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TENTH
ANNUAL DOE
LOW-LEVEL
WASTE
MANAGEMENT
CONFERENCE

August 30—
September 1,
1988
Denver, Colorado

PROCEEDINGS

Session V:
Waste Characterization and Quality Assurance

Convened by the
DOE Low-Level Waste
Management Program

National Low-Level Radioactive Waste
Management Program
Idaho Falls, Idaho

INEL
Idaho National Engineering Laboratory

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PROCEEDINGS OF THE TENTH ANNUAL DOE LOW-LEVEL WASTE MANAGEMENT CONFERENCE

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National Low-Level Radioactive Waste Management Program
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SESSION V: WASTE CHARACTERIZATION AND QUALITY ASSURANCE

HOW DOES ONE DEVELOP THE "RIGHT" QUALITY ASSURANCE PROGRAM FOR WASTE MANAGEMENT PROJECTS?

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ABSTRACT

The quality assurance requirements in use today for radioactive waste facilities, geologic repositories and hazardous waste projects were developed initially for the nuclear power plant industry, and their intent is being applied by regulations and guidance documents to radioactive and hazardous waste programs. The wording of the NRC quality assurance requirements in Appendix B of 10CFR50, the related guidance documents and the industry's ANSI/ASME NQA-1 were developed over a period of several years to address quality assurance for the design and construction of the complex and interactive systems to produce electrical power using nuclear fuel. Now, those same documents are the basis for the quality assurance requirements and guidance for waste management facilities and repositories. The intent of Appendix B of 10CFR50 and NQA-1 can easily be applied to waste projects providing one understands and uses the intent of the requirements. This paper describes the intent of existing QA requirements as they apply to radioactive and hazardous waste programs. Methods of ensuring that the quality assurance program design will be acceptable to DOE and regulatory agencies are illustrated.

HOW DOES ONE DEVELOP THE "RIGHT" QUALITY ASSURANCE PROGRAM FOR WASTE MANAGEMENT PROJECTS?

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INTRODUCTION

The wording of the quality assurance requirements in use today for radioactive waste programs by the Department of Energy (DOE), the Nuclear Regulatory Commission (NRC), and Agreement States was developed over a period of years to address quality assurance for the design and construction of the complex and interactive systems to produce electrical power using nuclear fuel. Managers of radioactive and hazardous waste programs can effectively apply these same requirements to radioactive or hazardous waste programs by understanding the intent of the requirements. Any attempt to apply the letter of these requirements to radioactive or hazardous waste programs can result in some misunderstanding and misapplication of controls. This paper addresses an effective approach for the development and implementation of a quality assurance program using the intent of the 18 criteria of either Appendix B of 10CFR50 or ANSI/ASME NQA-1.

What Do You Do First?

Perhaps it is wise to first state what you do not do first. You do not develop and implement an effective quality assurance program by starting with each of the 18 criteria and determining how it applies. This is the usual practice of people who wish to develop a quality assurance program for only that which the regulator will overview. There is sufficient bad experience in the design and construction of nuclear plants as well as some present day radioactive waste programs to dissuade a competent program manager from that approach. An NRC publication entitled "Improving Quality and the Assurance of Quality in the Design and Construction of Nuclear Power Plants" (NUREG 1055) provides a summary of quality problems and their root causes experienced by the nuclear power plant industry. Managers of radioactive waste programs could learn how not to approach quality assurance by reading this document.

The successful program manager will first determine and list what program objectives must be met. The list will include technical performance objectives and administrative objectives. Consideration will be given to necessary internal and external interfaces such as interface with regulators, legislative groups, intervenors, local citizen groups, and appointed technical overview committees. Once the total job is understood and can be articulated by the program manager, the organization can be structured, functions can be assigned, and plans can be formulated which integrate the actions to accomplish the objectives. When the objectives are clearly stated, the organizational structure established, functions, including interfaces, assigned, it is time to use the 18 criteria of NQA-1 or Appendix B of 10CFR50. The criteria should serve as a check-list of items that the nuclear industry and regulators have found to be important ingredients of an effectively implemented quality assurance program. All 18 may not apply to a given program, or the program manager may wish to apply more controls than are included in a specific criterion. The controls included in the 18 criteria should be considered as minimum. The program manager can best decide what additional controls are needed because of circumstances surrounding his or her program.

The quality assurance program is developed by the actions just described and should be documented in a quality assurance program description (plan) and implementing procedures.

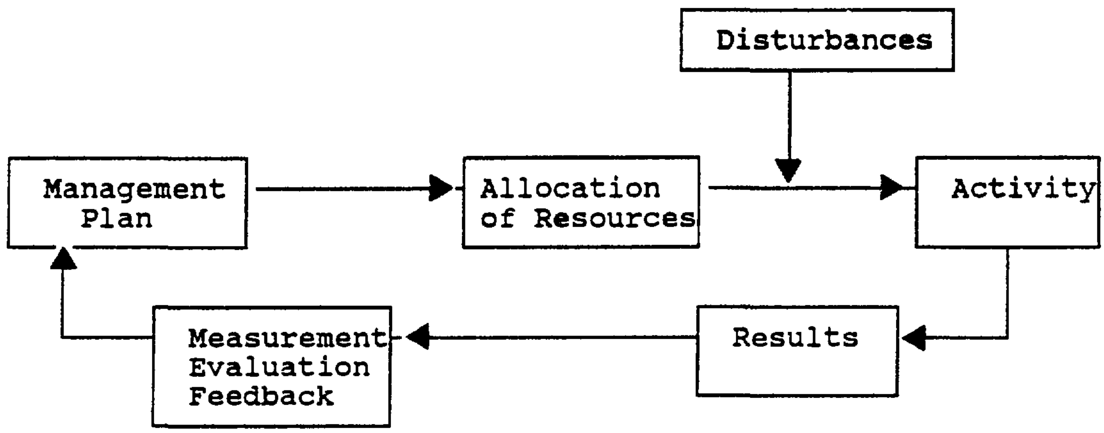
<u>What distinguishes the effectively designed and implemented quality assurance program</u>?

The single most important characteristic of an effective quality assurance program is a project manager who accepts full responsibility for the quality of the end product and has carefully assigned the achievement and assurance of end product quality to a capable and trained staff. A second important ingredient characterizing an effective quality assurance program is the careful planning and preparing of procedures for activities to accomplish the technical and administrative objectives. Such planning and procedures will be formalized, reviewed and approved by the project management prior to start of work activities. A third important ingredient characterizing an effective quality program is the design and use of "sensors" in the management systems to permit "real-time" measurement of the effectiveness of implementation of the planned actions and timely adjusting of management controls to correct for anomalies. This ensures that performance objectives are realized and that accomplishment can be demonstrated.

The effective quality assurance program will provide for the documentation, planning, direction and control of activities that accomplish the performance objectives and provide documentation to demonstrate to interested parties that performance objectives were acceptably accomplished.

I will use a simple management control diagram to demonstrate what I mean when I use the term, "an effective quality assurance program".

Management Control Cycle



I think the term "quality program" is more fitting, as adding the word assurance can cause some confusion, but since Appendix B and NQA-1 use Quality Assurance Program, so will I.

This diagram could be used to describe any project, agency or company. I could use this diagram to describe the quality assurance program used by a police department, a hospital or a radioactive waste project. The first block to consider is Management Plan. The management team must first fully understand their objectives and plan to accomplish them. They must consider any potential external disturbances to the management process and factor in any needed resources and management systems to counteract the impact of the disturbance. As an example, a high personnel turnover rate would disturb the process, but planned orientation and training could attenuate the disturbance. The degree of formality of the plans will be dependent upon the complexity of the organization and the objectives to be accomplished. In all cases, the planned management systems must be well integrated. In the three examples I have used, a police department, a hospital, or a radioactive waste project, many of the work activities will be conducted by formal procedures because of the necessity to be consistent in the way activities are performed and to have records to demonstrate the methods used and the results obtained. It is the results that will be the true measure of the acceptability of a quality assurance program. The management team will ensure that the planned activities are documented and well integrated to achieve and assure the quality of work necessary to meet the objectives. The chief of police, hospital administrator or project manager will have carefully assigned authorities to the staff and ensured that each understands their role and how they each interface with the other team members. The chief of police or project manager will be responsible and accountable for meeting the objectives.

One will find some of the most effective quality assurance programs implemented by well managed police departments. They have met the intent of all 18 criteria of NQA-1 even though they have never heard of the 18 criteria.

The first block in my diagram is the most important. If the end product or service cannot be fully described by the management team and activities identified to satisfactorily produce the product or service, planning will be inadequate and crisis management will result.

If the planning is adequate, the resources needed will have been identified. Any decision to reduce the predetermined resources can and should be identified with what will not be accomplished and what will result because of the reduction.

As planned activities occur, one can expect an occasional anomaly. For that reason, it is necessary to also plan sufficient overview of the work process to ensure that the final product is of adequate quality. Planned overviews will detect the occurrence of anomalies and provide the opportunity for analysis as to impact upon the final product. Information can also be given to the management team so they may decide upon any needed adjustments to the management systems or resources.

The 18 Criteria of ANSI/ASME NQA-1 and Appendix B of 10CFR50.

The 18 criteria of NQA-1 are very similar to the 18 criteria of Appendix B of 10CFR50. NQA-1 contains detail in supplements to further describe the application of the 18 criteria. The NRC has endorsed NQA-1 in a regulatory guide as acceptable for interpreting the requirements of Appendix B of 10CFR50 for design and construction of nuclear power plants and fuel reprocessing plants.

The DOE has endorsed the use of NQA-1 in DOE Order 5700.6.

Following is a short description of the intent of each criterion.

Criterion 1 - Organization

Project managers responsible for preparing quality assurance program descriptions or plans for waste management projects could benefit by observing how NRC staff is learning from past mistakes on nuclear power plants. The NRC staff is making a concerted effort to implement lessons learned from the quality problems experienced by nuclear power plants. Applicants for a license to construct a radioactive waste repository or facility can expect a penetrating examination of the quality assurance program described in the application for a license. The staff will carefully analyze the organizational approach described in the quality assurance program to determine if the potential of success is demonstrated. Any apparent weaknesses will be questioned.

Project managers for licensed or unlicensed facilities can use the following criteria to evaluate their management approach:

1. Does the project's quality assurance program description reflect full comprehension of the performance objectives of the regulations, and have authorities been effectively assigned to ensure accomplishment of the performance objectives and the design bases?

2. Has the project manager made a commitment to comply with regulatory requirements, and is this reflected in the assignment of functional authorities?

3. Does the project provide for maintaining control over work performed by contractors and suppliers that affects the accomplishment of the performance objectives of the regulations and the design bases?

4. Has the project designed an organization and assigned functions and authorities such that the achievement and assurance of quality are integrated and are a part of the everyday work activities?

5. Does the project assign an individual to be responsible for the development, implementation and assurance of continued effectiveness of the quality assurance program? Does that individual have organizational freedom to carry out the assignment?

6. Does the project manager retain full responsibility and accountability for the overall quality assurance program? Is the project manager responsible and accountable for the end product quality?

The review of a project quality assurance program should not be limited to determining that each criterion of NQA-1 or Appendix B has been addressed, but the review must also assess the effectiveness of the described organization and assigned functions and authorities in relation to accomplishment of performance objectives stated in the regulations. Any potential weaknesses should be questioned.

Experience in nuclear plants has shown that utilities unable to fully describe assignments of functions and authorities and relate those assignments to meeting performance objectives experienced significant quality problems. Also, utilities delegating achievement of quality to the "NRC-required quality assurance organization" failed to design and implement effective quality assurance programs. A reviewer of a quality assurance program description or plan should question imprecise assignments of authority and the placement of the management of the quality assurance organization in a position that permits attenuation of information emanating from that organization intended for review and action by the project or program manager.

Criterion 2 - Quality Assurance Program

The purpose of this criterion is to cause the project manager to articulate the actions necessary to plan and implement an effective quality assurance program. In the case of licensed facilities (by states or NRC), site characterization will have been concluded before the license application is submitted. The applicant must include a description of the quality assurance program used for scientific investigations, data collection, data analysis and computer modeling during site characterization activities. The following criteria should be considered in the review of a project's quality assurance program:

1. Has the project planned to establish an effective QA program prior to start of work?

2. In instances where the project chooses to use existing data (such as existing computer codes or data from existing boreholes), have measures been described to validate and/or corroborate the data before its use?

3. Has the project written or scheduled the writing of the policies, procedures and instructions such that the documented directions are to be in place before work starts?

4. Has the project identified the items and activities important to the accomplishment of the performance objectives of the regulations and the design bases stated in the application which are to be covered by the Quality Assurance program?

5. Has the project provided for qualified personnel, appropriate equipment, suitable environmental conditions for accomplishing planned work, and verification and inspection of completed work?

6. Has the project provided for timely measurement and assessment of the effectiveness of the QA program implementation, and are actions to be taken to correct deficiencies and prevent their recurrence?

Criterion 3 - Design Control

This element is one of the more significant elements of the QA program, and its careful review and assessment at an early stage can prevent ambiguity and misunderstandings at a later stage in the design. As defined in the Atomic Energy Act of 1954, the term "design" means: (a) specifications, plans, drawings, blueprints and other items of like nature; (b) the information contained therein; and (c) research and development data pertinent to the information contained therein. The term "research and development" means: (a) theoretical analysis, exploration or experimentation; or (b) the extension of investigative findings and theories of scientific or technical nature into practical application for experimental and demonstration purposes, including experimental production and testing of models, devices, equipment, materials and processes.

The design of a radioactive waste facility or repository includes: characterizing the geologic setting; predicting the long-term stability of the site; predicting the environmental interactions between the site and its surroundings; planning and specifying processes for handling radioactive waste; and specifying requirements for constructing facilities for handling radioactive waste. The design process includes developing computer codes.

The project manager may choose to include control of scientific investigations in the description of design control or break it out as an additional criterion. The following criteria should be considered by the project manager in establishing the management controls for the design process:

1. Does the project describe measures to assure that applicable regulatory requirements and the design bases are correctly translated into specifications, drawings, procedures and instructions?

2. Does the project establish controls for design interfaces and for coordination among participating design organizations?

3. Does the project describe the plans, procedures and controls used in the data collection and analyses leading to the description of the geologic, geotechnical, hydrologic, meteorologic, climatologic and listed features of the disposal site and vicinity?

4. Have provisions been made for verification and checking the adequacy of the design?

5. Have provisions been made to control design changes?

Criterion 4 - Procurement Document Control

It can be expected that activities important to the accomplishment of the performance objectives and the design bases will be performed by a number of contractors and subcontractors. It is paramount to the successful design and construction of a radioactive waste facility or repository that the project provide the management controls to manage the work activities of contractors and subcontractors and ensure acceptable quality of the results. Work instructions, design requirements and documentation of completed work will flow between the project, major contractors and subcontractors as "procurement documents." The project manager must be able to demonstrate that procurement documents are controlled. The following criteria should be considered in the review of the project's quality assurance program:

1. Does the project assure that applicable regulatory requirements, design bases and other requirements which are necessary to assure adequate quality are suitably included or referenced in documents for procurement of material, equipment and services, whether purchased by the project or by its contractors or subcontractors?

2. Does the project require contractors and subcontractors to have quality assurance programs commensurate with the importance of the work assigned to the accomplishment of the performance objectives and the design bases?

3. Does the project ensure that contractor/supplier quality assurance programs are reviewed for adequacy?

4. Does the project describe the organization responsibilities for (1) procurement planning; (2) the preparation, review, approval and control of procurement documents; (3) supplier selection; (4) bid evaluations; and (5) review and concurrence of supplier QA programs prior to initiation of activities affected by the program? Is the involvement of the QA organization described?

Criterion 5 - Instructions, Procedures and Drawings

The purpose of this criterion is to ensure the use of formal instructions for work activities related to the accomplishment of the performance objectives. These instructions, procedures and drawings are not only important to provide planned direction but to demonstrate later how work activities were accomplished.

Criterion 6 - Document Control

Documents prescribing activities related to the accomplishment of the performance objectives must be controlled during review, approval and distribution to ensure that those performing activities have only approved and up-to-date instructions.

Criterion 7 - Control of Purchased Items and Services

It is likely that many of the geotechnical services will be contracted and also likely that selected contractors will not have provided services for a project using a disciplined approach to quality assurance. This being the case, the project will need to oversee and control the work of contractors and suppliers to ensure that the results are consistent with the accomplishment of the performance objectives. The following criteria should be considered in the review of the project's quality assurance program:

1. Does the project ensure that purchased material, equipment and services, whether purchased directly or through contractors and subcontractors, conform to procurement documents?

2. Does the project ensure that documented evidence of the review and acceptance of the purchased material, equipment or service is retained and is available for review?

3. Does the project assess the effectiveness of the control of quality by contractors and subcontractors?

Criterion 8 - Identification and Controls of Materials, Parts, Samples and Components

All materials, parts and components important to the accomplishment of the performance objectives must be identified and controlled. It is particularly important that samples be identified and controlled in accordance with approved procedures to ensure the validity of data derived from testing of the samples.

Criterion 9 - Control of Processes

All work activities important to the accomplishment of performance objectives must be controlled. Work activities or processes characterized by a need for specially trained personnel, specialized equipment or qualified procedures should be identified and care exercised to ensure the proper use of equipment and procedures by qualified personnel.

Criterion 10 - Inspection

Independent, pre-planned inspections are performed where it is deemed necessary to establish the acceptability of a product, process or service, either in progress or upon completion. The inspection and results are documented.

Criterion 11 - Test Control

A test may be conducted to determine if an item or service is acceptable, or it may be conducted to acquire additional information. Test is defined as: an operation employed to resolve an uncertainty; a procedure to ascertain effectiveness, value, proper function, quality or other characteristics; a procedure to understand a system, subsystem, component or structure; or a procedure of submitting a statement to such conditions as will lead to its proof or disproof or to its acceptance or rejection. The description of the test should indicate the purpose of the test. The following criteria should be considered in the review of the project's quality assurance program:

1. Does the project establish a test program to assure that all testing to demonstrate that structures, systems and components will perform satisfactorily in service is identified and performed in accordance with written test procedures which incorporate the requirements and acceptable limits contained in design documents?

2. Does the project establish a planned program for sampling and testing and ensure the precision, accuracy and repeatability of analytical data?

3. Does the project provide for documenting and evaluating test results to assure that test requirements have been satisfied?

4. Does the project document the plans, procedures, results and verification of geotechnical tests?

Criterion 12 - Control of Measuring and Test Equipment

All measurements that affect the quality of the work related to accomplishment of the performance objectives must be taken only with instruments, tools, gauges or other measuring devices that are accurate, controlled, calibrated and adjusted at predetermined intervals to maintain accuracy within necessary limits.

Criterion 13 - Handling, Storage and Shipping

The purpose of this criterion is to control handling, storage, cleaning, packaging, preservation and shipping of items affecting the quality of work related to the accomplishment of the performance objectives. It is of particular importance that attention be given to application of this criterion to the control of samples to prevent damage, loss, deterioration and misidentification. When necessary for particular products, a special protective environment such as inert gas atmosphere, specific moisture content levels, and temperature levels, should be specified.

Criterion 14 - Inspection, Test and Operating Status

The purpose of this criterion is to identify the inspection and/or test status of samples, structures, systems and components. Such identification will prevent inadvertent use of a sample, structure, system or component which is yet to be inspected or tested or that has been found to be unacceptable for use.

Criterion 15 - Control of Nonconforming Items

Items not conforming to specified requirements must be identified and controlled to prevent inadvertent use.

Criterion 16 - Corrective Action

The management systems that comprise the quality assurance program must be constantly monitored and timely corrective measures taken to correct conditions adverse to quality. The following criteria should be considered in the review of the project's quality assurance program:

1. Does the project establish measures to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances, are promptly identified and corrected?

2. Does the project provide for identification and documentation of significant conditions adverse to quality, the cause of the condition and the corrective action taken? Are appropriate levels of management notified?

   A significant condition adverse to quality is defined as a nonconformance or adverse condition which, if left uncorrected, could have a serious effect on safety, reliability or performance.

Criterion 17 - Quality Assurance Records

Records of activities important to the accomplishment of performance objectives are necessary during the data analysis phase for later hearings, discussions with intervenors, and during the licensing process to demonstrate the quality of work performed to meet the performance objectives. Records will also be needed should any problems related to the performance of natural or engineered barriers occur at a later date.

Criterion 18 - Audits

Audits are a part of the management system's sensors to provide measurement of the effectiveness of the quality assurance program and permit timely adjustments to ensure performance objectives are met. Audits can be effective only if they are well planned, conducted by trained personnel familiar with the work being audited and designed to measure potential of the process or activity being audited to produce an acceptable product. A well planned and executed audit will provide the managers with needed information as to the effectiveness of the management controls in place and assist in determining any needed adjustments to ensure performance objectives are met.

CONCLUSION

The project manager is the key person in the organization who can have the most influence over the success or failure of a quality assurance program for waste management. The quality assurance program provides the project management team the management systems needed to achieve and assure the quality needed to meet the performance objectives. In addition, the quality assurance program provides the records needed to demonstrate the quality attained.

The 18 criteria of NQA-1 and Appendix B of 10CFR50, while developed for the design and construction of nuclear power plants, can be used for waste management projects. The project manager must consider the intent of each criterion and apply the intent to the project. If the project manager carefully articulates the objectives the project must accomplish, assigns functions and authorities for their accomplishment and writes policies and procedures for their accomplishment, the 18 criteria can serve as a checklist to see if anything was missed.

THE NEED FOR A REAL SOURCE TERM

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For the last year the Coordinating Committee for Low-Level Radioactive Waste Disposal Technology has investigated and discussed the accuracy of the current source term estimates used for the planning of new low-level radioactive waste disposal sites. These discussions resulted from an analysis of the performance assessments performed as part of the EPRI and DOE funded projects on alternative disposal technologies. When actual source term values from several states were used to assess the performance of the various disposal technologies using reasonable site conditions, there appeared to be problems meeting the performance requirements of 10 CFR 61. Further examination of the source terms revealed that current analytical techniques and reporting requirements have resulted in the overestimation of the quantity of certain long-lived radioisotopes in the waste stream. The biggest apparent problems appear to be with the reporting of iodine-129 and carbon-14. Our discussions have led the Committee to produce a technical bulletin on the issue which presents the following four points.

1. The use of generic source terms for scoping and preliminary planning purposes is appropriate. However, since the actual source term for each new disposal site will be different, a comprehensive evaluation of the expected source terms should be one of the first tasks accomplished in the development of a new disposal site.

2. The most accurate source term data will be developed through the use of a comprehensive generator survey in which all possible efforts must be made to secure a high response rate. In designing the survey, questions should be clearly structured and developed to yield all the data which will be required. Volumes of waste requiring disposal is important. However, the isotopic distribution and concentration levels will have a greater impact on the performance assessments. Depending on the individual statutory and compact requirements, or the requirements of the host state, the survey must do more than identify waste by 10CFR 61 class. Identification of waste forms and the amount of activity in each form is useful information and should be obtained. The amount of mixed waste and the reason for the waste being hazardous must be determined. In addition, the amount of NORM waste should be determined.

3. The analysis of the generator survey results should be accomplished by technically trained individuals who can recognize when reported amounts and values for activity and concentration do not appear to be reasonable for an individual generator.

4. The limitations of current analytical techniques and sampling methods must be evaluated in analyzing the data. Current reporting requirements have resulted in values reported as "less than" or values reported as "lower limit of detection" being converted to actual values. For most isotopes this type of data handling presents no problem. However, when applied to long-lived isotopes such as iodine-129 or carbon-14 serious consequences can arise when these values are used in performance assessments.

The first item appears to be self evident, however, during discussions of source term estimation it became clear that several states have been using the published data regarding waste generation within their state without attempting to verify its accuracy. From personal experience, I know that this approach will yield grossly inaccurate data. When Texas began its efforts to develop a facility, the published literature yielded volume estimates that varied by two orders of magnitude and did not consider the effect of nuclear power plants under construction. Since it is obvious that the power plants will be the largest source of waste to be disposed of, this presented us with a significant problem. Also, since the plants were under construction, there was no operating data with which to prepare volume estimates to evaluate the isotopic distribution within this waste stream. In the last five years the estimated volume of waste to be produced in Texas has fallen from 133,000 to 92,000 cubic feet per year. This decrease in volume is consistent with the national trend. Low-level waste generators are making every effort to decrease waste volume because of rising disposal costs.

The introduction of various volume reduction techniques has impacted waste generation significantly. However, while volumes has been significantly reduced, there has been little reduction in the amount of curies which will be disposed of. Since the performance assessment which will be required for licensing is dependent on the curies to be disposed of and their isotopic distribution, I do not believe that the real source terms have changed significantly.

Because the published values may not be accurate and because the isotopes and their relative amounts are critical to performance assessment, generator surveys are absolutely critical to the development of a source term. The Authority has conducted three comprehensive surveys of Texas generators during the past five years and each has yielded smaller volumes. However, since only one power unit is operational at this time, the volume is still questionable and the types of power plant are waste a based upon the average distribution of waste from PWR's. Even in areas where there is substantial operating data, the committee has discovered that analytical techniques and reporting requirements have worked together to overestimate the quantities of certain isotopes.

The generator survey can also be used to shed light on the issue of mixed waste disposal and on the generation of NORM waste within the state or region. While the various states and regions have indicated different approaches to the disposal of these types of waste, final decisions regarding the disposal of these materials will depend on the amount and types of mixed waste and NORM waste generated.

The analysis and compilation of the data derived from the generator surveys must be accomplished by trained and experienced professionals. This is necessary for two reasons. The first is that trained personnel will have an understanding of waste volumes and types of waste which are generated by the various types of waste producers. Secondly, the trained professional will be able to detect values which do not appear to be in a reasonable range for the type of generator reporting

The last of the four items mentioned in this paper is the most important. Under the existing regulatory framework the critical licensing issue will be the demonstration that the proposed disposal site will meet the performance objectives established in 10 CFR 61 for some period of time.The only way to adequately address this requirement is the use of performance assessment codes. The performance assessment will consist of integrating the source term into various transport models, i.e., groundwater transport, surface water transport, atmospheric dispersion, etc. The transport models have the inherent problem of trying to develop a precise mathematical model which approximates reality. There is, however, a history of using these models. A site which meets the site suitability criteria should be capable of being modeled. The key then becomes the accuracy of the source term.

As indicated in the introduction, during the conduct of studies for both EPRI and DOE, performance assessments were conducted for various disposal technologies at a hypothetical site which represented a northeastern location and the source term was based upon generation rates, isotopic distribution, and activity levels currently found in the literature.

The performance assessments of several disposal technologies indicated that the site would not meet the thyroid dose limit under several realistic scenarios. Several states then looked at the reported generation rates from their states and determined that the carbon-14 and iodine-129 concentrations reported were considerably higher than those used in the performance assessment, leading to the conclusion that there were serious questions about being able to site a disposal facility if the source term numbers were true and the performance assessments were realistic.

These states then began a process of backtracking the waste generation data to assess its validity. It became apparent that for several nuclides the values reported as actual activity disposed of where incorrect. Iodine-129 is particularly difficult to analyze and as a result many generators were reporting lower limit of detection or less than values. However, when these values were entered into the existing data base, the numbers became actual concentration values. Similar problems were noted in the reported values for carbon-14.

EPRI convened a two day workshop on the issue of the iodine-129 source term and the results indicated that the published values for iodine concentrations are at least one order of magnitude too high and possibly two orders of magnitude greater than actual values.

This situation presents a problem for both the waste generators and the developers of new disposal sites. From the generator perspective, the reporting of less than or lower limit of detection values is conservative and the increased costs of more sophisticated analytical methods may not be justified. From the developer perspective, the potential that this type of reporting procedure may adversely effect licensing efforts is unacceptable.

In conclusion, the committee feels strongly that more stringent reporting requirements may be needed in various states and regions and that generators should be required to utilize more sophisticated analytical techniques to provide more realistic values for source terms. Then, during site licensing a more realistic source term may be utilized in the performance assessments of the facility.

VERIFYING GENERATOR WASTE CERTIFICATION: NTS WASTE CHARACTERIZATION QA REQUIREMENTS

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Waste management activities managed by the U.S. Department of Energy (DOE) at the Nevada Test Site (NTS) include the disposal of low-level wastes (LLW) and mixed waste (MW), waste which is both radioactive and hazardous. A majority of the packaged LLW is received from offsite DOE generators. Interim status for receipt of MW at the NTS Area 5 Radioactive Waste Management Site (RWMS) was received from the state of Nevada in 1987. The RWMS Mixed Waste Management Facility (MWMF) is expected to be operational in 1988 for approved DOE MW generators.

The Nevada Test Site Defense Waste Acceptance Criteria and Certification Requirements (NVO-185, Revision 5) delineates waste acceptance criteria for waste disposal at the NTS. Regulation of the hazardous component of mixed waste requires the implementation of U.S. Environmental Protection Agency (EPA) requirements pursuant to the Resource Conservation and Recovery Act (RCRA). Waste generators must implement a waste certification program to provide assurance that the disposal site waste acceptance criteria are met.

The DOE/Nevada Operations Office (NV) developed guidance for generator waste certification program plans. The guidance integrates requirements of NVO-185, the Nuclear Regulatory Commission's (NRC) QA Guidance for Low-Level Radioactive Waste Disposal Facility (NUREG-1293, currently in draft), and the EPA's requirements in Test Methods for Evaluating Solid Waste (SW-846). The guidance format corresponds with the basic elements and titles of NUREG-1293 but is directed toward requirements necessary to characterize and certify waste.

Periodic technical audits are conducted by DOE/NV to assess performance of the waste certification programs. The audit scope is patterned from the waste certification program plan guidance as it integrates and provides a common format for the applicable criteria. The criteria focus on items and activities critical to processing, characterizing, packaging, certifying, and shipping waste.

Basic elements of the NTS waste certification program begin with organizational requirements. The organization responsible for certifying waste must be independent from the waste processing, characterizing, and packaging organization. The certification organization must provide independent oversight that the waste has been properly processed, characterized, and packaged. The waste certification program plan must clearly identify relationships and interfaces between various organizations.

Design control is required for facilities and processes that satisfy or confirm that waste certification criteria are met. This can include waste solidification, treatment, sampling, analysis, and inspection. Designs should be reviewed by persons other than the primary designers, and the review must be documented.

Purchases of materials, items, or services important to waste characterization and certification should be controlled by carefully prepared requisitions and purchase orders. Compliance with the written specifications must be verified upon receipt. Examples of purchased items or services important to the certification process are containers (U.S. Department of Transportation (DOT) Type A), analytical or assay services, and process equipment for production of acceptable waste forms.

In addition to purchased items and services, certain materials require identification and control. This includes waste packages with conforming waste materials, radiation detection instruments and the sources used for their calibration, acceptable waste containers, cement or accepted solidifiers, and waste samples. Materials, parts, samples, and components found to be out of specification, or not operable, should be handled as non-conforming items.

Activities critical to certification must be performed in accordance with written procedures and instructions. Activities requiring procedures, instructions, or drawings are waste characterization, analysis (includes both radionuclide and chemical constituents in MW), inspection, and compliance with EPA chain-of-custody, testing, and data control requirements. A document control system is necessary to manage documents critical to waste certification. The system whereby instructions, procedures, and drawings are authorized, reviewed, accepted, distributed, used, and kept current should be reviewed by persons independent of the waste operations organization.

Certain processes or series of activities important to waste certification must have controls or verification steps identified as part of operating procedures. These processes and critical inspection points must be clearly identified and described in the certification plan. For MW, critical EPA requirements related to sample collection, packaging, analysis, and data handling must be described in detail sufficient to qualify as acceptable waste characterization/waste analysis plans. Similar activities related to radiometric assays should be controlled and carefully described. The entire waste certification process, which provides evidence of compliance with NVO-185, is a controlled process with records, statements, reports, and data being used by the certifying official to sign a certification statement.

Certain physical tests are necessary to substantiate waste certification, to resolve uncertainties, or to verify quality. Examples of test controls are instrument calibration, spiked or split samples, replicate samples, blanks, background measurements, electronic calibrations, and calibration source traceability. Test plans or protocols should be prepared by those who will perform tests and reviewed by a second, disinterested but technically competent, individual. Test equipment and measuring devices should bear, by label, notation, or some other means, evidence that they are currently calibrated or certified for current use.

Wastes should be handled, stored, and shipped in a manner which will not alter certification status. Handling and storage considerations should include provisions for security and fire protection. MW should comply with EPA requirements for storage and shipping. Handling and storage of LLW or MW should comply with "As Low As Reasonably Achievable" (ALARA) precepts. Waste shipments must also comply with DOT requirements with respect to packaging, manifests, and labeling.

Inspection or surveillance of activities is performed by the certification organizations for waste certification or by the waste operations organization for process control or verifying waste characterization activities. Items or activities found to be out-of-specification or nonconforming must be removed from operating status or operational acceptance. Once identified, nonconforming items must be documented and tracked until successful resolution can be demonstrated. Adequate corrective action for nonconforming items is the responsibility of each individual associated with waste certification activities including certifying officials, waste generators and operators, shipping management, and QA management.

Records demonstrating compliance with certification criteria should be maintained for time periods equivalent to similar onsite records retention requirements. Quality Assurance records important to certification include, but are not limited to, the certification plan, organization charts, training records, letters/memos providing notification of planned audits or inspections, audit report checklists, responses, and nonconformance findings with completed corrective actions.

Audits/surveillances are conducted to assess performance of the waste certification program with certification requirements of NVO-185. Audits may be conducted internally by the DOE generator site personnel or externally by DOE/NV. The audits/surveillances are performed to assess the adequacy of the certification program with respect to waste process controls, assay and analysis compliance, waste form compliance, records compliance, and container and shipping compliance. The audits are formal events, fully planned and documented, with written notifications, checklists, reports, and resolution all being part of the audit method.

In conclusion, the waste certification program must meet DOE requirements for LLW and incorporate EPA requirements for MW. DOE/NV has combined the requirements into NVO-185, which serves as a criteria document for generators that dispose of waste at the NTS. At the disposal site, the NTS waste analysis plan in effect, becomes a technical audit of generator waste certification programs. Waste certification program plans document and provide assurance that wastes are properly characterized and that NTS waste acceptance criteria are met.

AN OVERVIEW OF THE WASTE CHARACTERIZATION PROGRAM AT CHALK RIVER NUCLEAR LABORATORIES

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ABSTRACT

In the last five years, Chalk River Nuclear Laboratories (CRNL) placed 17 000 m^3 of wastes into storage (excluding contaminated soil and fill). Almost half of the waste was generated off site.

CRNL is now developing IRUS, an Intrusion Resistant Underground Structure, and the IST, an Improved Sand Trench, to replace storage with safe, permanent disposal. IRUS will be used to dispose of wastes with radiologically hazardous lifetimes between 150 and 500 years duration and the IST will be used for wastes with radiologically hazardous lifetimes of less than 150 years.

A comprehensive Waste Characterization Program (WCP) is in place to support disposal projects. The WCP is responsible for (1) specifying the manifests for waste shipments; (2) developing and maintaining central databases for waste inventories and analytical data; and (3) developing the technologies and procedures to characterize the radiological and the physical/chemical properties of wastes. WCP work is being performed under the umbrella of a newly developed waste management Quality Assurance (QA) program.

This paper gives an overview of the WCP with an emphasis on the requirements for determining radionuclide inventories in wastes, for implementing record-keeping systems and for maintaining a QA program for disposal operations.

INTRODUCTION

The call for papers for this conference asked that participants address a number of designated issues relevant to each of the sessions held. This paper addresses the following issues in the context of the Waste Characterization Program (WCP) now in place at Chalk River Nuclear Laboratories (CRNL):

- Who needs waste characterization data?

- What techniques are available for waste characterization? (How are characterization data generated?)

- How accessible are the data to those that need them? (Is a standardized waste manifest required?)

- How is confidence in the data established?

WHO NEEDS WASTE CHARACTERIZATION DATA?

First and foremost, the operator of a waste management site needs characterization data to determine if:

(i) wastes received from off-site generators meet acceptance criteria (radionuclide inventories, free liquid content, toxic and hazardous substances content, etc.),

(ii) engineered waste forms (for example, bituminized or cemented wastes) meet process specifications; for example, radionuclide loadings, leachability, stability, etc, and

(iii) radionuclide and toxic/hazardous substances inventories for waste disposal facilities remain below derived limits.

Regarding point (i) above, the feedback of characterization data to waste generators from site operators would assist generators in meeting waste disposal site acceptance criteria and in correcting situations where acceptance criteria are not being met.

The regulators of disposal sites need access to the data that site operators use to obtain and to maintain approval for operations. In addition to accessing the data, the regulators must be provided with the means for assessing the level of confidence in them. Confidence in the data is discussed later in this paper.

WHAT TECHNIQUES ARE AVAILABLE FOR WASTE CHARACTERIZATION?
(how are characterization data generated?)

There are two types of waste characterization data. The first type defines the inventories of radionuclide contaminants in wastes and the second defines the physical/chemical properties of wastes.

Radionuclide inventory data

There are two ways of determining radionuclide inventories in wastes. The first uses inference. Based upon a knowledge of where and how wastes were generated, it is often possible to infer (i.e. estimate) their inventories by measuring total radiation fields and using scaling factors for relative abundances of individual radionuclides. In addition, by assaying radionuclides that are easily detected (e.g. Cs-137), it is possible to infer the inventory of radionuclides that are more difficult to measure (e.g. Sr-90). The second method involves the direct measurement of radionuclides by the noninvasive monitoring or the destructive, radiochemical analysis of wastes.

The optimization of costs and minimization of effort required to determine radionuclide inventories require the implementation of a well-balanced mix of inference and analytical methods.

(a) inference

The production of the medical tracer Mo-99 at CRNL involves the irradiation of uranium targets in a reactor, the dissolution of the targets and the chemical purification of the resultant solution. The processes involved are well defined, for example the irradiation time in the reactor is recorded, and it is possible to prepare estimates of the yields of the radionuclides generated in the targets. In addition, it is possible to estimate the fractionation of radionuclides into various product and waste streams during the dissolution and purification steps. Therefore, it is possible to infer the types and the quantities of the radionuclide contaminants in the wastes generated. Thus, it is feasible to infer standard radionuclide signatures for specific Mo-99 production waste streams.

When a site receives wastes for placement within a disposal facility, the regulator will likely allow the operator to use an inferred radionuclide inventory as the basis for acceptance for disposal if:

(i) the waste generator or the site operator has an <u>acceptable</u> (by the regulator) method for inferring the inventory in the wastes,

(ii) the generator or site operator has a <u>validated</u> alternate method for confirming the inferred inventory (for example by direct assay), and

(iii) the wastes received are clearly labelled to allow the site operator to confirm the origin of received wastes.

In Canada, radioactive waste disposal is not practiced yet and, therefore, CRNL accepts wastes for storage only. At present, CRNL uses inference to segregate wastes into the various storage facilities in use. In general, direct assays are not performed to confirm the inferred characteristics of wastes placed into storage. However, once disposal begins at CRNL, either with the <u>I</u>mproved <u>S</u>and <u>T</u>rench (IST) [1] or the <u>I</u>ntrusion <u>R</u>esistant <u>U</u>nderground <u>S</u>tructure (IRUS)[2] disposal projects, confirmation of inferred radiological characteristics will have to become the norm rather than the exception.

A *thorough review of the* CRNL *Waste Inventory Programs (WIP)* database, which is used to file the inferred characteristics of wastes now in storage, was performed to assess the quality of the information on hand. The review of WIP data showed that in the majority of cases the inferred characteristics of wastes would be inadequate to be used as a basis for acceptance by a disposal facility. This derives from the fact that, historically, waste generators were not required to, and therefore did not supply, inventory estimates that would meet acceptance criteria for disposal (CRNL has been accepting off site wastes for storage for over 42 years).

CRNL is currently formulating guidelines for waste generators to follow for providing estimates of the radionuclide inventories in their wastes. CRNL will reject wastes from generators if the guidelines are not adhered to or it will impose a surcharge to cover the cost of estimating the radionuclide inventory in the waste. This policy should result in a dramatic increase in the percentage of wastes that can be characterized for disposal using inference. This will reduce the need for, and the cost associated with, performing waste assays (periodic, confirmatory assays will still be required).

(b) waste assays

The second method to quantify the radionuclide inventories of wastes uses direct assays. Assays can be done on the entire population of wastes in any given stream (survey analysis) or on a representative sample of wastes. Assays can be done by noninvasive monitoring or by destructive, radiochemical analysis.

The noninvasive monitoring of wastes can be performed using neutron interrogation, gamma-ray spectrometry and gas proportional counting. Neutron interrogation methods can be used to assay alpha-emitter contaminated wastes [3]. Gas proportional counting is useful for determining radionuclides with low energy emissions, for example I-125, but it is not easily applied to the assay of radioactive wastes because of the geometries involved. WCP participants opted to direct their initial, radiological characterization efforts at CRNL to gamma-ray spectrometry [4] since Canada does not have TRU wastes generated from reprocessing and defence activities.

One advantage of monitoring is that larger quantities of wastes can be assayed than would be possible if costly radiochemical analyses were used. This permits the survey analysis of waste streams that are difficult, if not impossible, to sample for analysis. The survey analysis of wastes allows CRNL to identify specific radionuclides in individual waste items, such as bags, and to segregate these wastes prior to processing (for example, to keep Cs-137-rich bags out of bales). This technology would also be effective in meeting the requirements of 10 CFR 61 [5] for the segregation of class A, B and C wastes.

Figure 1 is a schematic of a gamma-ray waste monitor that CRNL developed. This monitor has been used to assay bags of trash prior

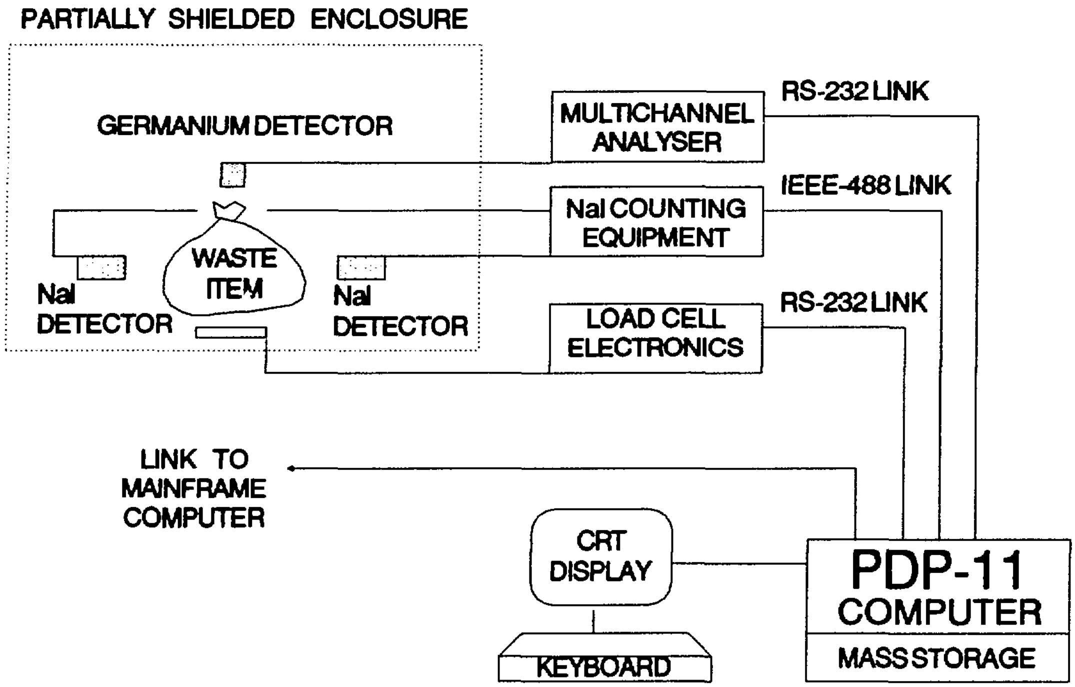

Figure 1: Configuration of the First CRNL Waste Monitor

to incineration or compaction and bales of compacted trash or drums of incinerator ash produced at the CRNL Waste Treatment Centre (WTC) [6]. A new waste monitor, based on multichannel analyzer cards in IBM-PC compatible computers, has been installed near one of the CRNL waste-receiving zones to assay wastes with activities that make them unsuitable for processing at the WTC (high fields or significant alpha- or long-lived beta-emitter contamination). Both of these monitors are being used to determine the specifications for a high-throughput waste assay station to be used to support waste disposal operations.

The disadvantage of gamma-ray monitoring is that it cannot be used to directly assay for alpha- and beta-emitting radionuclides in wastes having appreciable quantities of gamma-ray emitting radionuclides. However, if verified alpha-, beta- and gamma-emitter correlations are established via alternative methods (inference or radiochemical analysis), gamma-ray spectrometry can be used to infer alpha- and beta-emitter activities in wastes. The main objective of the CRNL ash analysis program [7] is to determine these correlations for wastes handled at the WTC.

Radiochemical assays have the potential to determine all the major radionuclides in wastes but this approach is limited by:

(i) the high cost of radiochemical analyses (about $CDN 1000 per sample for incinerator ash),

(ii) the long time required to do a complete analysis (two weeks from start to finish for ash samples), and

(iii) the difficulty in obtaining a representative sample of waste to analyse (ash is relatively easy).

Figure 2 shows the CRNL radiochemical analysis scheme for ash.

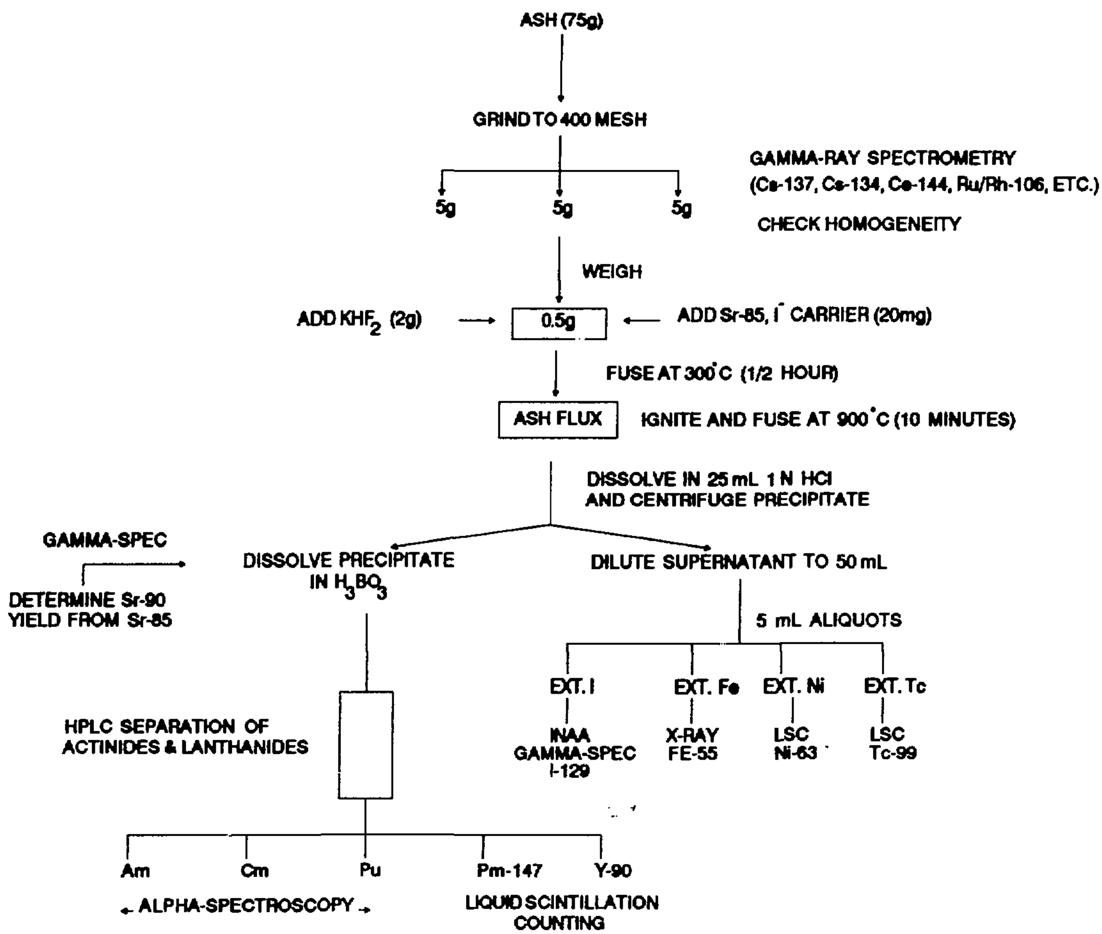

Figure 2: The CRNL Radiochemical Analysis Scheme for Ash

CRNL decided to use radiochemical analyses to determine, wherever possible, the alpha-, beta- and gamma-emitter activity correlations as a means of supplementing the gamma-ray monitoring of wastes. This is still the approach for developing characterization technology in support of disposal facilities.

Physical/chemical characterization data

Two types of physical/chemical waste characterization R&D are being done at CRNL. First, there is a program to develop stabilized waste forms that have enhanced radionuclide retention properties [8] and, second, there is a program to determine the behaviour of waste forms in repository environments [9]. Both of these programs involve the detailed characterization of the physical/chemical properties of wastes and the determination of the relationship between observed properties and waste form performance. They also provide needed information about the nonradiological, yet toxic and hazardous, components of wastes.

Currently, with storage being practiced and not disposal, CRNL relies upon the waste generator's description of the physical/chemical properties of wastes (on shipping manifests) as the basis for acceptance for storage. As with the radiological aspect, confirmation of these estimates will have to be provided by way of alternative methods, such as sampling and destructive analyses, once disposal begins.

HOW ACCESSIBLE ARE THE DATA TO THOSE THAT NEED THEM? (is a standardized waste manifest required?)

The Waste Management Technology Division at CRNL is responsible for developing computer databases in support of waste storage and future waste disposal operations. The WIP database, described above, was implemented on the CRNL site's mainframe CYBER computer and is accessible by anyone who is given valid entry passwords. Passwords are required at three levels to: (1) log on to the mainframe, (2) access procedures to use the database and (3) generate reports on the database's contents.

WCP participants, CRNL managers and the site regulator can gain access to the database from terminals located either at CRNL or off site via telephone lines. Procedures have been set up to produce reports for those who are given access to WIP. This level of accessibility ensures that all who need the data can get them.

WIP data are obtained from a Waste Transfer and Storage Record form, the waste shipment form now in use at CRNL. The form, which was designed by the Waste Management Technology Division prior to developing WIP, is completed every time wastes are moved around the CRNL site, for example from a research reactor to the WTC or storage, or when wastes arrive from off site. The form, and thus the WIP database, is used to record:

- a code to identify the waste origin (down to even a building or process origin code for a site),

- when wastes were stored and in what storage facility (in the future this will be disposal as well),

- the number and types of packages and their volumes and masses,

- the type of waste material (ash, trash, resin, etc.),

- solidification agents (bitumen, cement, etc.), and

- the inferred radionuclide inventory.

The CRNL waste transfer form also has a space to record a waste item identification (ID) number. The ID number is a key component to the CRNL inventory tracking system that is under development. All wastes to be stored or disposed will be labelled with the ID number that will be recorded on the transfer form as well. The transfer form data, including ID, will be routinely entered into the WIP database.

In addition, whenever wastes are assayed radiologically, by monitoring or sampling and analysis, or for physical/chemical properties, the analytical data will be filed in separate analytical databases along with the waste ID number. Whenever a waste item is to be placed into a disposal facility, its radionuclide inventory and physical/chemical properties can be reported from WIP by retrieving the inferred properties reported from the waste transfer form or the analytically determined properties from the cross-referenced analytical databases. The retrieved information can be used to calculate running totals of radionuclides and toxic and hazardous materials being placed into the facility.

The review of the WIP database, described earlier, pinpointed shortcomings in the database. These derived, almost exclusively, from deficiencies in the design and use of the waste transfer form. Only after a significant amount of data had been transcribed from the forms to the WIP database did these deficiencies become evident. Currently, the waste transfer form design and the WIP database structure are under review.

Since disposal is unlikely until 1991 or 1992, the use of the WIP and analytical databases and the testing of the inventory tracking system will be used to "iron out the wrinkles" in the support programs for disposal operations.

At present, the use of a standardized waste manifest at CRNL is limited to the transcribing of information from individual waste generator's manifests to the CRNL Waste Transfer and Storage Record form. Off site generators are not yet required to ship wastes with a standard manifest. Some of the data management problems that were uncovered in the WIP review may have been avoided had there been a standardized waste manifest in use.

Now that CRNL has gained considerable experience in the area of database management in support of waste management operations, it is in a position to develop and implement a standard manifest for use by all generators that send wastes to CRNL. A standard manifest would greatly simplify the task of database management in support of operations.

Waste manifests should be structured to reflect their relationships with electronic databases. That is, while it is always possible to design the structure of an electronic database to file the information from a manifest, it does not directly follow that the database's structure is suitable for proper reporting and analysis of the data filed. For example, the first CRNL waste manifest included the categories "other" for waste material type and "other" for package type. It also had a space to record comments. Upon review of the data in the WIP database there were entries for waste type "other" in package type "other" and the remarks field contained "miscellaneous waste". The quality of a database record of this sort is highly undesirable. Waste manifests should not offer ambiguous options for waste originators to select.

There were entries on CRNL's manifest such as "pipe", "metal pipe", "asbestos on piping", "pipes with alpha", and so on. Information should be recorded to clearly separate the description of <u>what an item is</u>, such as piping, from <u>what it is made of</u>, such as aluminum or steel, and from <u>what defines it as toxic or hazardous</u>, such as alpha contamination, mercury contamination, and so on.

HOW IS CONFIDENCE IN THE DATA ESTABLISHED?

Waste disposal site operators must satisfy operating license requirements and they should also strive to gain the confidence of the public. To accomplish both of these tasks, operators must demonstrate that the work they performed was done according to accepted standards.

In the area of waste characterization, operators must demonstrate that all data were properly acquired, processed, filed and reported. That is, operators must show that the methods to generate data (inference, monitoring and analyses) and the methods to calculate results and to store and retrieve data in databases were quality assured.

Figure 3 shows the overall structure of the waste management Quality Assurance (QA) program at CRNL.

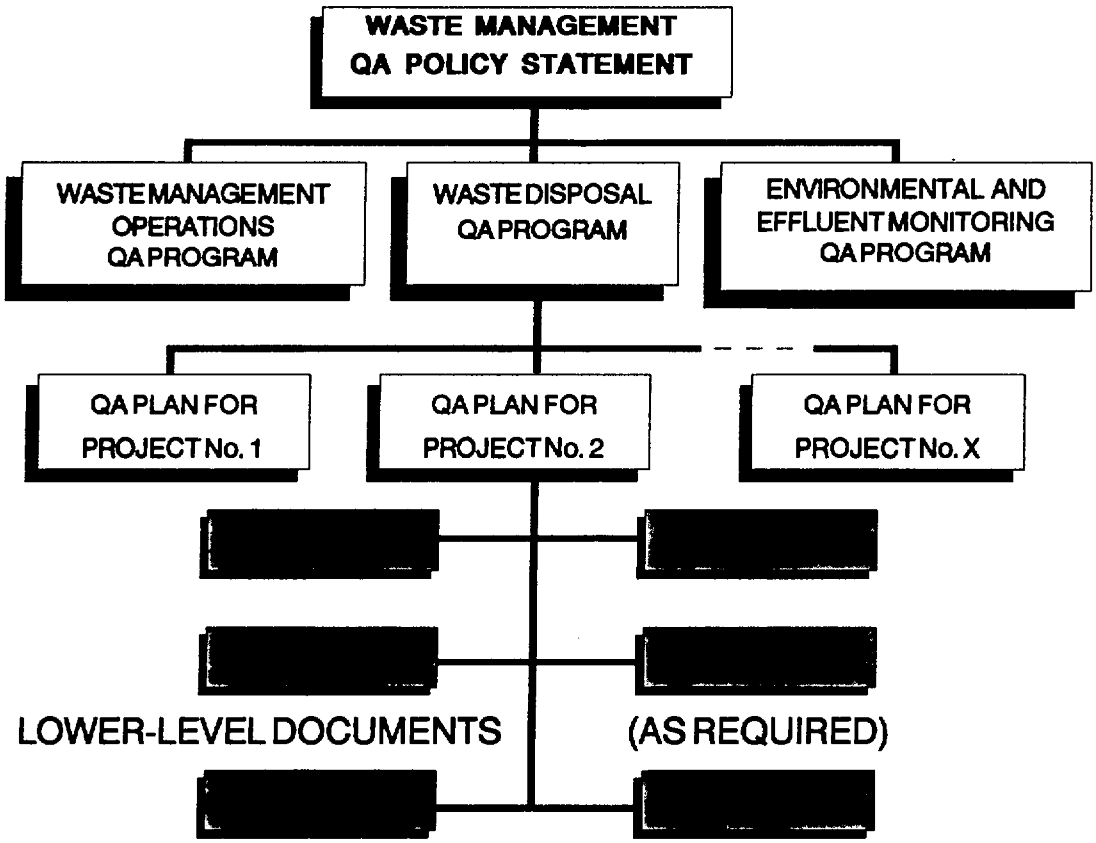

Figure 3: Structure of the Waste Management Quality Assurance Program at CRNL

The policy statement defines the operating guidelines for waste management at CRNL and formally states the site's commitment to the QA of work conducted. Since waste management encompasses many disciplines, three separate QA <u>programs</u> were set up within the framework of the policy statement.

The Waste Management Operations QA program focusses on assuring the quality of work associated with the routine handling of wastes (receiving, routine monitoring, data recording, storage and disposal operations, etc.), the Waste Disposal QA program focusses on assuring the quality of work specifically limited to disposal operations and the Environmental and Effluent Monitoring QA program focusses on assuring the quality of work associated with the protection of the environment, CRNL staff and the general public.

The establishment of three QA programs was carried out to accommodate the fact that greatly different tasks can be performed within each of the major areas of waste management. For example, the task of emplacing wastes in storage or disposal facilities and the recording of data on a manifest (in Waste Management Operations) is quite different from the computer modelling of waste disposal facilities (in Waste Disposal) or the mapping of groundwater flow (in Environmental and Effluent Monitoring). The diversity of tasks would require either a very complex overall QA program for waste management or the implementation of smaller, less cumbersome QA programs that could be better tailored to the type of work conducted within subprograms of waste management. CRNL opted to implement the second strategy.

Within the Waste Disposal QA program, CRNL implements QA by way of QA plans for each major disposal project undertaken. This project-by-project approach accommodates the fact that different projects can differ greatly in scope and would, therefore, require different implementations of QA. For example, the IRUS facility will require detailed engineering of the repository vault, whereas the IST facility will require much less design effort. Therefore, the QA programs for these two disposal concepts will vary greatly in scope and will be developed individually to match the scope of the work conducted.

Figure 4 shows the document hierarchy for the IRUS QA plan. Because of the large scope of the IRUS project, the QA plan is to be implemented on a phase-by-phase level for each major phase of the project. There are eight different phases to IRUS and various project participants have been assigned the responsibility for developing the QA plans for the phases. For example, the head of the design team is responsible for the Design Phase QA plan, the head of the Waste Management Operations Branch is responsible for the Operation Phase QA plan, and so on. This approach to QA implementation assures that:

- the best-qualified project participants are responsible for QA in the areas of the project they know best,

  [Approval for all QA programs, plans and procedures must be obtained from the site's Quality Management Division (QMD). Thus, even though development of QA for projects is distributed among participants, the QMD acts as the central site authority for approval of QA documents, programs, etc.]

- the QA plans for the phases are tailor-made to fit the type of work performed within project phases,

- QA plans for individual projects are matched to the scope of the projects themselves, and

- a clear and concise delineation of responsibilities for QA is set forth for the regulator.

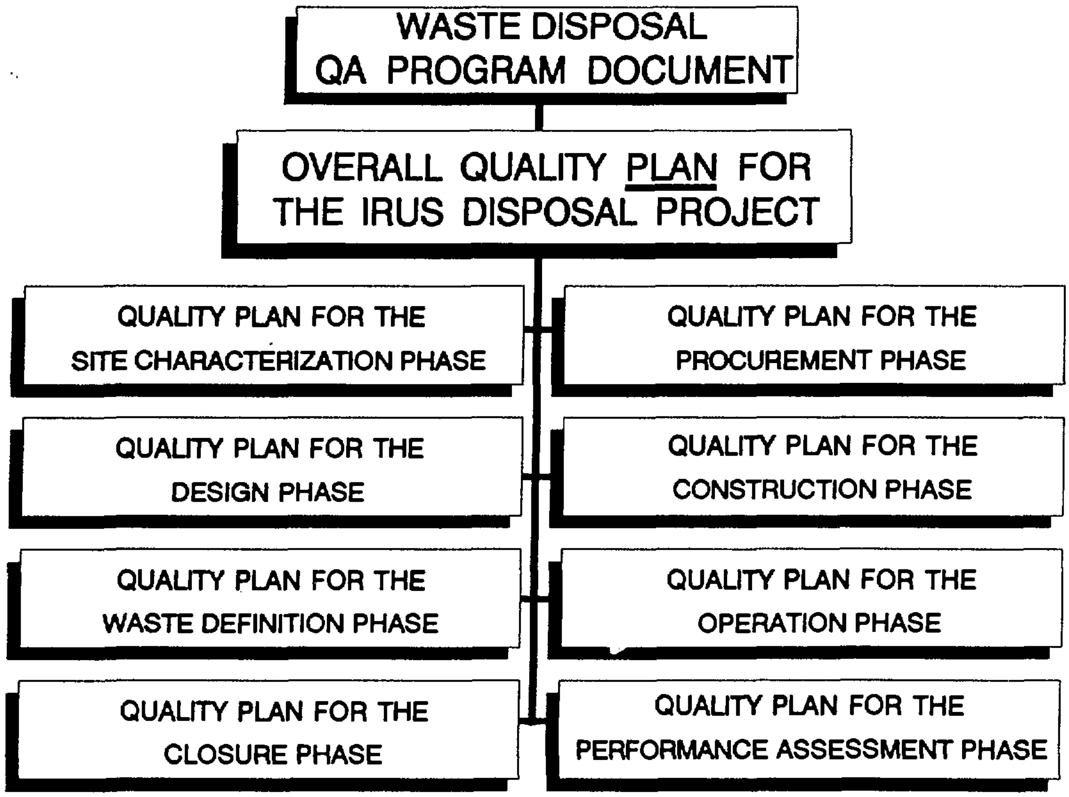

Figure 4: Document Hierarchy for the IRUS Disposal Project QA Plan

QA for waste characterization in support of the IRUS project is carried out within the Waste Definition Phase. However, since the type of characterization work to be carried out within the Waste Definition Phase of IRUS will be similar to much of the characterization work to be carried out for other waste disposal projects, most QA procedures developed to support IRUS can be applied directly to support projects such as the IST. Therefore, unlike the QA for most other phases of IRUS, the QA for the Waste Definition Phase is readily applied to other projects since the characterization work itself is readily applied across projects.

The QA program for Waste Disposal and the QA plan for IRUS were developed with close consultation by CRNL's regulator, the Atomic Energy Control Board (AECB). This consultative process should ensure that the AECB will be satisfied with the full implementation of the QA program for IRUS. It should also ensure that the AECB and the public will be able to gain full confidence in the quality of the work conducted by CRNL.

SUMMARY

The Waste Characterization Program at Chalk River Nuclear Laboratories, which was set up to support waste disposal projects, has been structured to ensure that:

- the information generated by the program is readily available to those who require it for operational or regulatory needs,
- the work performed within waste disposal projects, and in particular waste characterization, is quality assured, and
- prior to the start-up of disposal operations, all systems for characterization, data management and inventory tracking are tested within the waste storage program.

By implementing a balanced mix of characterization technologies, focussing on the standardization of methods across various disposal projects and consulting with the site regulator on QA issues, CRNL is confident that its characterization program will readily satisfy waste disposal site licencing requirements.

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CHARACTERIZATION OF A PRESSURIZED WATER REACTOR SPENT FUEL HARDWARE

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Abstract

Understanding the nature of a waste stream is critical to designing a system to properly handle, package, store, and dispose of the waste. Currently, many utilities are considering consolidating their spent fuel. This process removes the fuel pins from an intact fuel assembly and leaves ~30 kg of hardware per assembly to dispose. This paper will present the results of work done to characterize a Westinghouse 14X14 fuel assembly. Measurements of the radionuclide concentrations in samples of irradiated hardware are presented. Additionally, measurements of the elemental composition of each of the samples is given, in order that a correlation may be established between radionuclide generation and parent isotope.

I. Summary

Under the Nuclear Waste Policy Act (NWPA) of 1982, the Department of Energy will be accepting spent nuclear fuel for disposal. Included with the fuel will be a significant quantity of activated metal in the form of fuel assembly end fittings, grid spacers, guide tubes,etc. This report characterizes the activated metals in a representative spent fuel assembly, a Westinghouse 14x14, to better allow consideration of how to accommodate the activated hardware within the Federal Waste Management System (FWMS).

A total of twelve (12) samples were obtained and analyzed. These samples were analyzed for chemical composition and radionuclide content. The results of this laboratory work are presented in this paper.

II. Sample Description

Twelve samples were obtained to represent each of the materials of construction, in each possible location, as well as each of the fuel assembly's main structural components. Samples were taken from each grid spacer, and from the main casting of both the bottom and top end fittings. Additional samples were also obtained of the spring material in the top end fitting.

The location of each of the samples and the material it manufactured from is described in figure 1. The samples were obtained by mechanical means (i.e. by cutting and snipping). Sample sizes were on the order of 0.1-5.0 gm. These were latter sub-sampled, with the remaining sample being retained in the event that further analysis would be required. The sample locations were selected to represent all the different materials available on each fuel assembly in as many different regions as practicable. Samples were taken from each grid spacer to provide as much data as possible regarding the shape of the neutron flux through the core region. The grid spacer samples also provided a good indication of the variance in the elemental composition of a structural material (Inconel), in particular for the trace elements.

The irradiation history for the fuel assembly was obtained from information supplied by the utilities to the Department of Energy in the annual spent fuel data survey, RW-859. Table 1 provide a detailed irradiation history of each fuel assembly sampled.

Table 1

Westinghouse 14x14

Peach Bottom 400.7 kg U 3.192 w/o U-235

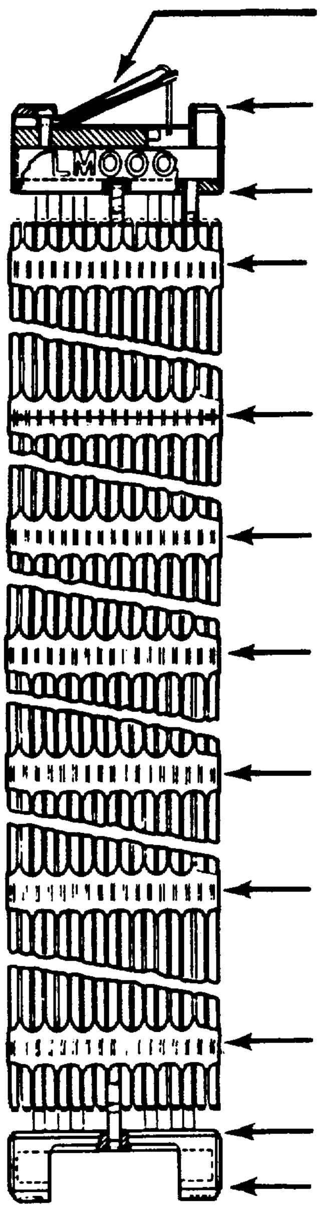
Cycle #	End of Cycle	Burnup @ EOC [MWD/MTU]
4 (out)	1 OCT 76	0
5	10 OCT 77	6,147
6	20 SEP 78	16,784
7	5 OCT 79	26,195
8	26 NOV 80	29,621
9	8 OCT 81	32,729

The results of the sample analysis is presented in figures 2-7. These figures show the concentration for each radionuclide and the amount of parent material in each sample. The figures also present the curies of the radionuclide normalized to the amount of parent material. From this information can be seen the relative production of each isotope as function of position.

III. Future Work

PNL is also performing similar sample analysis of a Combustion Engineering 14x14 and a General Electric 7x7 fuel assembly. In addition to the sampling program, PNL is doing calculations to predict radionuclide concentrations in all the samples obtained. This will provide a comparison of laboratory measurements to calculations to determine how well the concentrations of these radionuclides can be predicted. This work will help in describing the radioactive nature of the activated metals to assure that the material is handled, packaged, shipped and stored safely and properly.

Sample Locations - Westinghouse 14 × 14



W-10 Hold-Down Spring (Inconel)

W-12 Upper Nozzle (Stainless Steel)

W-9 Upper Nozzle (Stainless Steel)

W-8 Grid Spacer (Inconel)

W-7 Grid Spacer (Inconel)

W-6 Grid Spacer (Inconel)

W-5 Grid Spacer (Inconel)

W-4 Grid Spacer (Inconel)

W-3 Grid Spacer (Inconel)

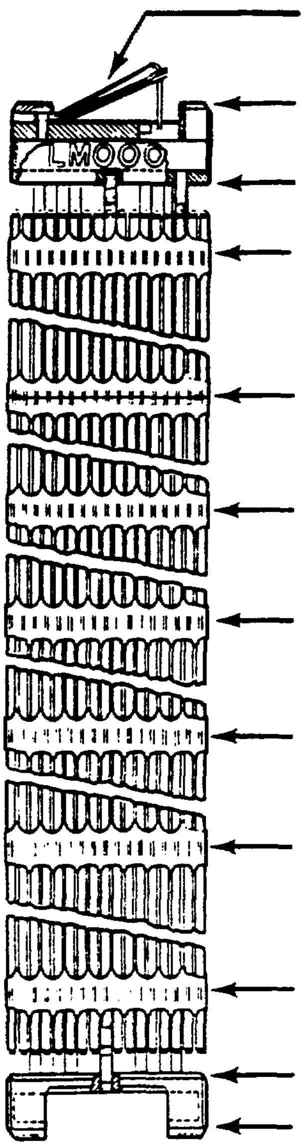
W-2 Grid Spacer (Inconel)

W-11 Lower Nozzle (Stainless Steel)

W-1 Lower Nozzle (Stainless Steel)

Radio-Chemical Analysis
Westinghouse 14 x 14

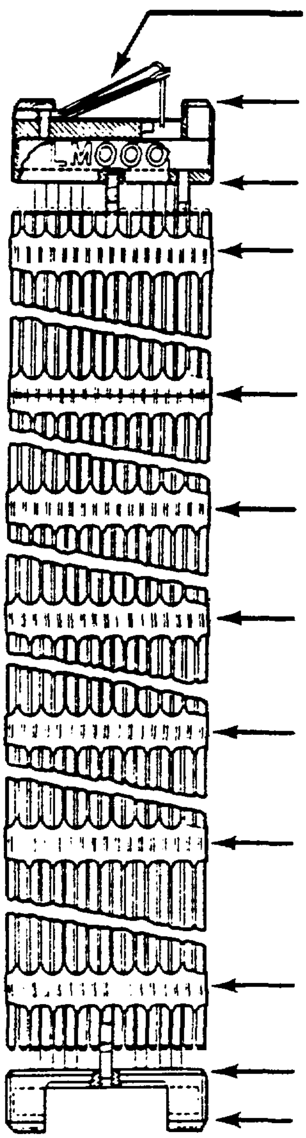
Co-60



Curies/gm of Sample	Parent Element w/o Cobalt	Curies ^{60}Co per gm Cobalt
3.24E − 5	0.0709	4.57E − 2
7.21E − 4	0.150	4.81E − 1
5.72E − 3	0.150	3.81
5.77E − 3	0.148	3.90
1.80E − 2	0.089	20.2
3.30E − 2	0.115	28.7
3.90E − 2	0.131	29.8
3.54E − 2	0.119	29.7
3.68E − 2	0.130	28.3
1.35E − 2	0.111	12.2
5.63E − 3	0.115	4.90
8.06E − 3	0.150	5.37

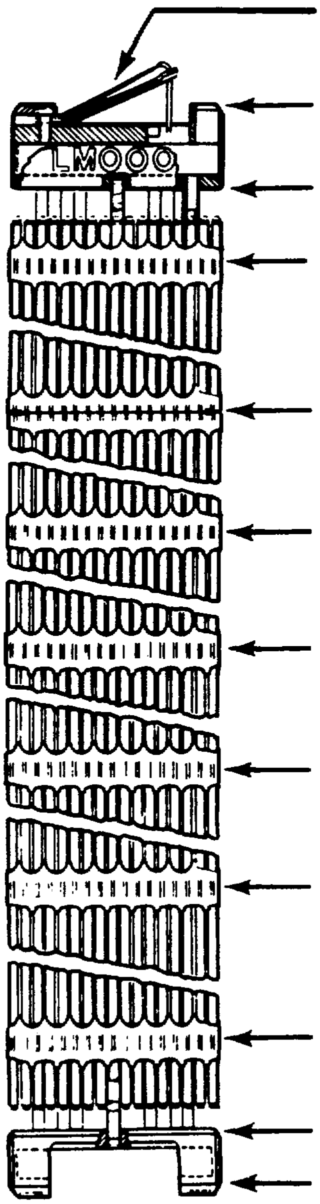
Radio-Chemical Analysis
Westinghouse 14 x 14

Nb-94



Curries/gm of Sample	Parent Element w/o Niobium	Curies ^{94}Nb per gm Niobiuml
7.39E−7	4.50	1.64E−5
4.09E−10	0.0033	1.24E−5
1.79E−9	0.0024	7.45E−5
6.98E−6	4.40	1.59E−4
1.20E−4	4.60	2.61E−3
4.41E−9	4.60	8.99E−4
5.40E−9	0.0156	4.10E−5
2.07E−8	0.030	6.89E−5

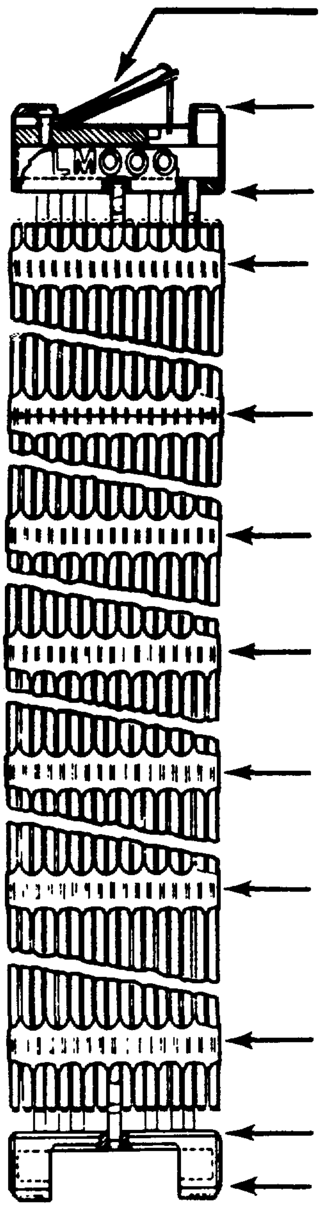
Mn-54



Curies/gm of Sample	Parent Element w/o Iron	Curies ^{54}Mn per gm Iron
3.60E−7	17.2	2.10E−6
1.13E−6	67.5	1.67E−6
4.02E−6	91.4	4.40E−6
<	16.0	<
3.46E−5	15.2	2.28E−4
5.36E−5	16.0	3.35E−4
2.36E−5	17.0	1.39E−4
2.45E−5	16.2	1.51E−4
2.21E−5	16.5	1.34E−4
<	15.8	<
2.22E−5	65.5	3.38E−5
1.42E−5	84.1	1.69E−5

Radio-Chemical Analysis
Westinghouse 14 x 14

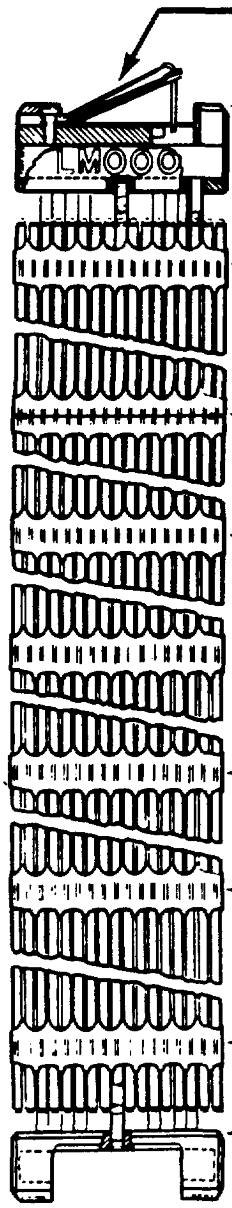
Fe-55



Curies/gm of Sample	Parent Element w/o Iron	Curies ^{55}Fe per gm I
3.69E-4	17.2	2.15E-3
7.39E-4	67.5	1.09E-3
5.77E-3	66.0	8.74E-3
2.59E-3	16.0	1.62E-2
1.07E-2	15.2	7.02E-2
1.11E-2	16.0	6.95E-2
1.26E-2	17.0	7.42E-2
1.30E-2	16.2	8.01E-2
1.39E-2	16.5	8.44E-2
6.31E-3	15.8	3.99E-2
9.55E-3	65.5	1.46E-2
8.47E-3	66.0	1.28E-2

Radio-Chemical Analysis
Westinghouse 14 x 14

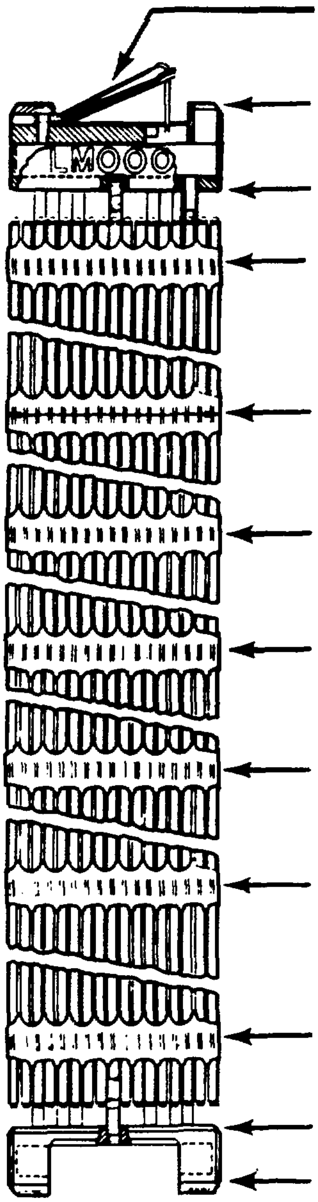
Ni-63



Curies/gm of Sample	Parent Element w/o Nickel	Curies ^{63}Ni per gm Nickel
2.72E−3	50.8	5.35E−3
3.52E−4	8.27	4.26E−3
3.06E−3	9.2	3.33E−2
1.97E−2	53.0	3.71E−2
6.53E−2	46.5	1.40E−1
8.51E−2	48.0	1.77E−1
8.83E−2	50.8	1.74E−1
8.02E−2	47.1	1.70E−1
8.92E−2	49.2	1.81E−1
3.76E−2	49.3	7.62E−2
3.76E−3	9.36	4.02E−2
2.87E−3	8.1	3.54E−2

Radio-Chemical Analysis
Westinghouse 14 x 14

Ni-59



Curies/gm of Sample	Parent Element w/o Nickel	Curies ^{59}Ni per gm Nickel
1.18E-5	50.8	2.33E-5
1.66E-6	8.27	2.01E-5
1.31E-5	9.2	1.42E-4
7.52E-5	53.0	1.42E-4
2.55E-4	46.5	5.47E-4
3.50E-4	48.0	7.30E-4
3.27E-4	50.8	6.44E-4
2.76E-4	47.1	5.86E-4
3.35E-4	49.2	6.81E-4
1.35E-4	49.3	2.73E-4
1.48E-5	9.36	1.58E-4
1.01E-5	8.1	1.25E-4

STATUS OF DOE INFORMATION NETWORK MODIFICATIONS[a]
(August 1988)

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ABSTRACT

This paper provides an update for conference participants on changes, that have been made, or are taking place, to the Department of Energy's National Information Network. A question and answer period is anticipated. Areas of focus are as listed below.

- o Data acquisition from commercial disposal site operators
- o Improved access methods to DOE Information network
- o Progress on Personal Computer interfaces
- o Availability of end user support.

INTRODUCTION

Efforts are underway to enhance the Department of Energy's computerized National Low-Level Waste Management Information Network (the network). This status briefing will update Conference participants on changes that have been made, or are currently taking place, pertaining to the network:

Section One: DATA ACQUISITION identifies current sources and status for the data being reported through the network.

Section Two: ACCESS METHOD IMPROVEMENTS addresses actions being taken to improve the user friendliness of the network.

Section Three: PERSONAL COMPUTER INTERFACES identifies the software and status of application interface both in place and under development for use on the network.

Work supported by the U.S. Department of Energy under DOE Contract No. DE-AC07-76-ID01570.

Section Four: AVAILABLE SUPPORT identifies the support functions available through the Nuclear Energy Low-Level Waste Management Program (NE LLWMP) and the Idaho National Engineering Laboratory (INEL), which relates directly with the network. Included in this section is a contact list of persons and phone numbers to contact if there are additional questions concerning the network.

Section One: DATA ACQUISITION

There are several sources for the data being reported through the network. The following list identifies each of these sources:

Surveys: State Briefing Books for Low-Level Radioactive Waste Management, 1980 (NUS Corp.)

1982 and 1984 State surveys (Conference of Radiation Control Program Directors, Inc.)

Annual Semiannual Reports: Waste Volume and Activity Summaries from Commercial Disposal Facilities, 1980 through 1988

Table 3, Effluent and Waste Disposal Semiannual Report, Solid Waste and Irradiated Fuel shipments (as reported to the Nuclear Regulatory Commission, reactors only)

Monthly Activity Reports: Waste Volume by State and Region report (From sited states 1986 through current month 1988)

NEW SOURCE:

Radioactive waste shipment records; electronic image of data captured from manifest at the commercial low-level radioactive waste disposal facilities (1986 through current month 1988)

The NE LLWMP has developed an Information delivery system called "Manifest Information Management System" (MIMS). This system was designed for the reporting of information obtained from the manifest currently being accepted at the existing commercial Low-Level Radioactive Waste Disposal facilities located at Barnwell, South Carolina; Beatty, Nevada; and Richland, Washington. This system differs from existing reporting systems available through the network in that MIMS reports detailed data from individual shipments as well as year-end summary information.

The MIMS contains data from shipments starting with 1986 through current month. Due to the volume of data recorded on the manifests, or radioactive waste shipment records (RSR), the NE LLWM program decided to contract with the disposal sites to provide the data which were already being captured electronically rather than re-entering the data from copies of the RSR.

The MIMS is being reviewed by a team of volunteer states to ensure that the MIMS is reporting the necessary level of detail and that access to the system is as user friendly as possible. Access to the MIMS will be available through the "standard access" authorized for all registered users of the network. This access will be incorporated as soon as the team review is completed, which is currently scheduled for the end of September 1988.

As of August 26 1988 the following data are available through the MIMS system:

Disposal Site: Beatty, Nevada and Richland, Washington

1986 and 1987 shipment summary data, and supplemental data viewing through brokers, have been incorporated in MIMS. The NE LLWMP has a contract with Utility Data Institute (UDI) to supply data from existing sites operated by US Ecology Inc.

1988 shipment data, recorded to a container level of detail, are supplied monthly by UDI with the current month being through June 1988. These data have been incorporated in MIMS.

Disposal Site: Barnwell, South Carolina

The NE LLWMP is negotiating with Chem Nuclear Systems Inc. (located in Barnwell, South Carolina) for the acquisition of the 1986 through 1988 RSR data. The data from Barnwell, however, will not be detailed to the container level for 1988 because this detail has not been captured on an electronic format.

At this time, the plan is for MIMS to report only shipment summary information from Barnwell for 1988 and shipment summary plus container detail for 1988 from US Ecology sites. If in the future Chem Nuclear Systems Inc. captures the container detail data electronically, the NE LLWMP will reconsider the option of acquisition for this additional data.

The NE LLWMP intends to use the RSR data as its sole source for the Waste Volume reports broadcast by the network and for those reports generated annually. This has caused some concern that a cross check for the data will not be available. The many sources of data used today have created their own cross check. This has proved valuable in the past by identifying errors in the data recording process. One of the sources for cross checking used today is the "Monthly Activity Report" generated by the sited states for purposes of surcharge accountability. The NE LLWMP staff believe that this report will continue to be used as a cross check, in addition to serving its original purpose of surcharge accountability.

Section Two: ACCESS METHOD IMPROVEMENTS

The NE LLWMP is continuing it's efforts to improve access to the network. The following improvements have been incorporated during 1988:

- o Elimination of unnecessary log-on steps: Three front-end access steps have been eliminated. After the initial "Network Director" screen has been responded to successfully, users now view an options menu.

- o Local phone access: Most users of the network have access to the TYMNET communication network via a local phone call. During the past year, every attempt has been made to incorporate additional TYMNET nodes in cities where they are needed to service users.

- o Additional access port: Two TYMNET access nodes are available to network users. The addition of a dedicated TYMNET access to the INEL host computer has further eliminated log-on steps and allows for somewhat faster response time. The two nodes are INELDOE and "dedicated" INELNOM.

- o Access "baud Rates" increased: The addition of 2400- and 9600-baud ports at the INEL allows users to access the network with phone modems capable of transmitting at 9600 baud. At this time however, 9600-baud equipment is not readily available in the marketplace. Increased demand will remedy this situation.

- o Consolidation of functions: New user access IDs have been issued to all registered users of the network. This has allowed consolidation of functions from a single ID. Those users who had access to the Rad Health Communication Network in addition to the National Information System are now able to access both functions from one ID rather then the two previously necessary. As new applications become available, (i.e., MIMS) they will be added as options to network IDs.

- o User friendly program upgrades: New capabilities are being introduced which will allow a greater degree of user friendliness to be used by the applications within the network. The Records Inventory Management System (RIMS), which is on display during this Conference, uses a new programming tool called "windows". This process allows users to view information from more than one source on a single screen or to select a specific pictorial display of information for update rather than having to type the data on a screen. The NE LLWMP intends to modify existing functions to include the use of "windows" wherever applicable.

o Independent system review: Suggestions from you, the users, as to how the network can best support your needs are always welcomed. In addition, the NE LLWMP believes that an independent review of the network and its applications will be beneficial to all. This review will involve some existing network users through an informal interview process. The Department of Energy is currently reviewing the scope of work developed for this independent review. It should be released for quote by the end of September 1988.

Section Three: PERSONAL COMPUTER INTERFACE

At the present time, personal computers have limited interface with the network. This interface requires the use of a software package called "RLINK" which is available through the NE LLWMP Program at no cost to the user. With this software and a communication device (i.e. modem) the PC acts as a "dumb terminal", allowing access to the INEL computer and the network.

Currently the only specific uses for a PC (other than as a dumb terminal) are the operation of the Disposal Site Economics Model available through the NE LLWMP, limited down loading of files from RIMS, and "up loading and down loading" text files that are being broadcast through the Radiological Health Communication Network.

Additional operations (i.e., ad hoc summary file generation from MIMS with down-load capability) are being considered for development. However, due to budget constraints at this time, there are no action items being addressed to complete these functions.

Section Four: AVAILABLE SUPPORT

The network is supported by technical and liaison staff at the Idaho National Engineering Laboratory from 6:00 am to 6:00 pm Mountain Standard Time, Monday through Friday, 52 weeks a year, excluding national holidays. Arrangements for additional support can be made with reasonable advance notice. This support staff can be reached by phone or in writing at the addresses listed below. If you experience problems while accessing the network, contact INEL customer user services at (208) 526-9355 or FTS 583-9355.

In addition to the support available over the phone, user training at your specific location is available on a request basis. Contact your NE LLWMP liaison person or one of the program contacts listed below to make the necessary arrangements.

For additional information concerning the National Low-Level Waste Information Network, contact Ronald L. Fuchs or any of the persons listed below.

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