Process for Evaluating QA Staffing Needs

Purpose of Guidance:

This guidance is describes the process that should be used to quantify the federal resources necessary to develop, implement, and maintain a comprehensive QA oversight program at a nuclear facility. When adapted to specific projects, the method described in this guidance can be used to develop estimates of the federal QA staffing needed for the project. This staffing may be included in multiple organizations and not specific only to the QA office. The process itself can also be useful as a tool for defining the scopes of work that will require oversight, and for identifying some of the special skill sets that the oversight staff will require.

Background:

This guidance is a result of a joint team investigation into QA resource loadings and resource requirements at Department of Energy Office of Environmental Management (DOE-EM) projects. DOE-EM has experienced problems with quality of items and services at many projects. These problems have added significant cost to the projects and caused delays in project completion and operation. Lack of quality oversight has appeared as a common thread from many investigations into these quality problems. In response, DOE-EM has been examining potential causes for weaknesses in the quality oversight function. One of the identified weaknesses has been a lack of resource loading for Quality Assurance (QA) staff assigned to verify achievement of quality within the projects by line organizations.

As part of the effort to rectify weaknesses in the quality oversight functions, the Office of Standards and Quality Assurance (EM-43 now EM-3.113) within DOE-EM in conjunction with staff from the DOE Chief of Nuclear Safety (CNS), has been examining the Quality Assurance resource loading issue at DOE-EM projects. The joint EM-43 (now EM-3.113)/CNS team compared QA resources available at DOE-EM projects to QA resources at similar types of projects in the nuclear power industry, examined typical QA work scope requirements for DOE-EM projects versus analogous requirements at nuclear power industry facilities, and compared the organizational structures and management systems affecting quality oversight activities. In addition, the following analysis considered some historical efforts to characterize a method for determining QA resource loading needs. In the report, *The Manpower Requirements for Quality Assurance During Various Phases of a Nuclear Power Project,* J.E. Vessely, Florida Power & Light Company, 1981, an emphasis was made that the various phases of the project have a direct impact on the number of QA and QC staff needed. As such, the quality staff numbers should peak at the same time the craft employee numbers peak. Further, this report emphasizes quality personnel must be actively engaged during planning for and decommissioning of a nuclear plant. The general rule of thumb adopted in this report is that the QA function should be represented as 0.6-0.8% of the total project budget and the combined QA/QC function should be represented as 1.5-2.0% of the total project budget. A separate report from the International Atomic Energy Agency, *Manpower Development for Nuclear Power: A Guidebook,* Technical Reports Series No. 200, International Atomic Energy Agency, Vienna, 1980, was also reviewed as part of this

effort. This report noted that the QC staff should be approximately 10% of the total project staff and the QA staff should be 1% of the total project staff for a nuclear power plant. These two references provide a general starting estimate to compare quality staffing levels with during the following analysis. However, it is important to emphasize that the current phase of work will have a large impact on the overall QA and QA requirements, and these numbers are a general rule of thumb that must be adapted to the existing plant situations.

The team also conducted closed interviews to determine how staff within the various organizations interacted with the QA organizations and how staff perceived the value of QA on the project. In numerous discussions the team was told that the availability of existing staff at facilities has driven decisions as to what oversight activities will be performed, and the frequency of those activities. This approach inevitably results in holes in oversight coverage of essential functions, driving the oversight effort into reactive mode, to investigate events rather than prevent failures. Projects in this mode are vulnerable to a regular stream of new problems. One of the necessary actions to avoid this reactive-mode quality situation requires appropriate oversight staffing, preferably early in a project.

General Factors for Consideration and Overall Process:

The determination of appropriate oversight staffing requires consideration of many variables. The first step in staff planning is to understand the scope of the project or activity- What is to be accomplished and what requirements must be satisfied by the end product?

For the acquisition of a new facility, staffing should be developed and adjusted to follow the normal progression of the project through the Engineering, Procurement, and Construction (EPC) phases. Each phase of the project presents the need for unique skills. The needed skill mix will change as the project progresses through the EPC phases. Adding complexity to the staffing equation is the fact that the EPC phases often overlap, particularly in “close-coupled” projects when design continues to iterate after procurement and construction have commenced. One typically unaccounted for cost in the closely-coupled design/procure/build strategy employed at DOE-EM nuclear projects is the substantial increase in required oversight activities, and particularly QA activities, needed to verify that these coincident processes are interfacing properly. This usually requires a higher frequency of implementation audits and task surveillances than would be required for a project constructing a nearly complete design. Also, the relative maturity of the processes to be employed in the project should be considered. New chemical processes or construction techniques may require additional, highly specialized oversight staff and oversight activities to produce design inputs that would not normally be considered in a more mature technology environment.

Planning for oversight of new work at existing facilities also requires consideration of the existing workload. The knowledge, skills and abilities of existing oversight staff, and their availability to take on additional responsibilities, are key factors in determining the staffing level necessary to oversee the new work.

Quantitative determination of staffing needs requires detailed job analysis of current and future oversight responsibilities. The job analysis should be based upon the activities included in the

project scope of work; these are typically defined by the life-cycle stage of the project (e.g., planning, design, construction, commissioning, operation, decommissioning). The amount of work to be performed in each of these work activities will be an important contributor to the estimate of oversight resources needed. The relative risk to safety or project success for each work activity should also be considered when identifying oversight resources. In addition, a graded approach may be appropriate based on factors such as the hazard categorization and relative risk of the project. However, any graded approach should be clearly documented including any assumptions to demonstrate the process used.

Based upon the amount of work and the risk to the project, each defined oversight responsibility is assigned a resource requirement load, typically in units of Full Time Equivalent (FTE). Results of the job analysis, when presented in a spreadsheet, provide a powerful tool to QA managers for estimating their staffing level needed for comprehensive QA oversight. For existing projects, the FTE values provided by the analysis can identify potential oversight gaps when compared to the current staffing complement assigned to those activities. With potential oversight gaps identified, projects with limited resources can prioritize assignment of resources to fill those gaps deemed to significantly contribute to project risk.

Attached is an example spreadsheet depicting a job analysis for a new project, including existing work activities. The list of project work activities, the FTE values assigned to the work activities, and the necessary skills shown in the example were based on interviews with existing staff, expectations of management, evaluation of the project schedule, data derived from the commercial sector, and expert judgment regarding the amount of time necessary to perform individual QA oversight tasks. When developing the spreadsheet, additional worksheets for follow-on years should be prepared to show changes over time, because the skill mix changes as the project progresses to completion.

<u>Estimating the QA Resources:</u>

Scope of work-

Determine the work scope and organizational responsibilities. The first step is to interview senior managers, federal project directors, and other internal clients to determine their needs for oversight of the federal office and contractors.

- Key questions:
    - Is the workload steady-state, or are new programs and projects on the horizon?
    - Is the site or its contractors experiencing problems, indicating need for additional oversight?
    - What are the regulatory drivers for oversight?
    - What roadblocks are there to sharing the oversight workload between organizations such as QA, Facility Representatives, Engineering, Operations, and Safety? Can these roadblocks be resolved?
    - What conditions exist that may increase project risk for quality problems? These might include immature technologies, long-lead procurements being performed before designs are finalized, uncertainty in some design inputs such as seismic

requirements, organizations working on the project that do not have a history of nuclear work, and expected procurement and fabrication of complex or novel components.

Analyzing the existing workload and capability-

After the scope is determined, perform job analysis of the existing oversight organization, or the to-be-established organization, to the level that enables assignment of 0.05 FTE values. For example, consider auditing:

- Team Lead = 3 weeks@40 hours= 120 hours per audit, times 12 audits per year/1900 hours, = 0.75 FTE
- Auditor= 2 weeks@40 hours= 80 hours per audit per auditor, times 12 audits per year/1900 hours, = 0.5 FTE, multiplied by the average number of auditors on each audit

The maintenance of the QA Program also needs to be counted in the staffing estimates. Activities such as personnel training and qualification, review and revision of implementing procedures, issues management, and other administrative duties consume considerable, yet often hidden, resources. The best source of information on the program maintenance workload is the existing QA organization and its management. See the accompanying example spreadsheet for additional types of program maintenance activities.

During this stage of the analysis, the capabilities of existing staff should also be determined and compared to the existing and future oversight needs. Shortfalls in skill mix should be targeted for resolution. Also to be considered are the actual oversight work time available for any given staff member. For example, although 1900 hours are used in the above calculations to represent an FTE, the average annual time available to perform oversight activities for any given person may be significantly lower.

Preparing for new work-

For the acquisition of a new facility, staffing should be developed and adjusted to follow the normal progression of the project through the Engineering, Procurement, and Construction (EPC) phases. Each phase of the project presents the need for unique skills. The needed skill mix will change as the project progresses through the EPC phases. Adding complexity to the staffing equation is the fact that the EPC phases often overlap, particularly in “close coupled” projects when design iteration continues after procurement and construction have commenced. Some useful tools in evaluating these factors may include the contract, as well as the DOE and contractor risk registries.

The relative maturity of the processes to be employed in the project should also be considered. New chemical processes or construction techniques may require additional, highly specialized staff for oversight of design, procurement, fabrication, and installation. Here are some general guidelines for estimating oversight staffing for new projects:

- Engineering-
    - At least 1 FTE to lead the client design reviews at 30/60/90%

    - Additional 0.5 FTE for assistance in the engineering disciplines.
    - Safety specialists as needed to support DSA/SAR reviews.
    - Duration is entirely dependent on the project and its schedule.
- Procurement of major system-
    - Review procurement documents for proper flowdown of requirements
    - Determine those procurements which may be most critical in terms of value, complexity, new technology, and long lead times with no schedule float, and observe pre/post award meetings with suppliers, and perform surveillance at supplier facilities.
        - Rule of thumb for supplier visits is 1 work week per visit.
        - Keep in mind that appropriate skills and experience are necessary for oversight of manufacturing processes. Consider candidates with fabrication, welding, and nondestructive testing experience for mechanical systems, and working knowledge of the National Electric Code for electrical equipment.
    - The workload for procurement oversight will peak quickly at the early stages of the project, and may be of short duration. Advance planning is essential in order to have the necessary resources available to deploy in the short procurement window. Contracting for staff augmentation should be considered for short term peaks, particularly to staff the vendor surveillances.
    - QA oversight presence for the duration of the contract is frequently required for major procurements under NQA-1 and may require appropriate staff.
- Construction and Testing- dependent on project complexity, FTE estimates are for the duration of the activity -
    - Periodic surveillance of the work control process = 0.1 FTE
    - Continuous field presence during soils and concrete activities = 1.0 FTE
    - Surveillance of welding/NDE for piping systems = 0.2 FTE
    - Surveillance of Code-required mechanical system hydro/leak tests = 0.2 FTE
    - Surveillance of control systems software installation, testing and configuration management = 0.2 FTE
    - Focused oversight of installation of critical procured items = 1.0 FTE
- Readiness, Commissioning, and Operations will also require QA oversight activities especially at turnover points and during development of safety management programs.
    - Oversight and support for readiness and commissioning activities = 1 FTE
    - Operations QA support will need to be determined based on the size of the project and the relative hazards and risk involved = 1.0+ FTE

As noted previously, some of these staffing levels may require substantially more support depending on the specifics of the project. For example, welding/NDE may require up to 1.0 FTE or more if there is a substantial amount of piping involved as has been the case on some EM projects. This should be considered when completing the staffing level analysis for the site. The attached example spreadsheet includes a listing of typical oversight work activities, but this list is by no means to be considered complete for any given project. Each organization must examine

the projects for which it has oversight responsibility. The spreadsheet workbooks for organizations with multiple projects requiring oversight will likely contain multiple sheets, each sheet summarizing the needs of a specific project. Finally, the QA resource load analysis is not static but will require occasional re-evaluation. As projects move forward or additional tasks become apparent, the work activities requiring oversight change, necessitating updates to the staffing load and the required oversight skill set.

Assumptions

Several assumptions were necessary in estimating the workloads depicted on the accompanying spreadsheets. These assumptions are idealistic and are not intended to represent the actual state of any DOE-EM projects. In projects where quality is an issue and these assumptions are not valid, appropriate corrections and increases in the quality staffing levels should be implemented. The assumptions include:

- The organization is not experiencing significant program problems
- The new work involves mature technologies
- The new work is progressing without problems
- Contractors and suppliers are experienced in nuclear-grade work
- "Close-coupling" of the EPC phases is managed smartly (not allowing procurement or construction to get too far ahead of final approved design, as an example)
- Make or Buy decisions are appropriate. (If the EPC contractor decides to keep work in-house for which it is not experienced, this will require additional oversight vs. sub-contracting it to an experienced firm. Software is prime example.)

Users are encouraged to similarly record their assumptions during development of their own staffing analyses. The assumptions are helpful in maintaining a clear thought process and are also invaluable when considering "what if" scenarios, such as when problems are detected on the horizon. In addition, estimates are improved over time and actual and planned values should be captured to refine estimates with site specific data.

DOE OFFICE QA RESPONSIBILITIES		Notes
	FTE	This sheet depicts steady-state "hotel loads" for DOE Office QA organization
Audits	1.2	Baselined from FY14 = 29 audits X 80 hours / 1900 = 1.2 FTE
Surveillances	1.1	Baselined from FY14 = 42 surveillances X 25 hours / 1900= 0.6 FTE, + .5 FTE to increase on-site surveillances
Supporting/responding to external audits	0.1	
QA Program Maintenance	0.4	Includes maintenance and revision of QA Program documents and internal QA procedures
Improvement Initiatives	0.1	Employee surveys and developing improvements from survey results, etc.
CAMS administration/oversight	0.3	CAMS= Corrective Action Management System, for managing DOE office-identified issues and corrective actions.
Procedure/correspondence review	0.5	Review of all DOE Office procedure revisions, review/approval of documents, and QA-related correspondence
Software QA	0.5	
QAD training and certification	0.2	includes ESH refresher and career enhancement opportunities
QAD provide training	0.1	
Admin/Coord/Planning/Support	0.3	
COR	0.1	
Contract review	0.2	includes input to RFPs, review proposals, and SEB
Total	5.1	

Assumptions:

The hotel loads are those functions necessary to maintain the DOE Office QA program and its implementation

DOE and contractor QA programs are in control; no major issues

No new programs or projects. If new work is expected, see the other sheets in this workbook.

	A	B	C	D	E	F	G
1	**DOE OFFICE QA RESPONSIBILITIES**						Notes
2			Current	New	FTE		*This worksheet depicts staffing analysis for an existing DOE QA office that is adding a new facility. See other sheets in this workbook for steady-state QA workload*
3							
4	Audits		X		1.2		Baselined from FY14 = 29 audits X 80 hours / 1900 = 1.2 FTE
5	Surveillances		X	X	1.1		Baselined from FY14 = 42 surveillances X 25 hours / 1900= 0.6 FTE, + .5 FTE to increase on-site surveillances
6	Supporting/responding to external audits		X		0.1		
7	Event Corrective Action Follow-up			X	1		100's of corrective actions from Event 1 and 2; +1 FTE through 2016 for follow-up/closure
8	Review new SAR			X	0.2		
9	QA Program Maintenance		X		0.2		Includes maintenance and revision of QA Program documents and internal QA procedures
10	Improvement Initiatives			X	0.2		Employee surveys and developing improvements from survey results, etc.
11	CAMS administration/oversight			X	0.5		CAMS= Corrective Action Management System, a new system for managing issues and corrective actions.
12	Procedure/correspondence review		X		0.5		Review of all DOE Office procedure revisions, review/approval of documents, and QA-related correspondence
13	Software QA			X	0.75		new SQA expertise needed for System A and to oversee contractor SQA
14	QAD training and certification			X	0.2		includes RAD II w/respirator for Staff, and COR/STA quals for Manager
15	QAD provide training			X	0.2		22 new hires projected, and upgrading/maintaining QA training for existing staff
16	Admin/Coord/Planning/Support		X		1		
17	COR			X	0.1		
18	Contract review			X	0.1		includes input to RFPs, review proposals, and SEB
19	Design Review			X	0.5		
20	Oversight of vendor qualification audits and Shop Inspection			X	0.6		Need *NOW t* o support System A Procurement schedule
21	Construction Inspection			X	0.7		Need March 2015 to oversee System A installation then retain for System B project, later
22				Total	9.15		
23							
24	Other needs:						
25	Develop or hire Root Cause Analysis capability within federal staff						
26							

Construction Project QA Oversight Analysis

Typical Activities Needing DOE QA Oversight	Disciplines: Structural	Mechan	Elec	HVAC	I&C	Nuc/NS	Chem	NDT/E	Current Oversight? X = yes	Recommended Oversight? frequency or X=yes	FTE load estimate	Range estimate variance	Notes/Comments
Cross-Cutting Activities													The FTE load assumes project is not experiencing problems
QAP Program Audit (18 NQA-1 Req)									3 yr cycle	annual cycle	0.75	0.25	
Corrective Action Follow-up									X	continuous	0.25	0.25	
High Priority Issue resolution									X	continuous	1	1	may be zero if no high priority issues
Review of Contract Deliverables									X	continuous	0.05	0.05	
M&TE oversight									X	X	0.05	0.05	
										Cross-cutting Subtotal	2.1	1.6	
Design													
High-Level Design Requirements									X	X	0.05	0.05	
Engineering/Design									X	X	1	0.25	
DSA (includes system walkdowns)									?	X	0.4	0.2	
										Design Subtotal	1.45	0.5	
Procurement													Procurement oversight assumes DOE QA people are not placed at
Procurement Engineering									X	X	0.05	0.05	supplier shops
Supplier Selection									X	X	0.05	0.05	
Supplier Qualification									X	X	0.05	0.05	
Acceptance NQA													
Vendor Documentation									X	X	0.05	0.05	
Receipt Inspection									X	X	0.05	0.05	
Warehousing									X	X	0.05	0.05	
Acceptance-CGD									X	X	0.5	0.5	
complex or novel item CGD									X	X	0.5	0.5	
Supplier Oversight (trips)									X	X	0.5	0.5	
										Procurement Subtotal	1.8	1.8	
Construction													construction values are only for QA personnel surveillances/audits
Field Engineering									?	X	0.1	0.1	oversight activities by fac reps and technical staff not included
Work Planning									?	X	0.1	0.1	
Civil													
Site Preparation									?		0		this assumes analysis is done for an existing construction project
Surveying									?		0		these early phase civil activities will not be zero
Support Infrastructure									?		0		for new projects
Excavation									?		0		
Embedments and penetrations									?	X	0.05	0.05	
Anchorages and supports									?	X	0.05	0.05	
Structural Steel									?	X	0.05	0.05	
SSC/Equipment Installation													
HVAC									?	X	0.1	0.05	
Mechanical									?	X	0.05	0.05	
Electrical									?	X	0.05	0.05	
I & C									?	X	0.05	0.05	
Fire Protection									?	X	0.1	0.05	
Post-Installation Inspections/Prelim Tests									?	X	0.05	0.05	
Finish Construction (trim work)											0		
Work surveillance/QC									?	X	0.05	0.05	
Construction/Pre-op Maintenance									?	X	0.05	0.05	
										Construction subtotal	0.85	0.75	
Software													Software assumes only one safety grade control system
Control Systems													Software does not include software CGD oversight
Supplier Oversight									X	X	0.2	0.1	
Integration and Testing										X	0.5	0.25	
Configuration Management										X	0.2	0.1	
Design and Analytical Tools									X	X	0.05	0.05	
Admin Support									X	X	0.05	0.05	
											1	0.55	
Work Package Closure										X	0.5	0.1	
Const Turnover to Startup										X	0.5	0.1	
Startup Turnover to Operations										X	0.5	0.1	
											1.5	0.3	
Commissioning													
Startup and Testing Procedures									?	X	0.2	0.1	Commissioning activities will phase in as project progresses
System and Equipment testing									?	X	1	0.2	
Clearance of Temp Mods									?	X	0.1	0.05	
Permit/License Compliance									?	X	0.1	0.05	
Training									?	X	0.1	0.05	
Qualification									?	X	0.1	0.05	
Readiness Activities									?	X	0.2	0.1	
											1.8	0.6	
Operations QA													
Core QA Program includes oversight of:										X	0	0	assumes none during construction phase

operations
maintenance
engineering
health/safety such as rad control
procurement
SMP Development

these will need estimating as project progresses