Applying Lessons Learned From Nuclear Power Quality Assurance Experience To DOE's Nuclear Waste Repository Program

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1.0 INTRODUCTION

There has been over 30 years of quality assurance experience in the nuclear power industry. With that experience has come a number of mistakes and problems along with the many technological advances and successes. It is probably no exaggeration to say that billions of dollars have been wasted in the nuclear power industry due to quality problems. We who are responsible for the nuclear waste disposal program must not make the same mistakes and suffer the same problems that have plagued the nuclear power industry. From studying past experiences in the nuclear power area we can learn many lessons. The purpose of this paper is to examine these nuclear power plant quality assurance experiences, or "lessons", to see which might be applied to DOE's nuclear waste repository program.

This paper draws heavily on the excellent report prepared by the Nuclear Regulatory Commission, "Improving Quality and the Assurance of Quality in the Design and Construction of Nuclear Power Plants," NUREG-1055, by W. Altman, T. Ankrum, and W. Brach. This report was prepared at the request of Congress to determine the underlying causes of major quality-related problems in the construction of some nuclear power plants.

This paper examines the similarities and differences between the nuclear power industry and DOE's nuclear waste disposal program, and then examines 13 problems from power plant construction experience with the purpose of looking for "lessons learned" to apply to DOE's program. These 13 problems, which are taken from the "Project Management Shortcomings" Section of NUREG-1055, are:

(1) inadequate staffing for the project, in numbers, in qualifications, and in applicable nuclear experience

(2) selection of contractors who may have been used successfully in building fossil plants but who had very limited applicable nuclear construction experience

(3) over-reliance on these same contractors in managing the project and evaluating its status and progress

(4) use of contracts that emphasized cost and schedule to the detriment of quality

(5) lack of management commitment to and understanding of how to achieve quality

(6) lack of management support for the quality program

(7) oversight of the project from corporate headquarters with only a minimal utility presence at the construction site

(8) lack of appreciation of ASME codes and other nuclear-related standards

(9) diffusion of project responsibility and diluted project accountability

(10) failure to delegate authority commensurate with responsibility

(11) misunderstanding of the NRC, its practices, its authority, and its role in nuclear safety

(12) tendency to view NRC requirements as performance goals, not lower thresholds of performance

(13) inability to recognize that recurring problems in the quality of construction were merely symptoms of much deeper, underlying programmatic deficiencies in the project, including project management.

2.0 SIMILARITIES BETWEEN NUCLEAR POWER INDUSTRY AND DOE'S WASTE DISPOSAL PROGRAM

There are many similarities between DOE's nuclear waste disposal program today and the nuclear power industry in earlier days. In this paper we first examine these similarities between the early-day nuclear power industry and DOE's current nuclear waste disposal program in order to emphasize the point that many of the lessons learned from quality assurance mistakes made by the nuclear power industry do have application to us.

There are four general areas in which striking similarities exist between DOE's nuclear waste disposal program and the early-day nuclear power industry: (1) A "new" regulated undertaking, (2) evolving technical standards and procedures, (3) evolving regulatory criteria, and (4) public awareness and concern. Each of these four areas of similarity are examined in further detail below.

2.1 A "New" Regulated Undertaking

When the commercial nuclear power industry first begun to flourish, expectations were high that dependable, reliable nuclear power plants could be built quickly and economically. This, in general, was not the case. There are many reasons why costs and schedules increased, but part of the answer was that this was a new and highly technical industry with which we had little experience. Quality problems did come to light during the construction and many of the problems could be blamed on the newness of the industry and the "learn while you build" phenomenon.

Thus, we can conclude that DOE's nuclear waste disposal program is "new", that many of the lessons learned by the nuclear power industry because of the "newness" of their technology are also applicable to us.

2.2 Evolving Technical Standards

The early nuclear power industry was faced with a problem of needing accepted standards for performing special construction activities, yet at the same time developing the very technologies for which standards were needed. Welding of pipes and components for the primary coolant system, for example, was almost state-of-the-art and required the development of new testing and inspection procedures along with the development of new welding procedures.

In areas like this where concensus standards for performing highly technical work do not exist, they must be developed. But work performed in the interim is especially susceptible to quality assurance problems.

We in DOE's unclear waste disposal program note that this is an area of similarity for us in that we too may need to develop technical standards at the very same time that the technology is needed.

2.3 Evolving Regulatory Criteria

There have also been examples in the nuclear power industry of evolving regulatory criteria. Sometimes changes in regulatory requirements have caused components that had already been fabricated to now become unacceptable to the regulators.

Because of the newness of nuclear waste disposal technologies, and the sparcity of branch technical position papers and NUREGS for waste disposal, we feel this is an area of special concern for DOE.

Mistakes were made in some areas of the nuclear power industry in their perception of NRC's role and NRC's authority. We in DOE note that the situation of evolving regulatory criteria in the quality assurance area that caused problems for the early nuclear power industry is also a potential problem for us as well. We must, therefore, pay special attention to this area.

2.4 Public Awareness and Concern

The nuclear power industry came under close public scrutiny and was a primary object of interest to several special interest groups. This attention brought with it an opportunity for the nuclear power industry to make some mistakes, and it did so. The public and special interest groups felt they had a right to know about the quality of the work at nuclear power plants. The knowledge, tenacity, and influence that the public and these special interest groups was underestimated by some.

Anyone familiar with DOE's nuclear waste disposal program knows about the level of public awareness. It is safe to say that the public, affected States and Indian Tribes, and special interest groups will play an even larger role and exert even more influence on our program than ever was done in the nuclear power industry.

3.0 DIFFERENCES BETWEEN NUCLEAR POWER INDUSTRY AND DOE's WASTE DISPOSAL PROGRAM

While there are a number of similarities between DOE's nuclear waste disposal program and the nuclear power industry, there are also a number of significant differences. Because of these differences not all of the lessons learned from the nuclear power industry quality assurance experience will have direct applicability to the DOE program. Below we discuss some of the key differences between the DOE nuclear waste disposal program and the nuclear power industry, with an emphasis on those aspects that are so clearly

different that the mistakes made by the nuclear power industry and the lessons learned there simply have little or no application to DOE's nuclear waste disposal program.

3.1 Repository Hardware Less Complex

One of the major differences between a nuclear waste repository and a nuclear power plant is that the repository is much less complex in design, construction. The design of the repository surface facilities, for example, although having some unique features, will have no nuclear reactor to control, will have no primary coolant system, and will have no state-of-the-art design, fabrication, or construction requirements. The underground facilities will draw on existing mining experience and, likewise, is expected to be far simpler than a nuclear reactor to design and construct.

Because of the simpler nature of a repository, some of the problems that arise during the design and construction of a nuclear power plant will be far less likely to occur. The number of personnel involved in the design, and in assuring the quality of the design, for example, can probably be fewer than for a nuclear power reactor.

3.2 Experienced Licensing Personnel Available

At some periods during the licensing of nuclear power plants, especially during the growth years, there were shortages of personnel in the licensing area who were experienced with the requirements of developing a licensed facility. In particular, personnel were not as familiar with or dedicated to the need for quality assurance and were unaware of the significant role of quality assurance in licensing a regulated facility.

At this time, however, there are a large number of personnel experienced in licensing. Some of these are working in the nuclear power industry, some at NRC, and some have been employed by and are now helping DOE in its nuclear waste repository program.

The challenge for DOE in this area will be to be able to attract and hire into government work the personnel experienced in the licensing process.

3.3 Role of NRC Well Understood

The nuclear power industry may, on occasion, have not properly understood, appreciated, and respected NRC's role as regulator. They may have felt that NRC would always side with them, or that they could easily win NRC over to thinking their way. And some mistakes affecting quality may have been made because of this misunderstanding.

We feel DOE today does properly understand and respect NRC's role as regulator of the nuclear waste disposal facilities. We have a perspective today that the nuclear power industry years ago may have lacked.

3.4 Nuclear Waste Policy Act

Another major difference between the nuclear power industry and the nuclear waste repository program is that DOE has the Nuclear Waste Policy Act. Congress has mandated the process for siting and constructing nuclear waste repositories, and has spelled out the roles that DOE and NRC are to play in this process. Having this legislation clarifies many of the questions early about who does what, and when. The nuclear power industry did not have such clear and detailed guidance.

The Nuclear Waste Policy Act also gives specific roles to affected States and Tribes and spells out many of the procedures for interactions between DOE, the States and Tribes, and the public. Having the roles and procedures that apply to all the involved parties clearly defined by the highest authority in our country should help avoid some of the misunderstandings that have plagued the nuclear power industry.

4.0 APPLICATION OF SPECIFIC LESSONS LEARNED

The remainder of this paper is devoted to the examination of the 13 problems discovered by NRC's review of nuclear power plant construction experience. These 13 problems were taken from Section 3.2.2 of NUREG-1055, "Improving Quality and the Assurance of Quality in the Design and Construction of Nuclear Power Plants."

Each of the 13 problems are examined to see what lessons might be learned and how these might be applied to DOE's nuclear waste repository program. Each problem is also viewed with the perspective set forth in Sections 2 and 3 of this paper, e.g., is the applicability of the lesson learned affected by the similarities or differences between the nuclear power industry and the nuclear waste repository program.

4.1 Inadequate Staffing

The first problem reported in Section 3.2.2 of NUREG-1055 is "inadequate staffing for the project, in numbers, in qualifications, and in applicable nuclear experience." The lesson to be learned here is that the applicant must have a sufficient number of staff, and that they must have the necessary qualifications and experience.

This lesson is certainly applicable to DOE's nuclear waste repository program. In the event we didn't have a staff sufficient (in numbers, qualification, and experience) to properly manage the repository program, DOE could end up, as some utilities did, without the capability to effectively manage, control, and assure the quality of the nuclear waste repository program. The table below shows the size of the total staff in DOE's three first-repository project offices one year ago, now, and the projected peak number needed during site characterization.

	One Year Ago	Current Level	Projected Need
Basalt Waste Isolation Project	28	36	54
Salt Repository Project Office	33	36	73
Waste Management Project Office	17	25	44

NOTE: The numbers needed by DOE for the management of the actual repository construction have not been finalized.

DOE is committed to the acquisition of qualified, experienced personnel in numbers sufficient to manage the repository program.

There are, however, certain potential problems for DOE in this area deserving our attention. First, recruitment into government positions is often a tedious and time consuming process and is often hindered by the lower salaries that can be government service offers. Secondly, personnel to manage and oversee the conduct of experiments and gathering/management of data will be more important for our program than for nuclear power plants. Thirdly, DOE will have a greater need in certain specialized areas, such as geology, hydrology, and mine engineering.

To avoid the same problem, then, that the nuclear power industry had, DOE must continue to aggressively recruit qualified, experienced personnel in sufficient numbers to preclude also having "inadequate staffing" to manage the nuclear waste repository program.

4.2 Inexperienced Contractors

The second problem reported in Section 3.2.2 of NUREG-1055 is "selection of contractors who may have been used successfully in building fossil plants but who had very limited applicable nuclear construction experience." The lesson to be learned here is that experience is needed, both in building something like that which you need to build now and experience with NRC's stringent quality assurance requirements.

For DOE there are two challenges in this area that merit special attention. First, a primary qualification of the contractors hired to design and construct the facilities is to have past design and construction experience for similar facilities. The second is that DOE contractors selected for these tasks should either have on their staffs or should make arrangements to hire personnel experienced both in the nuclear reactor licensing process and in establishing a nuclear quality assurance program that includes an extensive training program for personnel to familiarize them with the unique quality assurance requirements for the nuclear waste disposal program.

4.3 Contractor Management of Program

The third problem reported in Section 3.2.2 of NUREG-1055 is "over-reliance on these same contractors in managing the project and evaluating its status and progress." The lesson here is that the license applicant must aggressively manage and control the project and must have in place the necessary management information systems so that quality problems can be detected and corrected in a timely fashion.

For DOE's nuclear waste repository program there are six essential elements to assuring that problems of this type do not arise;

(1) DOE personnel must commit to the task of providing strong, aggressive management of the repository projects and never relegate this to a contractor.

(2) DOE must exercise the necessary management controls over the day-to-day operations and the major contractors should report to and take direction from DOE, not another contractor.

(3) DOE should review and approve the QA plans and implementing procedures of all major contractors and not delegate this responsibility to other contractors.

(4) DOE should review and approve plans for all major testing activities, repository design concepts, and all major publications by contractors.

(5) DOE must conduct its own aggressive audit and surveillance program to evaluate each major contractor's QA program and to assure that quality problems are being promptly detected and corrected.

(6) DOE must have and retain Stop Work authority for all major contractors that do work affecting the quality of the nuclear waste repository.

The above steps will help DOE to avoid making the mistake made by some utilities of over-reliance on contractors to manage their project.

4.4 Contracts Emphasizing Cost and Schedule

The fourth problem reported in Section 3.2.2 of NUREG-1055 is the "Use of contracts that emphasized cost and schedule to the detriment of quality." The lesson here is that cost and schedule requirements, while an important part of any contract, should not be incorporated into a contract in such a manner that the contractor will be rewarded for meeting cost and schedule objectives at the sacrifice of quality.

DOE is certainly not immune to this type of problem. Managers everywhere are, very properly, concerned about cost and schedule and these considerations all too often do dominate the terms of a contract. DOE can take three steps to help avoid this problem.

First, for all work affecting quality, requirements should be specified in the contract and given equal emphasis with cost and schedule. Contractors should not be rewarded for poor quality work that was completed within cost and on schedule. Secondly, all work that affects the health and safety of the public or is important to waste isolation should be placed in the highest quality category, and contracts covering such work should specify the quality assurance requirements. Thirdly, DOE managers and staff must foster an attitude in contractors that emphasizes the achievement of quality. QA training for DOE and contractor staffs should reflect the DOE's serious commitment to the achievement of quality.

4.5 Lack of Management Commitment

The fifth problem reported in Section 3.2.2 of NUREG-1055 was the "lack of management commitment to and understanding of how to achieve quality." The lesson is that management must know what quality is, must know how to achieve it, and must have a serious commitment to achieving quality.

DOE management must express and demonstrate a commitment to quality verbally, in program document, and in actions.

The challenge for DOE in the future in this area is to foster an attitude in workers of pride in the quality of their work, to base rewards to workers on the achievement of quality in their work, and to foster the feeling in workers that they are members of a successful team doing an important job in a quality manner.

4.6 Lack of Management Support

The sixth problem reported in Section 3.2.2 of NUREG-1055 was the "lack of management support for the quality program." The lesson is that management at all levels should enthusiastically and wholeheartedly support the quality assurance program.

DOE needs to be on guard for evidence that managers are not supporting the quality assurance program. Some potential indicators that such a problem may be developing are: (1) Statements by managers belittling the QA program, QA procedures, or QA personnel; (2) An inadequate QA staff in numbers, or in qualification and experience; or (3) A general lack of interest in QA matters.

To date, DOE managers in the nuclear waste disposal program have and are supporting the quality assurance program. Evidence abounds in verbal statements they have made, in the dramatic increases in the size of QA staffs that have occurred, and in the management support of and participation in special quality assurance training courses and seminars. DOE management respect for QA is also demonstrated by personal involvement and concern in responding to quality problems.

4.7 Minimal Site Presence

The seventh problem reported in Section 3.2.2 of NUREG-1055 was that "oversight of the project [was] from corporate headquarters with only a minimal utility presence at the construction site." The lesson to be learned

is that the license applicant must have a strong, local staff physically located near the project site to exercise day-to-day surveillance and management.

The DOE philosophy of providing policy guidance from headquarters but entrusting day-to-day management to project office managers in the field near the repository sites should help avoid this mistake of detached construction project management. These DOE project offices will oversee the construction activities and provide the management of the day-to-day activities of the contractors.

The two Federal sites, the Basalt Waste Isolation Project near Richland, Washington and the Waste Management Project Office in Las Vegas, Nevada, are already near the proposed repository sites. The Salt Repository Project Office, which is currently in Columbus, Ohio, will soon be relocated to be near the proposed salt repository site.

4.8 Lack of Appreciation of Codes and Standards

The eighth problem noted in Section 3.2.2 of NUREG-1055 was the "lack of appreciation of ASME codes and other nuclear-related standards." The lesson is that the license applicant and his contractors should be familiar with, and to the extent feasible try to use, the ASME codes and other nuclear-related standards, and should incorporate the requirements in these into their quality assurance program.

For DOE this lesson probably has somewhat less relevance because of the absence of pressure vessels, the absence of a primary coolant system and the associated piping and welding, and the lack of need for many of the special construction techniques and practices needed for nuclear power plants.

DOE must, however, commit to the use of national concensus standards and other standard and industry accepted practices and procedures where available and applicable. Because DOE is engaged in a new endeavor, numerous new codes and test procedures will need to be developed and used. It will be extremely important to document the development and use of these codes and procedures and to closely coordinate all these activities with the NRC.

4.9 Diffusion of Responsibility

The ninth problem reported by NRC in Section 3.2.2 of NUREG-1055 was the "diffusion of project responsibility and diluted project accountability." The lesson is that responsibilities need to be clearly defined, that there should be no duplication of responsibilities for tasks, and that managers and workers must know what they will be held accountable for.

Within each DOE project office the organization is clearly described and responsibilities well-defined. Matrix support personnel from the field office that provide support to the project office are kept to a minimum and, where used, have positions and responsibilities that are clearly defined.

Because of this decentralized arrangement, and the autonomous nature of each DOE project office, DOE will likely be able to avoid many of the problems that arose in the nuclear power industry due to a diffusion of responsibility and dilution of accountability.

4.10 Failure to Delegate Authority

The tenth problem reported in Section 3.2.2 of NUREG-1055 was the "failure to delegate authority commensurate with responsibility." The lesson is that you cannot expect to hold someone responsible for correcting problems unless they are given the authority and resources to take the required corrective actions.

We do not expect this to become a problem for DOE in its nuclear waste repository program. The DOE project managers have been given broad authority to carry out their charter of managing their project. Some examples of the authority routinely exercised by the DOE project managers are: (1) the selection of personnel to be employed in the DOE project office, (2) the selection of contractors to work on the DOE project, (3) the day-to-day management of the project including the DOE staff and the contractors performing work for the project, (4) the conduct of interactions with NRC including arranging meetings, signing meeting minutes, and making commitments to NRC on behalf of DOE, and (5) the handling of interactions with the affected States and Indian Tribes on behalf of DOE.

Thus we feel that the autonomous nature of the DOE projects combined with the authority routinely exercised by the project managers will help DOE avoid the problem of failing to delegate authority commensurate with responsibility made by some utilities in the nuclear power industry.

4.11 Misunderstanding NRC's Role

The eleventh problem reported in Section 3.2.2 of NUREG-1055 is that some license applicants had a "misunderstanding of the NRC, its practices, its authority, and its role in nuclear safety." The lesson to be learned is that a license applicant, and all of the personnel involved in the project, should have a clear understanding of the purpose and role of the license granting agency and should become familiar with the licensing practices and authority of the NRC.

The DOE and many of its contractors are already familiar with the NRC's role, authority and licensing practices. We have the benefit of the licensing history of numerous nuclear reactors. And from these historical case studies DOE can learn many pitfalls to avoid that were learned by some earlier license applicants.

Several of DOE and DOE contractor personnel have had licensing experience from the nuclear power industry. The challenge for DOE in this area will be in training and educating those who have not had this experience so that all DOE and contractor personnel will have a clear understanding of NRC practices, authority and role in nuclear safety.

4.12 Wrong View of NRC Requirements

The twelfth problem reported in Section 3.2.2 of NUREG-1055 was the "tendency to view NRC requirements as performance goals, not lower thresholds of performance." The lesson to be learned is that NRC requirements are required to be met, often with conservative assumptions being made and limiting conditions being assumed to exist.

In DOE's repository program, however, we have to comply with different regulations than the nuclear power industry did. And NRC's basic rule governing high-level waste disposal, 10 CFR 60, says, in part 60.101(a)(2):

> "While these performance objectives and criteria are generally stated in unqualified terms, it is not expected that complete assurance that they will be met can be presented. A reasonable assurance, on the basis of the record before the Commission, that the objectives and criteria will be met is the general standard that is required."

Thus in the repository licensing we may in fact have some performance objectives that are not requirements that have to be met with margin and conservative assumptions, but rather may be required only to present "reasonable assurance" that the objective will be met.

The challenge for DOE in this area will be in setting specific, numerical performance objectives for individual repository components. We certainly must work closely with the NRC in assigning such objectives and in determining what will constitute reasonable assurance that the performance objectives have in fact been obtained.

4.13 Inability to Recognize Programmatic Deficiencies

The thirteenth—and last—problem reported by NRC in Section 3.2.2 of NUREG-1055 was that some applicants had an "inability to recognize that recurring problems in the quality of construction were merely symptoms of much deeper, underlying programmatic deficiencies in the project, including project management." The lesson is that an applicant's quality assurance program must include provisions for recognizing recurring problems and to then require action to discover and correct any programmatic deficiencies.

This potential problem is something DOE should remain aware of and plan for, especially during construction of the repository.

One thing DOE has done already is to perform trend analyses of audit reports so that recurring problems of a similar nature can be discovered. We feel that this tool will prove valuable in the future in helping us uncover root causes of recurring problems. Another positive step DOE has taken is to require that, in responses to audit findings, the root cause of the problem be identified as well as the proposed corrective action. This should help assure that we don't just correct specific problems that really are only symptoms of some much more fundamental programmatic deficiency.

5.0 SUMMARY AND CONCLUSIONS

DOE's nuclear waste repository program has the potential to avoid many of the mistakes made by the nuclear power industry by paying attention to the lessons learned and applying them to our situation.

There are four key areas that DOE needs to pay careful attention to:

(1) The achievement of quality by aggressive and active management of the program by DOE personnel and by fostering pride of performance in workers.

(2) The commitment by DOE management to the achievement of quality and the support by DOE management of the quality assurance program.

(3) The development of systems to assure early detection and correction of quality problems.

(4) Close coordination with the Nuclear Regulatory Commission in developing and implementing the DOE quality assurance program.

(5) Adequate documentation of the quality achieved and the continued availability and retrievability of this documentation.

If successfully implemented, these steps will help DOE avoid making some of the mistakes made by the nuclear power industry.

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