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PHILOSOPHY FOR QUALITY ASSURANCE APPLIED TO NUCLEAR WASTE DISPOSAL: A PERSPECTIVE OF THE NEVADA NUCLEAR WASTE STORAGE INVESTIGATION PROJECT

presented by

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Good afternoon. "When, where and how much QA?" Specifically, when, where and how much QA as seen from the viewpoint of the manager of the Nevada Nuclear Waste Storage Investigations (NNWSI) Project? In preparing for today's discussion, I chatted with Bob Hartstern. Bob talked about physical facilities and I about earth sciences. And yet, we were both thinking about a high-level radioactive waste repository. We were both addressing a common point with strong convictions. Our perceptions and understandings of a repository were quite different and therein lies the roots of uncertainty.

Shortly thereafter, I was reminded of a statement made by John Kenneth Galbraith in his book, The Great Crash, 1929. He noted, "When people are least sure, they are often most dogmatic." In our work -- yours and my work, to site and license for operation, a high-level radioactive waste repository -- when we are sometimes unsure about a course of action -- we cannot afford to be dogmatic. We must work together. We must be sure together. We must examine and understand a common objective together.

And that is what I hope that we can do today, examine and understand together. Over the next thirty minutes I want to focus on a limited number of points that I believe are essential to understanding a high-level radioactive waste repository and the importance of QA to this facility. These points include:

- A repository is not a production and utilization facility;
- Philosophy for a repository or where QA;
- Defining windows of understanding or when QA;
- Practicalities of implementing QA for a repository;
- Applying levels of control or how much QA.

Let me now turn to the first of these points.

A Repository is Not a Production and Utilization Facility

A repository may be viewed as a system comprised of two types of facilities; quite simply, those facilities above ground and those facilities below the surface of the earth. The system is designed to receive high-level radioactive waste at the surface facility and transfer it to the subsurface facility for permanent isolation. The waste will be hermetically sealed in a high integrity canister. The performance specifications for these canisters require the maintenance of containment for 300 to 1,000 years. As for the waste enclosed in these canisters, it will be in a solid form. It will be either uranium oxide pellets in zircalloy tubes, or very large logs of borosillicate glass; waste forms which make it extremely difficult to disperse. Within the facilities where the waste will be received, handled and stored, there are precious few active or interactive elements. It should be clear that a repository depends on passive (non active) methods for protection against the release of a radiological hazard.

By contrast, nuclear reactors or reprocessing plants are facilities that contain highly radioactive material within a large set of complex, sophisticated and interactive systems. For commercial power reactors, although the highly radioactive elements will be contained in the solid uranium oxide pellets, these pellets are present in a high temperature, high pressure system, a system of great stored energy, for which the occurrence of a failure provides enormous potential for highly radioactive materials to be dispersed. In a reprocessing plant, the highly radioactive materials are processed and stored in a very mobile liquid form. The ability to keep the radioactive material contained, that is, keeping it from being dispersed into the surrounding environment, depends on the quality and reliability of the systems that comprise the facility that has been totally designed, fabricated, constructed and tested by man.

We recognized that all nuclear production and utilization facilities have a significant potential for impacting the health, safety and well being of the public. QA is a process that was established to control the design, fabrication, construction and testing of the systems, components and structures important to protecting man and his environment from the intrinsic radiological hazard. The rules of the QA process, in 10 CFR Part 50, Appendix B, were written initially with reactors in mind. The ensuing implementation of the process was further forged with reactors - over 90 of them. The process is aimed at building a facility whose total extent is under the control of man, a facility expected to operate over a time span of 40 years.

With the development of nuclear reactors, an industry has grown up; a strong, competent industrial and technical infrastructure has been put in place. This infrastructure is the one that specifies the configuration of the systems, components, and structures important to safety as well as fabricating, constructing and testing them. Detailed manuals covering the design and review of facilities have been developed; fabricators are authorized to N-stamp their product. Over 20 years, the utilization of QA has been reasonably well understood for designing and building these systems.

I would also like to note in passing that although we have great knowledge and ability to do the job correctly, if the intent or commitment to implement QA practices is not also present, then nothing has been gained. The recent report issued by the NRC entitled, "Improving Quality and the Assurance of Quality in the Design and Construction of Commercial Nuclear Power Plants" does a thorough job of identifying the shortcomings in the practice of QA.

Philosophy for a Repository - or Where QA

Thus, if a repository is not the same type of facility that the QA process has been applied to over the past 20 years, then it seems appropriate to ask, "Where will QA be applied?" This should become obvious as we look at the philosophy for a repository.

The basic technical questions before the owners of the repository are significantly different than those before the owners of a reactor. It is my belief that three fundamental questions must be answered before the traditional engineering questions are addressed. The fundamental questions are:

1. Are the intrinsic characteristics of the site's geologic, hydrologic and geochemical environment capable of providing long-term isolation?

2. Is it possible to design, build and operate a high-level radioactive waste repository within this environment without disturbing its intrinsic character to isolate waste?

3. Is it possible to construct and operate a repository without disrupting the societal structure in the communities surrounding the repository?

The first of these questions is an earth science question; the second is a geoengineering question; and the third is a sociopolitical question.

These questions present three important issues that must be addressed in determining how much QA for a repository. The first issue is time of operation or containment. While a reactor is examined in terms of a 40-year life span, a repository site must be evaluated in terms of 10,000 years and the engineering of the subsurface facility and man-made components of the containment system examined in context of 100 to 1,000 years. These time frames are well established in the existing regulations of 10 CFR Part 60 and 40 CFR Part 191. These requirements are significantly beyond those used by any conventional engineering project of today. They strongly indicate that we will likely have to use a different technical approach in establishing answers.

The second issue deals with the primary containment material. We are trying to site a geologic repository. In this case, the earth will serve as the major permanent barrier between the radiological hazard and man. This means that the primary barrier, or that part responsible for waste isolation, is more than 90 percent complete before the siting decision is made. We are seeking an existing location within a geologic regime that has been stable for millions of years. Man will have had no hand in putting it in place; he will not have been around to observe it being put in place. The siting process will require that we adequately understand the existing earth structure and the dynamic processes that are changing it. Furthermore, we must accurately describe the site and its environs based on information from field and laboratory studies resulting from the site investigation program.

Subsequently, the final decision to build and license a geologic repository for operation will focus on the description of the earth. This is quite different from the traditional license application for a nuclear facility. The traditional review and approval is focused on the review of design and the control of fabrication, approval of construction practice, or the testing of components. I would like to repeat this statement, the final decision will be based on the description of the earth and the analysis of its ability to isolate the waste. The isolation of high-level radioactive waste from man's environment, in a geologic repository, is dependent on the current conditions below the earth's surface as well as the natural physical and chemical processes that will operate over the next 10,000 to 100,000 years. The description of the site must present a picture of the site's structure, as well as the nature and magnitude of the processes that are likely to change it based on field measurements taken during site investigation and site characterization. A decision about the site's capability will be tied to the accuracy, or from another viewpoint, the level of uncertainty that exists with regard to the description and analysis of the site. This specific point will become an important aspect of the regulatory review, and consequently, of the QA process.

The third issue is also one of time, the time necessary to develop the technical data which will establish the description of the earth. This work will not be completed in a few months or even a few years. For example, the site we are examining in Nevada is Yucca Mountain. I estimate that by the time a decision is made to select the first geologic repository site, our evaluation work will have been ongoing for nearly 12 years. Most of the crucial data about the site will be obtained in the latter half of that time period. Therefore, the NNWSI Project must be sure that the record supporting a possible license application is authenticated by some means. A decade or more may elapse between the time when the data are taken and the time when they are reviewed in a regulatory hearing. A method or procedure must be developed to assure that the data are taken by an appropriate manner to preserve the exact details and conditions.

In our mind, the most important part of the repository will be the earth. By comparison to production and utilization facilities, types of facilities for which we have great experience, the repository surface facilities will be quite elementary in terms of complexity. It is clear to us that where the emphasis must be is on the data taking with regard to the earth, along with the analysis of the earth's long term performance. This will be the issue, the information that will be challenged.

Defining Windows of Understanding or When QA

And so we arrive at the second point: "When QA or defining windows of understanding." The Nuclear Regulatory Commission (NRC) has, to some degree, recognized that a geologic repository is not a reactor. However, there have been some unclear subliminal signals provided by NRC. One can see this in the initial guidance that was developed. It is this point that provided an obvious indicator of a long learning curve and a "window" for understanding requirements and for establishing a complete and comprehensive QA program.

The requirements for QA for a repository were initially outlined around 1979 in Subpart G of 10 CFR Part 60. The regulation states, "The quality assurance program applies to all systems, structures and components important to safety, to design and characterization of barriers important to waste isolation and to activities related thereto." The regulation further states that the QA program should be based on criteria of Appendix B of 10 CFR Part 50. Here, the standard that was held up was reactor oriented with little guidance with regard to site characterization and waste isolation.

Because of the uncertainty, it took time to decide how to change the approach. It took several years to sort out the factors that are important. NRC finally issued the Standard Review Plan for the repository QA program in June 1984. This guidance provided by NRC is an excellent first step, but it is clear that NRC's concepts and ideas are not complete. It is still concerned with systems, structures and components important to radiological safety. This will be applied primarily to the surface facilities for receiving and preparing the waste for disposal, and the handling equipment for emplacing the waste in the ground. In addition, they also outline those factors considered to be important to waste isolation and site characterization. However, we believe that more communication is necessary to understand their logic and reasoning to determining which activities and entities are important to waste isolation.

The point I am trying to highlight here is "when" QA must be applied. For surface facilities, it will be initiated with the design to be used as the basis for the license application; fabrication of components or construction of facilities are not anticipated until NRC has completed the licensing review. And yet, with a geologic repository, QA will need to start at a time far in advance of the initiation of the surface facility design.

Ideally, appropriate QA would be desirable from the first day that field and laboratory data are undertaken, especially if the data are to be used to demonstrate the site's ability to isolate the waste. However, this viewpoint must be moderated for two fundamental reasons. First, there was uncertainty as to how to fully execute a QA program on site investigations. The NNWSI Project experienced this uncertainty as did the NRC. It took several years of site investigations to fully appreciate the nature of the technical issues that had to be resolved as well as the extent of the controls that would be required to authenticate the data in preparation for the regulatory review. Second, is the fact that making a judgment about the earth is a far more expansive requirement than making a judgment about a design. This becomes obvious when you consider that one is making a judgment about something that is very large, complex, and has been in existence for a long time. The data about a site and its environs taken by the Project will be in addition to a large and diverse data base that has been generated over the last 100 years. This information is in the technical literature. It has been subjected to the standard scientific peer review process and has never gone through a formal "nuclear level" QA process. It is a statement of what is believed to be true and accepted by the people who will be supporting the NRC in making the judgment, whether the description and analysis is sufficient and accurate. The major test that will be applied to data on geology, hydrology and geochemistry is whether it is internally consistent with what is already known.

Information that is inconsistent with the accepted body of knowledge will be the one that is examined closely.

It has been our experience that the implementation of QA for the Yucca Mountain investigation has required a long learning curve. It is my belief that this is because we are all working in a developing but immature area, an area where we seek windows of mutual understanding, the window to establish a full and effective QA program. The question is, when in time does that window occur? As stated previously, the first boundary for that window is when the site investigations are initiated.

The remaining boundary of the window can be tied to a document known as the Site Characterization Plan. It is a document required by NRC that provides two major pieces of information. The document outlines what we know about the geology, hydrology, geochemistry, geomechanics and general engineering requirements of the site, and it identifies the remaining issues that need to be resolved along with an outline of the technical program to obtain the data. At this point, the time of the final push to obtain the data for finishing the description and making a decision, is the point <u>when</u> the QA program should be formalized and fully operational.

Practicalities of Implementing QA for a Repository

Having expended some minutes on the background of "understanding" as I see it, let me turn now to some nitty-gritty in the practicalities of implementing

QA. I would like to take a minute to run through several of the difficulties we have experienced in implementing the QA program in Nevada.

The first is the simple fact that previously prepared directions are written in the context of controlling design, fabrication, construction, and tests of a system or facility. They are not presented in a way that is consistent with the fact that most of the facility is already in place. The critical skills involved in the decisions are not in nuclear engineering, mechanical engineering and structural engineering, but in geology, hydrology, geochemistry, geophysics and mining engineering. For example, the definition of Criteria 3 of the 18 noted in 10 CFR Part 50 Appendix B is Design Control. But there will be no "design" of the earth's contribution to the isolation systems; it is not clear to an earth scientist that design control is a meaningful criteria. Conversely, the Site Evaluation Control requirements - something an earth scientist could relate to - the process of systematically reviewing the data to decide the suitability of a site - does not exist.

There are professional and viewpoint differences between the engineers and the earth scientists. Personally, I can attest to the fact that it's mighty difficult to give an earth scientist an engineering operational and control manual and expect him to implement it competently in a short time. Translation of good practices into the right language is required.

The second problem can be classified as a "perception of freedom" problem in the fields that we are talking about. Researchers piece together diverse facts to deduce a picture of conditions or processes that cannot be observed readily with the naked eye. Researchers have had great freedom to observe, experiment and document their findings. Their credibility is based on publication in refereed technical journals and the support of their postulations and theories by their peers. The technical quality of their findings is not established by conforming to written procedures, to filling out forms, or to having a supervisor approve their data sheets. The quality of the work is based on keen observation, good reasoning and effective presentation of information. However, these researchers have not fully recognized that the rules and requirements of a nuclear regulatory review are not the same as those in the scientific review process. They do not recognize that such reviews, as referenced in Administrative Law Courts utilizing rules of evidence, affect the basis for authenticating scientific work.

The third area is the bureaucracy of QA. Everything that is undertaken must be codified. Writing all the technical and administrative procedures for an effort of this magnitude is quite a burden. Researchers feel it is unpleasant and view it as a non-productive use of time. Surely there is need for a generic format, but there is also need for flexibility to deviate from the generic format. The process of reviewing and approving the procedure is tedious. The process of recording the data on an approved format and having it examined by a peer or supervisor is time consuming. The process of reviewing the records is monumental. The perception of the process as well as its value is not high in the minds of the working level scientist who must live with it on a day-to-day basis. If we consider Alan Lakeins' time management hierarchy, QA is not the A-1 item on their days to-do-list.

The fourth area is the development of a QA system that assigns various levels of control depending on the significance of the information. For other nuclear facilities, NRC has been concerned about structures, systems, and components related to safety. For a geologic repository, the NRC has added a category of activities important to waste isolation. Unlike systems, structures and components important to safety which have been established for each of the 90 plus reactors, an analogous list of activities or conditions important to waste isolation is still to be fully developed for the first time. This list is somewhat hampered by the view that performance assessment calculations must be executed first before it is possible to evaluate the effectiveness of the natural system. This area is one that needs open and frank discussion so that the logic of the license applicant and the regulator can be tested and accepted. Without sharing of viewpoints in this area all activities could get pushed to the highest level of control in a graded QA system.

Applying Levels of Control or How Much QA

One point that was readily recognized in the reactor business was that all systems, structures and components in a facility were not equally significant in protecting against a radiological hazard. The recognition of this point has resulted in hierarchal structure on the levels of control that are placed on the design, fabrication, construction and tests of the system. The concept of a "graded" approach to a QA program is well developed in the reactor area, and it is one of the features of the practice that will have significant value in the development of a repository.

The question before us, is how to apply the graded approach to the repository. For the facilities above ground, for facilities that have the same general features as other nuclear facilities, we have good practical experience on how much QA needs be applied to assure a reliable, safe facility. However, in the evaluation of the earth we are still attempting to put together the complete list of items and activities important to waste isolation.

Although we were unsure and were faced with uncertainties, the NNWSI Project issued its first QA program plan requirement in August 1980. It was revised in May 1984 to recognize the graded approach (see NVO-196-17 Rev. 2). An initial set of criteria was established to allow the scientists and engineers to determine the level of quality for their work. In the interim the entire repository program has been working toward a common approach. Only last month all the Projects and Headquarters met to establish a common framework for a uniform graded QA structure.

The first and most important decision is that there will be three levels of quality, each of which specifies how much QA to apply. QA Level I, the level of greatest concern and control, will be applied to all items and activities considered to be important to radiological safety, waste isolation and site characterization as identified in 10 CFR Part 60. This is the set of items and activities that we expect NRC to review.

Items important to safety are those engineered structures, systems and components essential to the prevention or mitigation of an accident that could result in a radiation dose, either to the whole body or to any organ, of 0.5 rem or greater, either at or beyond the nearest boundary of the unrestricted area at any time until the completion of the permanent closure of the repository. Items important to waste isolation are those natural, as well as man-made, barriers that contribute to preventing radionuclides from moving away from the subsurface portion of the repository into the accessible environment. Activities important to waste isolation, for the most part, are those data taking activities necessary to characterize the natural barriers and provide engineering input for the man-made barriers and the analysis of the performance of the barriers in retarding the movements of the radioactive materials. Other activities that could affect waste isolation include construction techniques for the underground facility that could reduce or destroy the effectiveness of the natural barriers.

In addition to the items that will be reviewed by NRC, two other classes of items or activities will also be controlled under Quality Assurance level. The first are items and activities that could be important to NRC at a later date and for which we will want to avoid the impact of trying to upgrade from a lower quality level. The second are items or activities that have a potential programmatic impact of $1 million or a 6 month schedule slip.

The extent of documentation and control for Level I will be specified by the 18 basic requirements of NQA-1, all NQA-1 supplements, non-mandatory Appendix 2A-1, the 18 criteria of Appendix B of 10 CFR Part 50 and the NRC QA Standard Review Plan.

QA Level II will be applied to items and activities involving worker safety, both radiological and industrial; those having a cost impact of more than $500K, but less than $1 million; those having potential schedule delays of more than three months but less than six months; and those regulatory requirements other than NRC and the EPA Standard, 40 CFR Part 191, such as MSHA, OSHA, etc.. The extent of documentation and control for Level II will be specified by the 18 basic requirements of NQA-1 and its supplements S-1, 2S-3, 3S-1, 7S-1, 10S-1, 17S-1, and 18S-1.

Quality Assurance Level III will be applied to items and activities not categorized as Quality Assurance Level I or II. The requirements consist of good working practices and will meet appropriate quality for the intended use as determined by the Project on a case-by-case basis.

The above is the current view of "How much QA?" will be applied. However, this is by no means final, and as we clarify our thoughts and logic, and reduce our uncertainty, we will expect these requirements to change.

Summary

In bringing this discussion to a close, I want to summarize the points I believe are critical in understanding when, where, and how much QA need be applied to a repository.

1. A repository is different from a production and utilization facility, and the understanding of the differences needs to be broadened.

2. The critical decision about a repository is the selection of its location - that decision is going to be based on a description of the site and the analysis of its performance.

3. The determination of which things in the earth and which activities are important to waste isolation is still in the embryonic stage, and needs open and forthright discussions between DOE and NRC.

I started this talk with a thought of John Kenneth Galbraith; I would like to use one of his comments to close it. In developing QA for a repository, we must be aware of the influences our past and experiences have on our outlook and judgment; we must recognize that conditions have changed and uncertainty has arisen; we must build on the things that are relevant and discard the nonsense; we must avoid falling into the attitude trap that Galbraith acknowledged in his book, The Affluent Society, where he highlights a commonly held belief that, "It is a far, far better thing to have a firm anchor in nonsense than to put out on the troubled seas of thought."