cycle of projects. As a result, this paper will draw closely upon DOE Order 413.3B, *PROGRAM AND PROJECT MANAGEMENT FOR THE ACQUISITION OF CAPITAL ASSETS* and associated guides, since those documents define how DOE manages projects. The capital project "critical decision" defined phases will provide the framework for this guide's discussions regarding the involvement of the QA program and will address considerations that local project teams (DOE and contractors) will use in devising/tailoring their project's Quality Assurance Program throughout the project's life.

It is the intent of this paper to provide guidance to two audiences; DOE project personnel who are planning and overseeing projects within Environmental Management (EM), and contractor personnel who will be responsible for executing project QA activities. Also, the paper will examine the evolution of the QA program as different acquisition strategies (including Engineering, Procuring, Constructing (EPC), Architect/Engineer (A/E), and Management and Operating/Integrating (M&O/I) options) are considered.

This paper will also discuss the concept of an assurance system where quality is expressed as a project value that is shared in by all personnel assigned to the project throughout its life. Noteworthy practices that have been identified during audits and assessments of EM activities will be highlighted where appropriate.

In accordance with the project stages defined in DOE Order 413.3B, the discussions in this paper will generally align as follows:

- CD-0, Approve Mission Need
- CD-1, Approve Alternative Selection and Cost Range
- CD-2, Approve Performance Baseline
- CD-3, Approve Start of Execution; and
- CD-4, Approve Start of Operations or Project Completion

Projects often evolve from ongoing program funded activities where mission needs are understood and possible approaches to meeting those newly identified needs begin their evolutionary development process.

2. ACTIVITIES UNDERWAY SUPPORTING CD-0, APPROVE MISSION NEED

- Conceptual design activities
- Request PED funding
- Justification of mission need document

- Acquisition Strategy
- Pre-conceptual planning
- Mission Need Independent Project Review

General Discussion:

During the CD-0 time frame, EM needs to focus on developing a project quality system that assures early activities are performed in a manner that provides information of sufficient quality to support subsequent tasks. Putting the project QA framework in place at the outset will also institute the type of quality environment necessary for delivering a project that meets all the performance requirements needed to fulfill the mission.

The EM staff managing the early phases of major projects must ensure that the overall quality requirements for the project are communicated to and understood by all organizations and personnel involved with the project. Understanding and communicating expectations that define the quality requirements and goals of the project are a key consideration. Although the final project contractual structure may be nebulous at this early point in the project, the approach to be used for including EM quality expectations into the project should be part of the project execution planning activities. This early planning should include items such as:

- What will be the overall quality program requirements?
- How will EM ensure that these requirements (and any other quality expectations) are communicated to prospective project organizations?
- Is preliminary work to support the project being performed, and is this work subject to EM's quality expectations? (one example might be early phase R&D and pilot/prototype activities needed to support project design activities).
- Are persons familiar with the EM quality systems part of the early phase project planning teams?
- When will certain quality oversight activities be implemented for the project?

In summary, at this early stage of the project when the executing organization may be somewhat unclear in terms of the level of involvement the M&O/I organizations will have (leading or supporting), whether or not A&E specialty contractors will be relied upon for design services, or if the project will be acquired thru the services of an EPC contractor, QA needs should be understood and accounted for either in existing M&O/I contracts or through independently developed A&E/EPC contracts and other related documents that will be defining EM's expectations for the execution of the project. Building an effective quality environment early in the project is essential. As has been noted, projects are evolutionary in nature and the establishment of clear QA requirements and expectations early will ensure reliable data is developed. Establishing appropriate and clearly communicated Quality Assurance requirements

and expectation will ensure the reliability of early efforts later in the project lifecycle, minimizing the need for the project to regress.

The goal of early phase project quality activities is to build an organization that understands EM's quality expectations and communicates to all project personnel that *Quality is bigger than QA***.** Regardless of the acquisition strategy selected, the Federal Project Director (FPD) should be focused on instituting a "project assurance" mentality within the executing organization(s) whereby all project personnel understand that the responsibility for achieving quality resides at the level where work is being performed. Individuals and organizations must be focused on delivering quality products that contribute directly towards mission success (e.g., programs, procedures, calculations, designs, drawings, specifications, plans, etc.).

When acquisition strategies identify the use of A&E/EPC contractors, the FPD will need to assure those contracts fully describe the expectations for Quality Assurance activities under the contract. Assurance requirements will need to fully describe, not only lifecycle QA expectations, but also how EM expects the oversight of early research, development, and design related activities to be performed.

It is not unusual that during this time, process flow sheets are leading to preliminary calculations and design products used to describe early concepts associated with the project (pre-conceptual design documents). The project quality system must ensure that the quality status of such early work is identified to personnel who will subsequently be using this information as sources of design inputs or safety analyses. Concurrently, the FPD needs to understand where his project is headed in terms of new construction or modification of existing facilities, purchase of services, and what safety significant/safety class systems the FPD anticipates being needed. These and other considerations will play heavily on the project's QA requirements as well as the structure of the FPD's assurance team.

The contractor's assurance system must provide for clear definition of interfaces between the varying disciplines involved in design and provide for a process of cross-checking of deliverables at those interface points by the involved organizations. The system needs a strong and independently functioning Quality Assurance organization performing oversight of critical activities such as long lead-time procurements and the design activities producing the specifications for these items. The contractor's assurance system also needs a strong management review process wherein senior leadership of the organization evaluates the performance of their organization and takes effective corrective actions where their oversight identifies deficiencies. The FPD may also decide it is important to establish expectations within the contract requiring the parent corporation to periodically review the work of the local entity and identify weaknesses and initiate improvement.

The efforts included within the CD-0 time frame are largely engineering and design support functions, and the need for a significant QA organization independently overseeing these

activities is to be determined by the FPD. This is a prime example where an assurance system that places responsibility for quality at the point where work is performed adds tremendous value. Introducing quality assurance concepts, even at this early stage of the project, creates a project culture that allows the continued evolution of assurance to proceed and develop as project conditions warrant.

As the project progresses, the activities being performed will transition to those necessary for executing the CD-1 project phase.

3. ACTIVITIES SUPPORTING CD-1, APPROVE ALTERNATIVE SELECTION AND COST RANGE

- Allow expenditure of PED funds for design
- Acquisition Plan
- Conceptual Design Report
- Code of Record
- Preliminary Project Execution Plan and baseline range
- Project Data Sheet for design
- Verification of mission need
- Preliminary Hazard Analysis Report
- Process Related Studies such as Material Balance and Process Flowsheets associated with facility mission

General Discussion

Generally, M&O/I contractors will be supporting EM as directed in developing the pre-conceptual design information as well as other documents that support the decision related processes.

In cases where the acquisition decision defines the M&O/I contractor organization as the executing organization, understanding how that contractor's quality processes will be engaged early needs to be considered. Contractors should examine the applicability of their quality system to any project tasks assigned to their organization.

EM and any project contractors will also need to begin defining the project Code of Record. The Code of Record work should identify those upper-tier design basis documents that will apply to the project. Also, the method for configuration management of the Code of Record as well as products extending from their use, from a project perspective, must be developed.

Specific Considerations:

- Ensure that contract procurement documents include the requirements communicated within the EM Quality Assurance Program (EM-QA-001).
- Where appropriate, incorporate the standard Quality Assurance Clause as communicated via Memorandum of August 21, 2009 into the prime contract responsible for executing the project. (available online at www.em.doe.gov/Pages/QABoard Meetings.aspx#feb2010)
- Cross reference existing M&O/I Quality Programs to the requirements in EM-QA-001 to assure existing program scopes adequately address the projects anticipated needs.
- Begin defining the Code of Record and institute configuration management.
- Verify that project-related research and development work is proceeding under acceptable quality assurance requirements.

4. ACTIVITIES SUPPORTING CD-2, APPROVE PERFORMANCE BASELINE

- Establish baseline budget for construction
- Continue design development
- Request construction funding
- Preliminary design
- Process Related Studies: Material Balance and Process Flowsheet associated with facility mission
- Review of contractor project management system
- Final Project Execution Plan and performance baseline
- Independent cost estimate
- NEPA documentation
- Project Execution Planning (PEP)
- Project Control System Descriptions
- Project Data Sheet for construction
- Draft Preliminary Safety Analysis Report
- Performance Baseline External Independent Design Review reports and other Technical Baseline Documents
- Geotechnical/seismic investigations, studies, and reports
- Optimization/Value Engineering Studies
- Design Reviews
- Modeling/prototyping
- Testing programs (demonstrating technologies or material sufficiency)
- Analytical Laboratory Design Requirements
- Technology Readiness Reviews
- Process Flow Diagrams

Project Related Quality Activities:

The following are activities projects will be engaging as they marshal project documentation in preparation for CD-2.

- Supporting Design processes and review of design deliverables:
    - Develop and implement procedures for reviewing:
        - Specifications
        - Drawings
        - Calculations
        - Design reviews
        - Design interfaces
        - Design changes
    - Provide oversight of configuration management program for control of upper tier design requirements such as design inputs and design criteria
    - Provide oversight of design change control process
    - Assist engineering in developing commercial grade dedication process
- Supporting Procurement Processes:
    - Develop comprehensive quality related procurement subcontract clauses to be flowed to applicable subcontractors, suppliers and vendors addressing:
        - NQA-1 related expectations and requirements
        - Suspect/Counterfeit Item (S/CI) program requirements
        - Commercial Grade/Item Dedication (CGD) requirements
        - Software QA requirements
        - Flow-down of requirements to lower level suppliers
    - Institute grading process for requirements identification and flow-down in subcontracts
    - Define and implement a comprehensive process for qualifying subcontractors, suppliers and other vendors
    - Identify long-lead procurements and ensure the capability to provide required QA/QC oversight is available
    - Develop receiving processes in conjunction with the engineering organization addressing normal receipt inspection activities as well as CGD capabilities and S/CI evaluation processes
- Implement Software Quality Assurance program for applicable design and analysis activities including modeling codes and calculations.
- Develop Quality Control (QC) program plans and procedures
- Develop training and indoctrination plans and procedures for project participants
- Early Procurements: Ensure QA/QC capabilities to oversee those early activities are available (CD-3x requests: project specific as the project employs the approach)

General Discussion

Progress on the project will begin to pick up momentum during the period leading to CD-2. Testing and/or modeling programs are normally nearing completion during the phase which allows process definition to mature. As that maturation process continues, material selections based on process parameters will be made. Drawings and specifications, as well as the calculations supporting those designs, will be underway. Geotechnical investigations will likely be in the field gathering fundamental data to support resolution of soil/structure interactions as well as seismic conditions that will play into the civil/structural design of the building(s) that will house the process. As process definition matures, the ancillary supporting processes and perhaps the facilities where they will be housed will be defined. As stated initially, a tremendous amount of activity will be performed by the technical organizations.

The contractor QA organization will be busy confirming the bases for engineering decisions are well executed as data and calculations are translated into plans, designs, specifications, etc. Particular care needs to be paid to ensure adequate and appropriate QA requirements are defined within those specifications. NQA-1, Part II contains insight within the amplified requirements that the project should consider.

The QA organization must also ensure the contractor QC programs and procedures are appropriate to measure those characteristics that will define the quality of an item being installed. The codes and standards defined by the code of record and referenced in the various design documents will define attributes that must be achieved to assure that Structures, Systems, and Components (SSCs) will perform as expected. Procedure authors must consider all these requirements and devise a set of procedures that ensures data is collected and retained that demonstrates reasonable assurance the SSC will perform as required.

For example, QC inspection procedures must confirm that fit-up requirements defined within Weld Process Specifications (WPS) are accurately used by crafts performing welding of pipe, accurately referenced and used by the QC personnel at all organizations including fabrication related suppliers or field personnel, etc. Another example is drawn from structural steel erection. The American Institute of Steel Construction (AISC) provides a Specification of Structural Joints Using ASTM A325 and A490 Bolts. Therein it discusses acceptable fastening processes for the various kinds of joining operations associated with bolted connections. QC procedures should address specific fastening processes selected by the designer and collect information as necessary to substantiate fastening of the structural components to achieve the design expectations.

Also during this phase, the QA organization must verify that all appropriate organizational interfaces have been defined and understood. In particular, lines of communication and organizational responsibilities for activities specified in project execution plans must be clearly defined in interface documents and understood by the appropriate project personnel. For example, close coordination of procurement and fabrication organizations with design personnel

is required so that QC and QA procedures accurately plan for the collection of the right information that verifies the design intent is actually achieved. The specific responsibilities for design and fabrication activities by all involved organizations, including contractors and EM organizations, should be defined in interface control documents or other project plans, procedures and subcontracts, where applicable. The design authority and design agency functions should be included in these interface definitions.

Specific Considerations:

Early Procurements:

As projects develop, the need for specialty services, such as geotechnical/seismic engineering services and/or soil sampling/testing capabilities to support in-house engineering activities may be identified. Also, it is often appropriate for early CD3x authorities to be granted to address long lead procurements or site development needs. These are business decisions and will be tailored to the particular project based on their needs to move in an orderly fashion to executing the full CD-3 scope.

The FPD and contractor will be working closely to identify those strategies that are appropriate for their particular project. When such authority is granted, special care must be taken to ensure the QA/QC requirements and programs/procedures supporting those scopes are well developed and adequate to assess those early activities. That may require expediting development of these kinds of documents, particularly in the case of EPC managed projects, to ensure the early work is performed in a competent manner. Procedures controlling Supplier Qualification Audits as well as those needed to provide oversight of suppliers/subcontractors must be available when executing early work.

FPDs should have resources associated with the oversight of the contractor's early services subcontracts, as well as any subcontracts related to early CD3x activities, identified, available, and deployable as the authority is conveyed and work moves to execution. Further, the FPD should carefully examine how the contractor is overseeing both in-house and subcontracted work to help identify weaknesses and correct them before full CD-3 construction authorities are granted.

Supplier Qualification:

Experience suggests supplier evaluation/qualification is a very important process and weak processes may allow problem suppliers onto project approved supplier lists (ASLs/QSLs). Both EM and EFCOG have concluded that diverse audit teams, representing QA and technical organizations are best to effectively evaluate supplier capabilities.

EM's experience has shown there are suppliers with effective QA programs predicated on NQA-1, which appear competent based upon initial reviews. However, some suppliers have been ineffective in operating those programs as the work is performed. This forces EM's prime contractor to dedicate additional resources to assure the adequacy of supplier performed work. This experience is primarily in heavy industries engaged in ASME related activities (vessels/piping) and needs to be evaluated based on the scope of the project and market surveys completed by the contractor in ascertaining potential participants in subcontracts.

EM has a collective wealth of experience with numerous suppliers and regularly observes that suppliers are contracted to multiple projects. Contractors should engage other EM/DOE contractors within the complex as these kinds of decisions are being made. The FPD may need to facilitate those discussions.

The project may experience poorly implemented QA programs within some supplier shops. Projects will have to be ready to focus additional resources to assure the quality of the items being fabricated in that supplier's shop meet the project's design expectations. A best practice observed in the EM complex is to assemble teams of QA and select technical personnel that bring the requisite skills to the problem and deploy them to the problem shop to supplement supplier resources and perform additional assurance functions as required. These are often diverse teams involving QC, NDE, welding and QA expertise. Depending on the nature of the engineered equipment being fabricated and observed performance issues, these teams may be deployed for extended periods. EM has observed skills possessed by the NDE and welding engineering personnel are not needed on a daily basis in the supplier shops. They normally rotate thru the supplier's shops as suppliers perform radiographic/ultrasonic examinations (RTs/UTs) or qualify welders.

Welding engineers may need to pay additional attention as suppliers introduce new welding processes into the work or begin welding under different WPS to ensure the supplier's qualified welders possess the appropriate skills for the work. The welding engineers should review the supplier's welder qualification processes to ensure they are adequate.

There have been instances where skill of supplier's NDE interpreters has been less effective than necessary. In these instances, prime contractors have bolstered their Level III interpretation resources and periodically deploy them to perform oversight of this crucial process. The NDE skills, particularly of RT examiners may also rotate thru shops as the work necessitates.

These decisions will be considered in the context of the problems being encountered and the need for compensatory oversight plans to address the unique weaknesses discovered within the supplier's organization.

Software Quality Assurance:

The EM contractor requirements for software quality assurance are defined in Attachment 2 Section 5 and Attachment 5 of DOE Order 414.1D. Guidance on implementing a software quality assurance program that meets EM expectations is provided in DOE Guide 414.1-4. Early establishment of a software quality program is essential to providing confidence in the quality of design results because many design activities are now performed using computer codes and models. Additionally, the proficiency of today's engineers in writing software and developing spreadsheet models virtually ensures that such personally-developed calculation routines will be part of the design process. The quality assurance program must include persons with knowledge of software quality assurance early on and must develop procedures for identifying and controlling software used in design activities, research, or development work that develops design inputs.

Many of EM facilities are reliant on distributive control systems to operate facilities. Computer software used to automate Safety Instrument Systems and Balance of Plant DCS systems require special care. EM observations are that it is crucial to develop clear and concise technical requirements to all procurements, but perhaps the best example is with DCS related equipment and software.

QA Organization and Budgeting:

Special care must be taken when building budgets in support of project oversight by the QA organization. There are times contractors present these costs as Level of Effort (LOE) activities and this approach is routinely viewed as suspicious by those tasked with assuring budgetary requests are reasonable. Contractors should consider directly linking QA/QC activities to specific work activities within resource loaded project schedules. This approach represents a clearly correlating link between the work being overseen and the resource(s) needed to perform its oversight. It is recognized that all oversight, particularly that of other LOE activities in project budgets, isn't practical. In those instances, contractors need to pay careful attention to documenting the scopes included in the LOE and making the clearest possible link to those LOE activities being performed by other organizations. It may best serve the QA Organizations' interests to use the WBS dictionary descriptors as it develops these narratives and expand on the nature of the oversight attributable to discrete WBS entries rather than attempting to generate overarching discussions to justify resource requirements grouped together. The former should result in a clearer case for the resource allocations being requested within the CD-3 budget request.

When allocating risks within the project baseline, the contractor and FPD should work closely together to understand the nature of the work, the nature of the supplier pool likely assisting the project, and evaluate risk appropriately. FPDs observing contractors planning minimal oversight of suppliers should enter discussions with the contractor to understand their basis for this

decision and determine if their approach for identifying project risks is reasonable. FPDs should ensure their contractor is adequately examining the risks associated with subcontractor/supplier performance and, when appropriate, addressing those risks within the project's risk management/mitigation planning.

Commercial Item Dedication:

The project will likely be engaged in the dedication of commercially available items. Requirement 7 of NQA-1 should provide the basis for project programs and procedures involving the dedication process. The project personnel responsible for establishing Commercial Item Dedication requirements/programs should consult a document entitled Guidance for Commercial Grade Dedication, published July 2011 and may be found at: http://www.em.doe.gov/Pages/QACorporateBoard.aspx.

QA will have a role in the dedication activities; however, their responsibilities should be generally limited to performing the tasks associated with item acceptance, as identified by engineering. Therefore, engineering must have the lead in identifying the required dedication activities. QA's participation can, however, be invaluable as assure Critical Characteristics for Acceptance (CCFAs) adequately relate to safety function(s) associated with a SSC, and CGD documents, be they supplier or project originated documents, adequately address the dedication data being communicated.

Commercial Item/Service Dedication must:

- Clearly identify the item/service
- Bound the application
- Research the design to identify the safety functions, the service conditions and the design margin
- Determine the safety significance of the item considering the consequences and likelihood of failure
- Determine the characteristics of the item that are critical to performance of the safety function
- Select acceptance methods, acceptance values and sample plans commensurate with the items significance
- Document approval that the item/service will, with reasonable assurance, perform its safety function
- Fully document the basis for all decisions associated with the dedication of an item or service

QA and Engineering will also have important duties for suppliers performing dedication activities. Validating the effectiveness of dedication actions down in the supplier's supply chain

is essential to understanding how dedicated components get assembled into larger assemblies and eventually accepted for use in the project/facility. Lessons learned by EM projects suggest the lower tier suppliers often don't understand the dedication process or how to implement it with the level of rigor required to adequately demonstrate the item/material/service will perform its intended function. Contractor specifications need to thoroughly address the expectations associated with commercial item/service dedication and establish requirements within prime-subcontracts that the requirement be passed down to subordinate subcontractors.

The contractor must review each dedication plan developed by prime-subcontractors and their subordinates to ensure the lower level dedications are performed effectively and do not introduce unresolved quality issues as the eventual item or service is delivered to the facility. Although the engineering organization will have the lead, QA has a role in supporting the validation of subsupplier dedication activities.

In order that these reviews are performed correctly and consistently, project QA programs must address oversight of supplier dedication activities. Particular care needs to be paid, in plan approval, to supplier's technical evaluations to assure the item or service will perform as intended. Close communication may be required to adequately convey the functional requirements associated with the item or service so those responsible for identifying critical characteristics associated for the item or service are effective. The project may see the need to have review/approval of this process so engineering organizations are assured the communications leading to the identification of those critical characteristics, and eventually the selection of those key characteristics for acceptance by suppliers, will be effective.

Material Verifications:

The project needs to identify, within its procedures, the methods to be employed for verifying materials by both self-performed activities as well as those activities performed by suppliers. The project should identify sources of specialized laboratory support in performing chemical and physical properties testing. QA will need to qualify laboratories in terms of adequate procedures, appropriately qualified personnel, and the adequacy of equipment to perform against the various consensus standards controlling the properties of the material. Similar considerations will be needed by suppliers, depending on the approach to material verification they will use.

EM contractors are widely using Positive Material Identification (PMI) techniques in validating material. Project engineering personnel need to consider the convenience and limitations of the available equipment. Particular care needs to be taken in describing, in project procedures, the expectations regarding verifying certified material test reports (CMTRs) for all materials. Depending on the materials identified within the design, engineering may need to identify additional controls that are needed when examining exotic metals, particularly those low-carbon alloys with chemical makeup beyond the limits of PMI equipment or other alloying materials not measured by PMI equipment. Recognizing its limitations, PMI should NOT be viewed as an

independent analysis of alloying ingredient content. Rather, PMI provides a degree of confidence that the material is accurately represented by the accompanying CMTR; that no mix-up has occurred during procurement and storage. If the chemical and physical properties of the material must be independently tested, or the content of light elements such as carbon and nitrogen must be verified, then a sample should be sent to a qualified laboratory for the appropriate analyses.

The project needs to address, if it selects to utilize PMI in material validation, how it relies on PMI-obtained chemical properties in accepting physical properties (tensile and yield strength, hardness, ductility, etc.) data found on CMTRs and CoCs. ASME Code Case N-483 entitled *Alternative Rules to the Provisions of NCA-3800, Requirements for Purchase of Material Section III, Divisions 1 and 3,* is an instance where that code body has devised a methodical approach to using alternative data to validate vessel material. Engineering must identify the bounds within which PMI can be used and define where it may not.

Inspection and Testing Support:

In general, NQA-1, Part I, Requirement 10 states within 100 Basic "Inspections required to verify conformance of an item or activity to specified requirements or continued acceptability of items in service shall be planned and executed." Identifying those attributes of an item or activity that are essential and are to be documented will require close coordination and identification/agreement of the engineer designing the item or specifying the activity.

The requirements continue by emphasizing "Characteristics subject to inspection and inspection methods shall be specified. Inspection results shall be documented." This is where QA/QC procedures will clearly layout the expectations and preferably the actual requirements associated with the work being executed. At a minimum, the QA/QC procedures must define where inspection requirements or acceptance criteria is found, such as concrete specifications (compressive strength, slump/air content, temperatures, truck revolutions, etc.), Weld Process Specifications [fit-up requirements (gap, land, bevel, preheat, post-weld heat treatment, etc.)], etc. are to be found.

Project QA personnel need to plan for specialized testing services that may be needed to support QA and QC activities. These services may be obtained via staff augmentation or may take the form of specialty subcontracts where services are needed to perform supporting activities like concrete testing, radiographic examinations, material testing, etc.

These services will either be obtained from organizations with existing and effective NQA-1 QA programs or from service suppliers with QA programs finding their basis in some other standard, and dedicated (CGD) by the project. The decision regarding the method the project will use will likely be driven by commercial conditions that will only be known as the procurement is

processed. As a result, it is recommended these services be procured at the appropriate time, such that the services are available when needed to support the work.

The project, if it involves concrete, needs to be mindful of the storage requirements for test specimen that will be generated as construction proceeds. ASTM C31 will normally be the standard that establishes the storage requirements for freshly molded concrete test specimen. It establishes the physical requirements as well as temperature limitations associated with temporary storage of the specimen. Potential difficulties associated with temperature extremes need to be understood and planning effective in assuring cylinders do not exceed the limits established within the standard. Other controlling codes or standards to a project need to be understood and similar considerations recognized and planned to avoid disruptions.

Nondestructive Examination (NDE):

Engineering needs to define the requirements associated with NDE as it pertains to the various materials to be used within the project. In the case of weld examination for process piping systems, ASME B31.3 establishes visual examination as well as other examinations required under the code. In the case of Normal Fluid Service piping, Section 341.4 requires at least 5% of circumferential butt and miter groove welds be examined fully by random radiography. The code goes on to provide some cautionary statements associated with the RT examination frequency. The code body advises:

> *Random or spot examination will not ensure a fabrication product of a prescribed quality level throughout. Items not examined in a lot of piping represented by such examination may contain defects which further examination could disclose. Specifically, if all radiographically disclosable weld defects must be eliminated from a lot of piping, 100% radiographic examination must be specified.*

This advice needs to be considered by engineering as they are determining the NDE requirements for the systems they are designing. If the service of the piping, or other welded components, mandates the potential presence of a weld defect could compromise the integrity of the system and that compromise would result in an unacceptable consequence, then the NDE requirements associated with that work needs to be commensurate.

EM has observed piping that underwent 5% random sampling within the initial inspections, actually contained ~30% defects. Engineering needs to be mindful of this potential as it establishes NDE requirements for piping, vessels and similar components.

EM’s experience has shown instances where 100% radiographic examination of piping or vessel components is appropriate. In instances where components are destined for areas of the facility that, due to design considerations, repairs are impossible or otherwise inconceivable, (e.g., embedded within concrete structures) an increased radiographic examination is warranted. These

considerations will not only affect QA inspection plans but also will affect specifications of procured engineered equipment destined for these areas. Fabricated components (i.e., spool pieces) performed via subcontract agreements will also be included.

Another consideration engineering needs to define as it prepares its specifications is how piping "lots" will be managed within the context of the NDE examination processes. ASME B31.3 states:

> *A designated lot is that quantity of piping to be considered in applying the requirements for examination in this Code. The quantity or extent of a designated lot should be established by agreement between the contracting parties before the start of work. More than one kind of designated lot may be established for different kinds of piping work.*

It may be in the project's interest to manage piping lots around those components shipped concurrently. This allows for a simplistic approach to the transfer of QA supporting document that may benefit the project. By defining shipped quantities as lots where possible, all QA records, including radiographic or other NDE examination records, may accompany the shipment, making records management more simple. This approach may be particularly helpful when subcontracting for large quantities of spool pieces or other similar fabricated items with NDE associated with the item's production. Similarly, defining lots for internally produced spool pieces will make NDE, particularly when predicated on sampling approaches, more manageable and defensible as reviews of QA documents take place.

Although it is recommended specifications establish lot designations, it is not imperative. As advised by ASME, there needs to be agreement between the parties before the start of work. Since the lot designation process has the potential to effect the amount of NDE performed as the items are fabricated, it is recommended that subcontract documents clearly establish the expectations so that suppliers may appropriately plan and bid the work.

Lastly, Engineering needs to define those processes, acceptable under the various codes that are deemed acceptable processes to be used on the project. For example, ASME allows volumetric examination using ultrasonic (UT) as well as radiographic (RT) processes. Engineering needs to evaluate the pros and cons as they define the project NDE requirements. There are instances where geometry limitations restrict RT. There are other instances where interferences restrict UT. When Phased Array UT is contemplated, the limitations and difficulties associated with the approach need to be understood and planned. Digital RT also involves considerations that need to be understood and planned by the project. These processes need to be considered and any project specific expectations addressed within specifications for engineered equipment or other items fabricated by suppliers.

Measuring and Test Equipment:

The project will need material and test equipment (M&TE) in validating the work performed. Planning must also address the calibration capabilities that will support the confirmatory process associated with M&TE. Understanding the design associated with the various SSCs found within the project will aid in understanding the nature of the M&TE inventory needed to support the project. Ensuring these items are available when needed is essential to ensure work is not delayed.

Qualifying QC personnel:

ASME NQA-1 Requirement 10 establishes “Inspection for acceptance shall be performed by qualified persons other than those who performed or directly supervised the work being inspected.” Accordingly, testing procedures must require that QA/QC personnel divorce themselves from the performance of work in order to maintain their independence and objectivity when performing their duties. QA/QC programs and procedures must establish minimum qualifications for personnel performing tests and inspections and should likely reference the recommended practices found within the ASNT SNT-TC-1A. SNT-TC-1A provides guidance concerning the qualification of personnel performing the various NDE testing methods typically relied on by EM projects and operating facilities. Contractor qualification processes are to conform to the contract requirements concerning QA, but at a minimum should be relying on processes described in SNT-TC-1A.

Note to FPDs:

NQA-1, Requirement 2 identifies an expectation that NDE, Inspection and Testing personnel will be qualified. In communicating this expectation and while preparing prime contract QA requirements, it is suggested that consideration be given to elevating the “recommended practices” found within American Society for Nondestructive Testing, Inc.’s (ASNT) SNT-TC-1A and convey the qualification process as the minimum requirement for qualifying QA/QC personnel. The SNT-TC-1A requirements associated with Written Practices (Ref. Chapter 2) should also be required within the contract. The FPD should convey the expectation that these requirements be flowed into appropriate subcontracts where applicable work is to be performed, including, but not limited to, any procurement for engineered equipment or other items where fabrication activities requiring NDE to validate the acceptable nature of the work is to be performed. Although other qualification and training processes are potentially acceptable and capable of ensuring testing personnel are appropriately capable, ASNT processes are widely recognized as a competent method for qualifying NDE personnel.

EM personnel:

The FPD will continue assembling his integrated project team (IPT) adding different talents as the project moves from design to construction. During CD-2, the IPT will be reviewing contractor originated programs, plans and procedures that will define the QA program and activities used throughout the duration of the project. These reviews will be focused on adequacy to provide the required oversight of the project. Planning for the availability of personnel with the skill sets required within the scope is necessary as the FPD puts together the oversight team. In scopes where considerable welding of piping systems and vessels are included, it is recommended the FPD obtain the services of personnel with experience in the appropriate ASME codes. It is also recommended, since many EM projects have considerable civil/structural features, that personnel experienced in the American Concrete Institute (ACI) and American Institute of Steel Construction (AISC) be integrated into the staff. Electrical, HVAC, instrument and controls, and radiological controls are skills that will be needed to support final design and installation.

The FPD will need to understand how to obtain these resources and plan accordingly. Often time, these skills may not exist within DOE employees and will have to be obtained thru contract support instruments. As the FPD develops the budget for the DOE related costs associated with the project, the planning needs to not only provide for the employment related costs associated with these resources, but for the travel and perhaps equipment and other supplies required to support oversight of contractor and supplier quality processes.

The Quality Assurance program developed during the CD-2 phase will then be implemented across a wide range of activities during the CD-3 project phase.

5. ACTIVITIES SUPPORTING CD-3, APPROVE START OF EXECUTION:

- Approve expenditure of funds for Construction
- Update Project Execution Plan and performance baseline
- Final design and procurement packages
- Verification of mission need
- Budget and congressional authorization and appropriation enacted
- PDSA is updated
- Execution Readiness Independent Review
- Operations Assessment (HAZOPS Review)
- Operations Requirements Document
- Site Layout Drawings
- Construction, Procurement, and Acceptance Testing Planning
- Procurement System
    - Qualifying suppliers of SS/SC SSCs and other critical procurements

    - Supplier oversight
    - NDE/QC presence when appropriate
    - Acceptance of supplier delivered items
    - CGD oversight of supplier and subsupplier organizations
    - Receipt Inspection Plans
- Construction Work Packages
- QA/QC programs
    - Audits and assessments
    - Acceptance Testing Program of Constructed SSCs
    - NDE/Destructive testing
    - Inspection in the field/supplier shops
    - Accepting work
    - Record generation and retention
    - Inspection Guides/Plans
- S/CI
- CGD
- SQA
- Start-Up/Commissioning Plans
- System Operational Tests/Integrated System Operational Tests

General Discussion

The Quality Assurance organization is entering the project period during which it will be processing numerous quality related activities concurrently. The organization will have to be staffed and organized in order to meet the challenges. The work will not only be at the project site, but will likely begin to accelerate in supplier shops as engineered equipment and other items are being fabricated for the project.

At this point in the project, the QA organization's procedures must be mature and ready to support construction. An important part of supporting the project involves remaining cognizant of those activities being performed as well as those upcoming. The schedule is an important tool in remaining aware, but involvement in the construction organization's internal meetings is also needed. Plan of the Day meetings and the like should be attended so emerging events are understood and planning for effective and timely oversight may be accomplished.

Generally, Civil/Structural activities will be the early focus although other discipline activities may be underway depending on the project's use of early construction authorities. Receipt inspection activities, as raw commodities are delivered, will be numerous. Inspection plans that cover installation, as well as the receipt of materials, need to be available as these activities occur. If the execution strategy is to utilize M&O/I contractors to deliver the project, the QA/QC procedures, Receipt Inspection Plans, etc. will likely be already developed. If the execution

strategy is to use an EPC contractor, these plans may not exist immediately prior to the inspection activity. Regardless, inspection procedures need to thoroughly document the quality requirements identified by design that are essential to the performance of the item and capture the details to be documented as the item is inspected.

Specific Considerations

Appropriately qualified personnel must perform inspections.

The QA staffing level will be influenced by several decisions by the Contractor. One model in use today places responsibility for the achievement of quality with the work crews and assigned Field Engineers. The FEs provide crucial guidance to the crafts in understanding the design, and FEs also help communications (interface) with Engineering, QA and other organizations. If the contractor elects to not assign sufficient FE resources, then QA and QC personnel, may fill the vacuum. As management seeks to maintain adequate resources on the project needs to be mindful that QA/QC must maintain its independence from the execution of work and take action when the interactions between QA/QC and other personnel begins to encroach on that independence. The same point may be made for Field Welding Engineers.

ASNT SNT-TC-1A provides guidance concerning the qualification of personnel performing the various NDE testing methods typically relied on by EM projects. SNT-TC-1A conveys methodological approach that is widely recognized to meet the qualification expectations NQA-1 expresses within Requirement 2. This document should provide the basis for prime contractor, subordinate subcontractor, and supplier qualification programs. QA personnel assigned to oversee supplier operations will be reviewing the qualifications of personnel performing various inspections within those shops. It is imperative that the suppliers' qualification processes effectively demonstrate the abilities of the NDE personnel and other inspectors, as well as the welders when necessary, within the scope of work assigned. Equally important are the inspection procedures, written practices, etc. these personnel will be using as they perform inspections. Weld Process Specifications (WPS) will communicate both the fit-up requirements to the welder and the same information becomes acceptance criteria for the QC personnel as they inspect that work. The inspector will utilize written practices in defining the steps to be used while performing those inspections. Written practices are particularly important to nondestructive examiners (NDE) personnel. Whether the examination uses dye penetrant testing, ultrasonic tests, radiographic tests, etc., those practices are of critical importance. The written practice must faithfully implement the applicable standard controlling the work and be followed closely by the NDE personnel. Prime contractor surveillance of supplier performed inspections should regularly focus on the adherence of the inspection to the written practice covering it.

Quality Assurance and Quality Control (QA/QC) personnel must be thoroughly familiar with all the provisions of the documents that describe the work, including submittals and other documents pertinent to the work (design changes, requests for information, etc.). The inspections

are to be directly relatable to plans and specifications, including all revisions, changes, and amendments.

Records:

The Quality Assurance organization of the prime contractor and suppliers' organizations will generate numerous records that provide documentary evidence that items or activities meet specified quality requirements. These records will fall into two broad categories:

- Lifetime records: Those records that meet one or more of the following criteria:
    - Would be of significant value in demonstrating capability for safe operations,
    - Would be of significant value in maintaining, reworking, repairing, replacing or modifying an item,
    - Would be of significant value in determining the cause of an accident or malfunction of an item.
    - Provides baseline data for in-service inspections

Lifetime records are required to be maintained for the life of the particular item while it is installed in the plant or stored for future use.

- Nonpermanent Records:
    - Those records required to show evidence that an activity was performed in accordance with the applicable requirements but need not be retained for the life of the item because they do not meet the criteria for lifetime records.

Nonpermanent records shall be maintained for the retention period identified by project procedures or as identified in applicable national code or standard.

Part II of NQA-1 contains additional guidance on the records normally required. NQA-1 integrates national consensus code requirements associated with record retention into the record retention requirements. Part II subparts typically end with a Records Section that requires:

> *Record copies of procedures, reports, required qualification records, test equipment calibration records, test deviation or exception records, and inspection, examination, and check records shall be prepared. These records shall be retained with other project records as required by code, standard, specification, or project procedures.*

Additional records requirements may be defined in design codes or standards specified in the project Code of Record. ASME B31.3, *Process Piping*, for example, is a code typically used in EM projects. Chapter VI entitled Inspection, Examination, and Testing establishes the requirements associated with the QA/QC activities for Process Piping. Section 346 specifically discusses the minimum records required under the code and should provide the basis for the

project's determinations associated with lifetime and nonpermanent records. As the design work proceeds, the project may decide other tests are required to confirm the acceptability of the component to perform the design intent. Records associated with those additional tests will be generated and retained as indicated by project procedures. These additional records will be additive to those identified by the national code or consensus standard upon which the design is predicated since the code or standard identifies those minimum tests required.

Other codes will similarly be used as the record determinations are made, acceptance criteria are identified, testing and inspection activities are developed and performed, and QA documents are prepared and accepted into the project's document control system. Procured items require special care when reviewing deliverables that accompany the item. Quality documentation will be retained by the project, some are lifetime while others are not. Radiographic film requires extraordinary care. Project design and QA personnel will need to ensure procurement requirements associated with vessel weld radiographs are addressed in a manner consistent with project's QA and records-retention needs. Many projects identify vessel RTs as Life-Time Records under one or more of the criteria associated with its definition. The code is requiring the fabricator retain RT films. The project may decide to require vessel fabricators (and perhaps others) to prepare double cassettes when radiographing welds. This will allow the fabricator to remain compliant with the code requirements and the project to possess a lifetime record of the vessel installed in the facility.

As preparation for operation begins, the quality assurance organization must transition its activities and staff to support an operating facility.

6. ACTIVITIES SUPPORTING CD-4, APPROVE START OF OPERATIONS OR PROJECT COMPLETION

The tasks that involve quality assurance include:

- DSA
- TSRs
- Cold Commissioning Process Verification Report
- Design Capacity Performance Tests
- Off-standard Operational Testing
- Cold Commissioning Results
- Certification of Completion of Cold Commissioning
- Final Documented Safety Analyses
- Readiness for Hot Operations
- Hot Commissioning Start
- Environment Performance Test
- Hot Commissioning Results

- Documents Attesting to Completion of Hot Commissioning
- Project Closure Package
- Facility Turnover
- As-built drawings
- Document close-out
- Start-up Plan

General Discussion

There are several tasks within CD-4 (Approval of Start of Operations and Project Completion) that the Contractor quality assurance organization completes or supports to assist the project. These activities generally verify that processes for preparation, review, approval, issuance, use and revision of documents that prescribe processes, requirements, and design are implemented (including change control for revision) to ensure that actions are planned and carried out by qualified personnel using approved procedures, instructions, and equipment under administrative, technical, and environmental controls.

Also, the quality organization must verify that design processes are implemented which provide appropriate control of design inputs, outputs, verification, configuration and design changes, and technical and administrative interfaces. These processes include configuration management activities pertaining to operations and maintenance and transition of the design authority role to cognizant individuals within the operating facility organization.

Specific Considerations

The following discussion provides insight into specific items needed within the general tasks mentioned above.

Checkout, Testing, and Commissioning Plan

QA should review all associated documents and records to assure that processes for preparation, review, approval, issuance, use, and revision of the plan are implemented and that the plan addresses the QA requirements of the operating organization. This should include inspection and acceptance testing to assure that performance expectations, acceptance criteria, inspections and tests, and calibration of M&TE are adequately addressed. Some of the documents that QA should be monitoring may include: Test instructions (TI), Grooming Packages (or other packages that may be used locally to establish prerequisites for system testing), Test procedures, Test Deficiency reports, Test Directives and Procedure Change Requests. QA/QC personnel should remain engaged as other organizations conclude testing to assure tested systems are restored appropriately as the testing program concludes.

Allow start of operations or project close-out including document closeout

As construction work is completed, the work control documents are reviewed for closeout. If the construction was performed by a subcontractor with responsibility for the cold/hot testing, then the work control document closeout may be a subcontractor responsibility with final acceptance by the Contractor as vendor data. Alternately, if the construction was performed by the Contractor, then the Contractor would be responsible to review and close the work control documents. In either case, QA should review the documents ensuring the necessary signatures, dates and inspection reports were completed. In addition, QA should review any nonconformances or deficiency reports related to the work control document ensuring those reports were closed. If there is a transition between construction work control and operations work control processes, the QA organization should be engaged in this transition and turnover process to assure QA requirements for documentation and work control are effective. This includes verification that processes for preparation, review, approval, issuance, use and revision of documents that prescribe processes, requirements, and design are implemented (including change control for revision) to assure that actions are planned and carried out by qualified personnel, using approved procedures, instructions, and equipment under administrative, technical, and environmental controls. QA will verify that design processes, which provide appropriate control of design inputs and outputs, verification, configuration and design changes, and technical and administrative interfaces, are implemented.

Operational Readiness Review and acceptance report

QA is an integral part of testing and commissioning. The QA tasks include test plans and procedure reviews ensuring adequate acceptance criteria are cited, verifications during the testing phase that acceptance criteria are met, and review of the test reports for completeness. Testing would include the design capacity tests, hot and cold commissioning tests, environmental performance test, component tests, and integration tests. As part of the testing process, QA would complete surveillances of testing operations ensuring procedure compliance. QA also is responsible for the quality control and inspection activities that support the testing and commissioning activities. This includes completing and validating inspection reports, pressure tests, and other hold points as called out in design and work control documents.

There is also a need for QA to assure that processes are in place to identify, control, and correct items, services, and processes. If the processes do not meet established requirements, then corrective actions are developed and implemented to preclude recurrence.

It is also critical for QA to review work control and work documentation to assure that the planned scope of work demonstrates that work prerequisites have been satisfied, personnel have been suitably trained and qualified, and detailed implementing documents and management controls are available and approved.

Project transition to operations plan/report

QA is responsible to assist operations and construction organizations in preparation and implementation of processes that assure quality management approaches are established and implemented for preparation, review, approval, issuance, use, and revision of the transition plans.

Final Documented Safety Analyses

During the final Documented Safety Analysis preparation, QA reviews the QA chapter to ensure the information is up-to-date. During subsequent operating procedure reviews, QA determines if the appropriate QA requirements are included in the procedures and helps assure that processes for preparation, review, approval, issuance, use, and revision of the DSA and TSR documents are implemented to assure that applicable design inputs are controlled and configuration management requirements are met.

As-Built Drawings

QA may provide several services during the as-built drawing phase including, some field verification of the drawings, review and approval of the final drawings, and confirmation that the drawings have been properly reviewed, approved, and placed in document control. Another QA activity is the verification that a key or essential drawing list has been established for operations and that those drawings have been as-built and released for use. The as-built process is part of the overall facility turnover activity.

Facility Turnover

When the facility is ready for turnover or partial turnover, a punch list of items is normally generated between the constructor and the facility owner. Those punch list items are remaining work that either must be done before the constructor leaves or items the owner agrees to finish. Many times the QA organization helps develop and verify the punch list items. As a minimum, QA ensures there is a defined process for the turnover process including the use of punch lists. The facility owner may decide to use a corrective action system to track the punch list items. In which case, QA will have to factor those action items from the corrective action system into the close out verification before operations start.

O&M Manuals

The facility owner will have to ensure that all the needed O&M Manuals are obtained from the constructor. Those manuals should have been transmitted via a vendor data system during construction turnover. However, a review of the vendor data system by the appropriate system engineers is necessary to ensure all needed vendor data, including the O&M Manuals are present.

Management Self-Assessment

During management self-assessments (MSA) the project determines their readiness for an independent review, usually an ORR. QA evaluates the existing QA program at the project level to determine adequacy for operations. QA also reviews QA training records to ensure required QA pre-operational training is completed. If the QA staff supporting operations must complete some operations-related training (i.e., DSA training) this verification would include evaluating completion of that training. In addition, a review of open nonconformance and deficiency reports is completed and a list provided to project management. Project management then determines the priority of open issues as either pre-start or post-start issues. QA provides support to the project during MSA, ORR, CRA, etc. preparation and performance. The QA support during MSA, ORR, and other internal or external reviews is to assist with the preparation of objective evidence files, providing status on nonconformance and/or deficiency reports, verification that the as-built drawings and other operational documents are approved and released, and close-out of construction work control documents.

Oversight Plan

Another QA task during CD-4 is preparation of an oversight plan or strategy for the upcoming operations phase of the project. QA may periodically complete surveillance on various operations to verify procedure compliance and identify opportunities for improvement. The schedule or strategy is coordinated with the operations staff to ensure the surveillances focus on important operational activities.

Final Project Closeout Report

QA is also tasked with helping assure that project has established, implemented, and documented processes to detect and prevent quality problems and that problems have been corrected and documented.

7. CLOSING THOUGHTS

As communicated within the body of this guide, establishing a comprehensive QA program appropriate for the project scope requires considerable investment in understanding the work to be performed by all parties involved. There is no “model” that may be applied to individual projects that shortens this process.

This guide would be remiss if it weren’t to reference the vast number of tools for EM projects to consider as projects are managed, and particularly as those projects’ QA Programs are developed. These tools include the Standard Review Plan Modules, which are available on the EM Website (http://www.em.doe.gov/Pages/qualityassurance.aspx). DOE personnel should consider the content of these modules when considering what particular requirements and

expectations are being developed. The lines of inquiry should point out to contractors what elements need to be addressed within quality programs and procedures.