HOW CAN THE UNITED STATES IMPROVE THE QUALITY OF NUCLEAR ACTIVITIES AND OPERATIONS AND DECREASE QA REQUIREMENTS AND COST SIMULTANEOUSLY?

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ABSTRACT

The purpose of this paper is to present some options for developing cost-effective QA programs that will really focus on improving work quality while reducing costs. The paper provides a narrative background on the evolution of QA in the nuclear industry from the early stages to the regulatory emphasis of today. The current focus of compliance-based QA for equipment identified as "safety-related" based on a "Q" list or reliability list is extremely costly. A cost-effective solution is offered which will provide flexibility in developing and applying "QA" programs. A risk based approach to QA is discussed, and an example chart is provided for this purpose. The risk model applies fault-tree analysis approaches to determination of risk. An attempt to quantify risk in mathematical terms is provided in this paper. Some of the factors that are considered in this approach are: Health and Safety, Environmental, Mission, Political, and Regulatory. A couple of examples will be provided to demonstrate how this concept works.

BACKGROUND AND INTRODUCTION

The United States is fortunate to be blessed with an abundance of many things; from food, minerals, and water, to crime, media pervasiveness, and over-regulation leading to a country with more lawyers per capita than anywhere on earth. The over abundance of regulators and lawyers has permeated every industry from food production, toy production to waste management. It was not long ago that if one was involved in "waste management" people would smirk because they knew that waste management was a nice way of saying garbage collection. The term "sanitary engineer" was a code name for sewerage management. However, waste management is now "in". It's o.k. to be involved with waste management; sanitary engineering is respectable and nuclear waste management is important. However, one thing remains constant, the public still remains scared of contents of nuclear "garbage" and feels the need to be protected. Hence the regulators have moved in to fill the void, and protect the public from the menace of nuclear waste. Of course recent headlines of DOE's coming clean on irradiating 400 - 800 unknowing, ordinary individuals is not helping matters any. We can only look forward to more regulations and more lawsuits, and more stringent environmental protection as well as stringent QA requirements. In order to stop the myriad of new regulations that could be extremely costly to implement, we need to adopt a new approach; one that is more rational, and focuses on prevention of problems based on risk. Therefore, the objective of this paper is to present some of these innovative approaches to increase the quality of nuclear waste management activities and reduce the QA requirements and cost simultaneously.

HOW WE GOT TO THIS POINT

Formal quality assurance programs and requirements have been evolving since the late 1960's. Prior to this time Quality was something inherent to the craftsman, factory worker, and the neighborhood grocer. Most workers had a sense of pride, as well as being well trained in a particular trade to produce the quality expected by the customer. However, with the eventual push of production over quality, and schedule pressures, as well as decline of work force apprenticeship programs, the quality of goods and services have declined as well. Serious problems emerged such as steam pressure vessels exploding and killing people, as well as refinery explosions, metal fatigue corrosion and cracking in aircraft and ships, and failure of motors and pumps in various industries. The government therefore stepped in and mandated that certain Quality standards be developed and used. The defense industry issued the infamous MIL-Q-9858, MIL-STD-105D, etc. The nuclear weapons production-facilities worked to QC-1 and the nuclear industry promulgated 10CFR50 Appendix B. 10CFR50 identifies 18 criteria which constitutes a Quality Assurance Program. The criteria are:

- I. Organization
- II. Quality Assurance Program
- III. Design Control
- IV. Procurement Document Control
- V. Instruction Procedures and Drawings
- VI. Document Control
- VII. Control of Purchased Items and Services
- VIII. Identification and Control of Items
- IX. Control of Processes
- X. Inspection
- XI. Test Control
- XII. Control of Measuring and Test Equipment
- XIII. Handling, Storage, and Shipping
- XIV. Inspection, Test, and Operating Status
- XV. Control of Nonconforming Items
- XVI. Corrective Action
- XVII. Quality Assurance Records
- XVIII. Audits

These 18 criteria have been the cornerstone of QA requirements in the nuclear industry since 1974. However, the interpretation of these regulations has been the real problem. Hence the standard ANSI N45.2 series emerged to provide guidance to the nuclear industry. However, the guidance was interpreted differently by the Nuclear Regulatory Commission, the utilities, suppliers/ manufacturers, Architect-Engineers, constructors, and operators. The NRC had used liberal interpretation of 10CFR50 Appendix "B" for enforcement actions sometimes referred to as "ratcheting" and levied fines, stop work, and threats of license revocation, or lack of license issuance. Consequently the nuclear industry defended itself through aggressive QA/QC programs and oversight. Aggressive *enforcement* of compliance to QA program/procedures requirements has been the industry practice. QC inspectors and QA auditors had the power to stop work and halt any nonconforming activities they judged to be non-compliant with requirements. However, in some cases, it was the procedure requirement that was the problem and not the activity or item. Both the NRC and the nuclear industry were guilty of promulgating QA requirements for QA's sake without sufficient regard for the item or activity. If an item or activity was on a "Q" list or identified as "safety-related" a full QA program was applied along with all the compliance and documentation aspects. Many smaller suppliers and specialty manufactures were forced out of the nuclear business due to the cost of doing business in this regulated environment.

Meanwhile the Department of Energy, and NRC were formed as separate agencies from the Atomic Energy Commission, and the DOE was exempted from oversight by the Nuclear Regulatory Commission. Consequently many DOE activities were conducted without compliance to the rigid standards of the commercial nuclear industry due to their important military mission and "secret" operations. Their activities continued until exposure by the media of dangerous radioactive releases, environmental pollution of air and water and a myriad of other problems. DOE Order 5700.6B was issued in 1986 and provided guidance that ANSI/ASME NQA-1 was the preferred standard for use in all DOE Nuclear facilities with the exception of weapons production and Naval Reactors. Over time DOE had progressed to the exact situation where the commercial nuclear industry was back in the 1970's; i.e. rote compliance to procedures, lack of focus of QA program with regards to the nuclear activities, and lack of management buy in. This has resulted in large costs for regulatory and QA staff, lack of improved activities, and lots of money spent on rewriting programs to continuously changing requirements.

HOW DO WE FIX THIS MESS?

First we need to understand and quantify this problem. We have a chance to do this in nuclear waste management activities and operations. We should only adopt the best practices and industry standards of the nuclear industry and not duplicate the mistakes. The biggest problem facing the nuclear waste management industry is the definition of what is nuclear waste. Is the definition that nuclear waste is all waste containing any radioactive elements? Is it high level nuclear waste from spent nuclear fuel or plutonium production? Unfortunately in today's environment any waste that contains any amount of radioactive elements is considered nuclear waste. Therefore, 10CFR50 Appendix B applies to NRC regulated activities, and DOE Order 5700.6C/NQA-1 applies to activities performed by the Department of Energy. Within the medical community, nuclear medical wastes are covered either by state compact regulatory bodies or by the NRC. The solution for assuring that the requisite quality is applied to specific activities is in defining the risk elements. Once the risk elements are defined, analytical tools such as performing fault tree analysis inherent in PRA's should be used to provide a scientific approach to quantification of the risk. Items and activities identified on a "Q" list or reliability list must be re-evaluated. Should the entire component be treated as safety-related and therefore be subject to QA controls, or can we find the true, critical subcomponents and parts that pose the greatest risk?

RISK MODEL APPROACH TO QA

In order to provide a solution, I have identified a risk model with some unconventional areas of risk, and assigned a numerical weighting application to identify true risk. Let's look at a practical application of the risk formula.

First let's define risk. Risk is the quantitative and/or qualitative expression of loss or harm associated with an activity, considering both the consequences of failure and the probability of occurrence. Risk based QA is consistent with the concept that line management has the responsibility for quality because line management is in the best position to determine risk and be responsible for risk management.

When designing a QA program based on risk the following factors and consequences of failure must be considered:

- Health and Safety-General Public and Workers
- Environmental Management
- Economics
- Regulatory Impacts
- Political Influences

The greater the risk factors, the higher the level of Quality Assurance applied to the activities. Therefore, the graded approach to QA is tied to the elements of risk. The application of risk evaluation is similar to assignment of safety class. It requires development of some standard methodology procedure that can be easily applied, as well as a scoring mechanism for risk.

The risk-based approach evaluates the categories of risk and identifies possible consequences in each category based on worst case scenarios in each category. A QA level is assigned based on composite numerical risk factor. An example is:

1. RISK MANAGEMENT FACTOR > 25 - Apply full QA program that is comprehensive and stringent
2. RISK FACTOR 15 - 25 - Graded QA factors
3. RISK FACTOR 5 - 15 - Limited reviews, independent reviews
4. RISK FACTOR < 5 - Good management practice

The QA Level versus the risk consideration is provided in Fig. 1:

PRACTICAL APPLICATIONS

The QA levels are based on QA grading factors such as QA program (plans), procedures, staffing-qualifications, inspections, audits, evaluations/assessments, records management, item identification, document control, etc.

When grading, the following should be considered:

- Providing less rigid compliance requirements-provide options for performing activities.
- Provide for well-established management principles when training personnel.
- Have less reliance on inspections than on worker performance.
- Provide for self-assessment programs and trend analysis information.
- Apply proactive approaches and techniques.

A QA scoring system should be developed to identify QA approach and risk factors

QA Level	Factor: Public Safety	Worker Safety	Environment Impacts	Cost/Schedule Impacts	Political Impacts
I.	Death or severe injury	Death or severe injury	Catastrophic impact	Severe cost implication	Major
II.	Injury or illness	Minor injury or illness	Contained impact	Major	Impact
III.	Long-term, not immediately noticeable	Routine cautions	Minor	Minor $ or schedule delay	Impact
IV.	None	None	Minor	Minor	Low

Fig. 1. QA grading and levels to correspond with risk.

An example Risk-Tree Analysis is provided for your thoughts. (See Fig. 2)

Now let's take 2 practical examples and apply risk based techniques to determine the appropriate QA program.

Example 1: There is possible soil contamination around a nuclear facility. In order to develop a graded QA program for analysis of the surrounding area, let's apply a risk based approach and develop a table.

Example 2: A canister containing vitrified high level radioactive waste is to be transported from area "A" to area "B". What are the required QA controls? Develop a table.

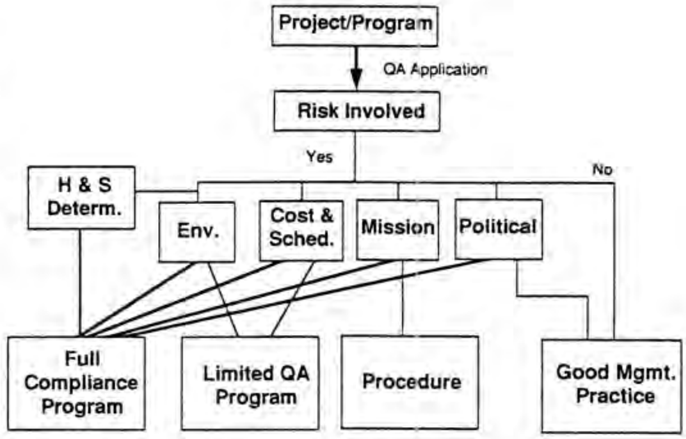

Fig. 2. Risk tree analysis.

A typical table would look like Table I.

Now that we have gone through two examples of this approach, we can see that risk-based QA approach provides a more scientific methodology to QA program development, and should provide a mechanism that allows for buy-in by Management and Technical staff.

TABLE I
Risk Weighting Factors

RISK		Weighting Factors: Health and Safety	Enironmental	Mission	Regulatory	Political
Public Safety	5.0	5.0	4.0	3.0	2.0	1.0
Worker Safety		25	20	15	10	15
Toxic Release	4.0	20	16	12	8	4
Noise/Aesthetics						
Minor Release	3.0	15	12	9	6	3
Mission Delay	3.0					
Cost Input	2.0	10	8	6	4	2
Political Input	1.0	5	4	3	2	1