

Revision 0

06/10/86

SUPPLEMENTAL QUALITY ASSURANCE REQUIREMENTS

SUPPLEMENT No. 3

METHODOLOGY FOR FORMULATING A Q-LIST

June 10, 1986

**U.S. Department of Energy
Office of Civilian Radioactive Waste Management
Office of Geologic Repositories**

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SUPPLEMENTAL QUALITY ASSURANCE REQUIREMENTS

METHODOLOGY FOR FORMULATING A Q-LIST

1.0 GENERAL

This Supplement provides amplified requirements for formulating a Q-List. It supplements the OGR QA Plan and ANSI/ASME NQA-1-1983 (Basic Requirement 2). The requirements in this Supplement are to be used in conjunction with the requirements embodied or referenced in the governing QA plans and procedures.

2.0 PURPOSE

The purpose of this Supplement is to specify requirements for formulating a Q-List for geologic repository projects.

3.0 SCOPE

The requirements of this Supplement are applicable to the methodology for identifying structures, systems, components, and activities that are important to safety and/or waste isolation for the mined geologic disposal system (MGDS).

4.0 DEFINITIONS

4.1 Q-List - A list of geologic repository structures, systems, components, and activities that have been determined to be important to safety and/or waste isolation and are thereby subject to the highest quality level (Quality Level 1) of the formal QA program.

5.0 REQUIREMENTS

Each geologic repository project shall prepare a procedure(s) for determining the items and activities to be placed on the project Q-List. Attachment A is a guideline for a methodology for formulating a Q-List.

Attachment A

**METHODOLOGY FOR
FORMULATING A Q-LIST
FOR MINED GEOLOGIC DISPOSAL SYSTEMS**

May 1986

**U.S. Department of Energy
Office of Civilian Radioactive Waste Management**

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1.0 SUMMARY

This attachment describes a general philosophy to be used by DOE projects in determining the structures, systems, components and activities that are important to safety and waste isolation for the mined geologic disposal system (MGDS). The resulting list of structures, systems, components and activities which are important to safety and waste isolation is called the "quality list" or "Q-List". The items and activities on the list will be subject to the highest quality level, Quality Level 1, of a formal quality assurance (QA) program as required for site characterization and licensing of the geologic repository. As such, only these Q-List items and activities will be subject to NRC licensing review and oversight. NRC may examine any item or activity not in the Q-List to assure that no items or activities important to safety or waste isolation have been omitted from the Q-List. This is consistent with NRC's philosophy as set forth in a "Preliminary Draft NRC 'Q-List' Positions" paper, which states in part as follows:

"For items and activities which are neither important to safety nor waste isolation but which will be referenced in the construction authorization application to support findings required by Part 60 (such as requirements for worker radiological safety and environmental monitoring contained in 10 CFR 60 Part 20), DOE should describe and reference the program for documenting and assuring that these requirements have been fulfilled in the construction authorization application. DOE should also describe, at least in general terms, such programs in the SCP.

For all other items and activities supporting the development of a repository, DOE may apply QA programs based on reliability, cost, and other programmatic considerations. The staff will review these non-"Q-List" items and activities only to assure that the "Q-List" is complete."

The QA requirements and application of Quality Level 1 to Q-List items and activities are discussed in QA Supplement #8.

The Q-List will change over time with a final list emerging at the completion of NRC's review of DOE's license application. During the evolutionary period, two milestones stand out: (1) the Q-List to support the Site Characterization Plan (SCP) data gathering and design efforts and (2) the Q-List to support the License Application (LA) design stage. The methodology to generate the SCP stage Q-List is based primarily on engineering judgment and is described in Section 3.1 of this Supplement. As site characterization and design activities progress to the point of allowing quantification of key input parameters, the LA design stage methodology described in Section 3.2 will be followed.

This Supplement does not apply to the Monitored Retrievable Storage (MRS) facility or the safety-related aspects of the Transportation Subsystem.

The term "safety" as used in this document refers to preclosure radiological safety for members of the public, and "waste isolation" refers to postclosure control of radionuclides.

2.0 INTRODUCTION

The Mined Geologic Disposal System (MGDS) of the DOE Office of Civilian Radioactive Waste Management (OCRWM) encompasses structures, systems, and components. Those structures, systems, components, and activities which are important to the radiological safety of the public or to the control of the isolated waste are identified on the Q-List. The activities that are involved in the design, fabrication, testing, installation, and operation of these items, and in the characterization of the repository sites, will be performed in accordance with QA procedures corresponding to Quality Level 1. All items and activities are covered by a QA program in which the requirements are graded, or varied, according to the importance of the item or activity to safety, waste isolation, or the accomplishment of DOE Mission objectives. Section 3 of this report addresses the criteria and methodologies used for identifying whether or not a given item or activity is placed on the Q-List and assigned to Quality Level 1. The graded approach to QA is discussed in a separate QA supplement (Supplement #8). Three levels of quality are defined and a methodology for grading within each level is set forth. This methodology requires that Q-List items and activities be assigned to Quality Level 1 and permits assignment to Quality Level 1.

3.0 ITEMS IMPORTANT TO SAFETY AND WASTE ISOLATION

3.1 DETERMINATION OF Q-LIST ITEMS FOR SCP DESIGN STAGE

3.1.1 ITEMS IMPORTANT TO SAFETY AT SCP DESIGN STAGE

Structures, systems, components, and activities that are important to safety are defined by the NRC in 10 CFR 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories," 60.2, as:

"those engineered structures, systems and components essential to the prevention or mitigation of an accident that could result in a radiation dose to the whole body; or any organ, or 0.5 rem or greater at or beyond the nearest boundary of the unrestricted area at any time until the completion of permanent closure."

An equivalent statement used by the NRC in its draft "Generic Technical Position on Licensing Assessment Methodology for High-Level Waste Geologic Repositories" (USNRC-7/84), is

"... structures, systems, and components are important to safety if, in the event they fail to perform their intended function, an accident could result which causes a dose commitment greater than 0.5 rem to the whole body or any organ of an individual in an unrestricted area."

Items important to safety must be on the Q-List to ensure that the design addresses their safety requirements and that appropriate QA controls are applied. Central to the above NRC definitions is the dose consequence of the failure of the items. The assessment of the dose consequences of the failure of structures, systems, or components, however, requires a detailed assessment of their functions under design basis conditions which are not available until (1) the design effort attains a certain maturity, (2) design basis conditions are identified, and (3) the analytical assumptions to be employed during safety analysis are established. Prior to that time, the methodology which the DOE employs will be based on engineering judgment and is described herein. The methodology for the LA design phase (i.e., the mature design) is described in Section 3.2.

The NRC's definition of "important to safety" contains a criterion for assigning an item to the Q-List: whether the item can prevent or mitigate an accident that could result in a dose in the uncontrolled area of 0.5 rem or greater. Another criterion may be inferred from the definition, although not explicitly stated: a determination that the accident scenario is credible. The term "credible accident" as used here implies that the accident has an overall probability of occurrence which is smaller than the probability for anticipated operational events but yet not so small as to be considered insignificant or incredible. The quantitative limit below which an event ceases to be considered credible is not identified in 10 CFR 60. For purposes of identifying structures, systems, components and activities to be placed on the Q-List, the DOE will disregard any scenarios which would have an annual probability of 1×10^{-5} or less. The probability of incurring a health effect from a one rem whole body exposure is approximately 1×10^{-4} *. The combined annual probability of incurring a health effect among the off-site population

is therefore less than 1×10^{-9} from a failure whose probability is 1×10^{-5} or less per year which could result in an off-site dose of 0.5 rem. This risk is significantly smaller than "risks that would be regarded as negligible by the exposed individuals", ** which are on the order of 1×10^{-6} health effects per year.

The dose consequence estimate should be based on a radiation transport model which uses conservatively estimated parameters where design and site details are lacking. One such model is set forth in NRC Regulatory Guide 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequence of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Waste Reactors".

To summarize, the Q-List at the SCP Design stage shall be comprised of the structures, systems, components, and activities essential to the prevention or mitigation of any scenario with probability of occurrence of 1×10^{-5} or greater and dose consequences exceeding 500 mrem.

3.1.2 ITEMS IMPORTANT TO WASTE ISOLATION AT SCP DESIGN STAGE

From 10 CFR 60.2, it may be inferred that structures, systems, and components important to waste isolation would be those natural and engineered barriers which are relied upon to inhibit "... the transport of radioactive material so that amounts and concentrations of this material entering the accessible environment will be kept within prescribed limits." These items must function in a certain way in order to meet the long-term isolation objective after repository closure.

In 10 CFR 60, paragraph 60.113, the NRC has defined performance objectives for the repository after closure. the four performance objectives are related to the following performance measures:

- o Waste package containment time
- o rate of release of radionuclides from the engineered barrier system
- o preemplacement ground-water travel time
- o cumulative release to the accessible environment

Consequently, structures, systems, and components important to waste isolation may include engineered barriers (e.g., waste package), and features of the natural site system.

* International Commission on Radiological Protection, "Recommendations of the ICRP", ICRP Publication 26, Pergamon Press, Oxford, 1977

** International Commission on Radiological Protection, "Radiation Protection Principles for the Disposal of Solid Radioactive Waste", ICRP/85/C4-8/12, Section 8, Exemptions

Performance goals will be set for selected structures, systems, and components of the MGDS which, when attained, will provide appropriate assurance that the above performance objectives are met. Structures, systems, components and activities necessary to comply or demonstrate compliance with these performance objectives will be placed on the Q-List.

The designation of structures, systems, and components to be placed on the Q-List at the SCP design stage, and all site characterization activities that are essential to adequately evaluate these items, will be based on technical judgment of the items that will be found necessary to comply or demonstrate compliance with the repository performance objectives as the repository performance analyses are completed.

As the site characterization activities take place and as the understanding of the site changes, the performance goals may change. As a consequence, some changes to the Q-List are expected as the site characterization program progresses. All site characterization tests and activities must therefore be carefully planned and take into account not only the primary tests for the items initially placed on the Q-List, but must also include some contingency for items that may be later added to the Q-List. A conservative approach at the SCP design stage is recommended to ensure that data necessary to demonstrate compliance with 10 CFR 60 are obtained and preserved in accordance with quality assurance requirements.

3.2 DETERMINATION OF Q-LIST FOR LA DESIGN STAGE

3.2.1 ITEMS IMPORTANT TO SAFETY AT LA DESIGN STAGE

A risk assessment methodology is a tool for preclosure safety analysis. It can be used to help identify structures, systems, components, and activities important to safety. An example of such a methodology is described in NUREG/CR-4303. "High-Level Waste Preclosure Systems Safety Analysis, Phase 1 Final Report".

Q-List development will be accomplished by examining an event sequence frequency and dose consequence. The structures, systems, components, and activities that are involved in the event sequence will be examined to determine their contribution to risk. If an item is essential to the prevention or mitigation of an event sequence which has a probability of 1×10^{-5} per year or greater and could result in radiation dose of 0.5 rem at the nearest boundary of the unrestricted area, then that particular item should be on the Q-List.

3.2.2 ITEMS IMPORTANT TO WASTE ISOLATION AT LA DESIGN STAGE

The determination of the structures, systems, components, and activities important to waste isolation at the LA design stage shall be accomplished in a similar fashion to that required at the SCP stage. However, at this more mature stage, the evaluation of importance to isolation will be based on direct assessments of whether the performance objective will be met rather than indirect assessments based on the preliminary performance goals set at the SCP stage. Throughout site characterization and performance assessment, activities must be geared to demonstrate compliance with the performance objective of 10 CFR 60 including the release limits set in EPA's 40 CFR 191.

3.3 RETRIEVAL OF EMPLACED WASTE

Retrieval of the waste from the repository, for either public radiological safety or resource recovery, is a design contingency and shall be treated in the same manner as waste emplacement. Much of the equipment needed for retrieval is expected to be the same or similar to the equipment that was needed for waste emplacement. The same procedures and criteria used to classify the items and activities needed to emplace the waste shall be used to determine if equipment and activities needed to retrieve the waste should be included on the Q-List.