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U.S. DEPARTMENT OF ENERGY

OCRWM

YUCCA MOUNTAIN

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

RADIOLOGICAL MONITORING PLAN

DECEMBER 1990

UNITED STATES DEPARTMENT OF ENERGY

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

RADIOLOGICAL MONITORING PLAN

DECEMBER 1990

Revision 1

Prepared by

U.S. Department of Energy
Yucca Mountain Site Characterization Project Office

Prepared for the Yucca Mountain Site Characterization Project as part of the Civilian Radioactive Waste Management Program. The Yucca Mountain Site Characterization Project is managed by the Yucca Mountain Site Characterization Project Office of the U.S. Department of Energy (DOE). Yucca Mountain Site Characterization Project work is sponsored by the DOE Office of Civilian Radioactive Waste Management.

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1/9/91
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1.0 INTRODUCTION AND PLAN SUMMARY

The Radiological Monitoring Plan for the Yucca Mountain Site Characterization Project (RADMP) is the controlling Yucca Mountain Site Characterization Project document for radiological monitoring activities for the Yucca Mountain Site Characterization Project. This document contains the technical basis and criteria for this program.

If Yucca Mountain is (1) determined to be suitable by the Department of Energy (DOE), (2) approved by the President, and (3) licensed by the Nuclear Regulatory Commission (NRC), then the Project will oversee the final six of eight possible phases for the site. These eight phases overlap in some instances and include the following:

1. Site selection (selection of sites for further characterization; completed May 28, 1986).

2. Site characterization.

3. Data gathering for preparation of the EIS.

4. EIS preparation and review (the Project provides technical input to an OCRWM contractor who will prepare the EIS) and Safety Analysis Report (SAR) preparation and review.

5. Construction authorization/Construction.

6. License to receive and possess/operation.

7. Permanent closure and decommissioning.

8. Postclosure monitoring.

Details of the Project activities are discussed in the "Environmental Assessment, Yucca Mountain Site, Nevada Research and Development Area (NRDA), Nevada" (DOE, 1986a); "Site Characterization Plan Conceptual Design Report" (SNL, 1987); and "Site Characterization Plan, Yucca Mountain Site, NRDA, Nevada" (DOE, 1988b).

To allow proper planning, the RADMP addresses monitoring for all Project phases through site closure. During these phases, it is important to ensure compliance with applicable regulations, monitor the impacts of Project activities, and gather data required by the Yucca Mountain site and environmental program. The major environmental radiological monitoring activities necessary to support the phases of the Project are summarized in Figure 1-1. Because of the uncertainty associated with the requirements that may be applied to future phases of the Project, the activities detailed in this revision of the RADMP emphasize the site characterization phase. The RADMP is a dynamic document, and regular revisions are planned to accommodate the various phases of the Project, and nonroutine revisions as necessary. This document does not, however, indicate the final outcome of the repository selection process. If the Yucca Mountain site is not licensed as the repository site, Phases 5, 6, and 8 will be eliminated (since they will not occur) and the schedule shortened.

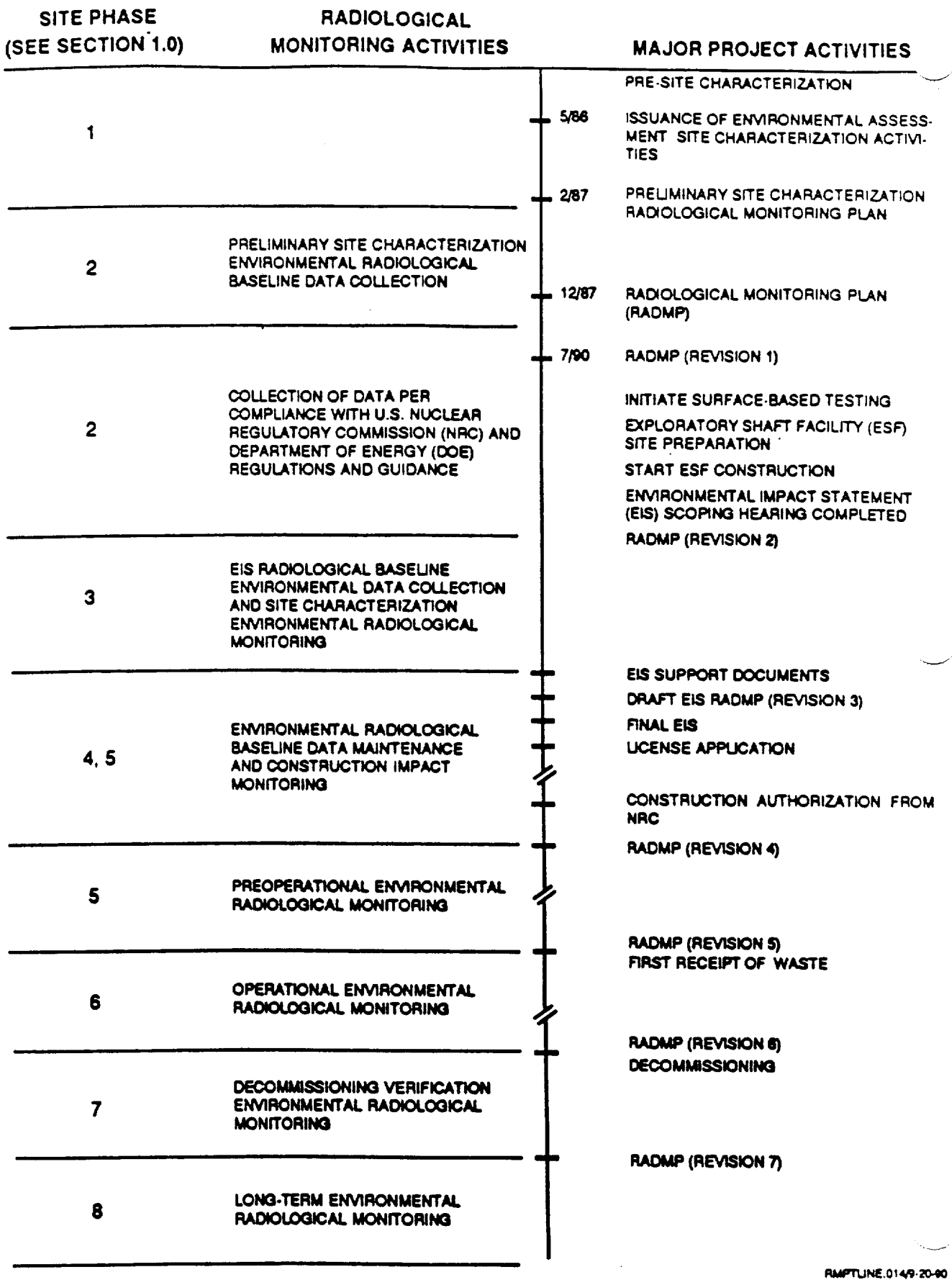


Figure 1-1. Radiological monitoring timeline. (See Section 1.1 for a description of the site phases.)

The RADMP describes the activities to collect data on the existing radiological environment in the Yucca Mountain area and to monitor any changes in these conditions as a function of time. The RADMP implements many of the requirements in the Yucca Mountain Site Characterization Project Safety and Health Plan (SHP) (DOE/NV, 1990). In addition, each Project Participant will operate within the requirement of its own safety and health plan, to ensure the implementation of applicable requirements. It should be emphasized that neither radiological monitoring nor site characterization activities will introduce radioactive waste into the Yucca Mountain environment. The radioactive materials associated with radiological monitoring that are not already present in the environment are radioactive sources that will be used for calibration or accuracy checking of instruments. These sources:

1. Contain extremely small quantities of radioactive material.

2. Are present in limited number.

3. Are carefully controlled by the T&MSS Radiological Field Programs Department, or by other Project Participants under the requirements of their approved safety and health plans.

4. Must be disposed of at an authorized radioactive waste disposal site when no longer needed, or removed from the site for use elsewhere; thus, they will not remain at Yucca Mountain.

Other than these radiation sources used during the radiological monitoring activities described in this document, the only radioactive materials that will be used at the site are part of activities commonly used in the mining, drilling, and construction industries. A few examples of the types of radioactive materials that might be present are standard well-logging instrumentation and weld analysis (nondestructive) radiographic equipment. Currently no radioactive hydrogeological tracers are planned for use.

As required by the NWPA, Project does not plan to introduce radioactive waste into the Yucca Mountain area unless a license to operate the facility has been granted by the NRC, and the DOE is fully satisfied with the adequacy of any facility constructed.

As specified in the SHP (DOE/NV, 1990), the RADMP is the controlling document for implementing the radiological monitoring activities. The RADMP describes the collection of required radiological data identified in the SCP (DOE, 1988b), EMP (DOE, 1990b), and other Project documents.

The RADMP complies with the requirements of the Project QARD (OCRWM, 1990a), QAPD (OCRWM, 1990b), and supporting documents, as well as with applicable Project and the supporting organizations' procedures.

The RADMP identifies the technical requirements for the implementation of procedures for the radiological monitoring activities. The procedures are prepared as described in instruction and procedural documents for each organization, such as the RMIM (SAIC, 1990b). Each organization in this activity issues technical procedures and instructions as part of the

controlled procedures manual, which is maintained in an updated, audited form by each user. In addition, upper tier Project-level procedures may be used to implement specific requirements affecting all organizations or the Project program as a whole.

2.0 ORGANIZATION AND RESPONSIBILITIES

The reporting structure for the radiological monitoring program is shown in Figure 2-1. Solid lines indicate the flow of technical direction and dashed lines indicate the flow of technical input and support. The day-to-day direction of this activity is the responsibility of the Operations Control Branch of the Yucca Mountain Site Characterization Project Office's Project Operations and Control Division. The T&MSS is responsible for implementation of all environmental radiological monitoring (ERM) activities with support from EG&G/EM as directed by the Project Office Operations and Control Division Director. T&MSS will perform the various activities in conjunction with EG&G/EM. The RFPD Manager is responsible for coordination of these activities.

Technical control, support, and direction is provided by the Project Office's Project Operations Control Division (POCD) Director. The Office of Environment, Safety, and Health (OESH) of the DOE/NV will also provide technical support to the Project Office.

The Project Office Manager is the approval authorities for this plan. The concurrence of the Project Office QA Manager verifies that the applicable QA requirements have been appropriately addressed in this document.

The radiological monitoring program will consist of six major tasks:

1. Program development and planning.
2. Specific program implementation (operation).
3. Data and sample archiving.
4. Quality control activities.
5. Analysis of data and reporting.
6. Program revision.

Under Task 1, there are several subtasks. These subtasks include the preparation of required documents (in accordance with the applicable organizations' administrative and technical procedures) and completion of the following activities:

1a. Technical plan(s).

1b. Hazard review/safety plan.

1c. Training program.

1d. Procedures.

1e. Identification of required equipment and services.

1f. Procurement specification after identification of the required equipment and services.

1g. QA/quality control implementation plans/procedures.

1h. Checklist for assessing an activity's operational readiness.

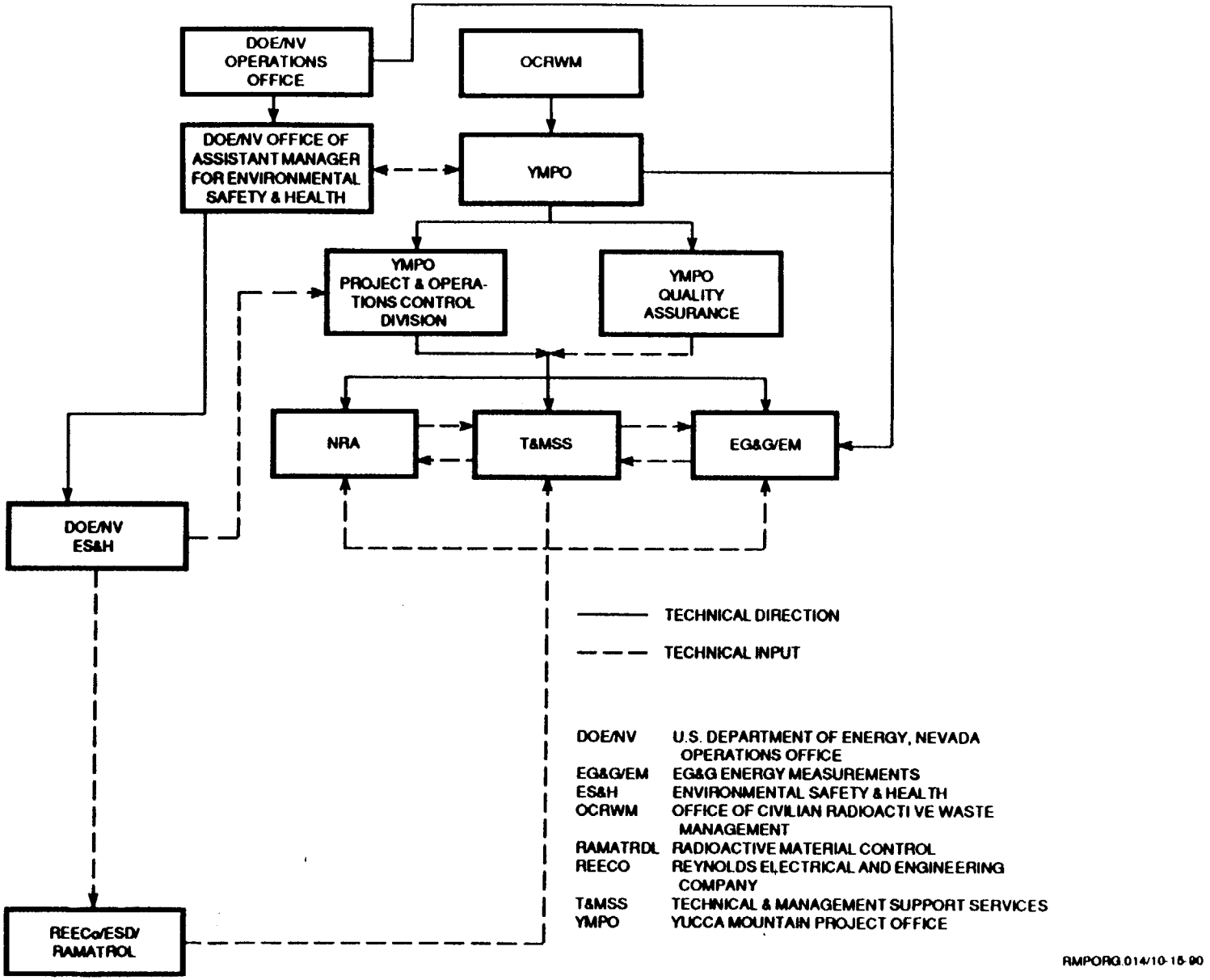


Figure 2-1. Environmental radiological monitoring activities organization chart.

1i. Budget and staffing requirements.

1j. Planning and scheduling of expected activities.

1k. Project Office authorization to initiate the expected activities.

Task 2 can also be broken into various subtasks:

2a. Procurement of required equipment.

2b. Procurement of outside services.

2c. Personnel training (procedures and equipment operation).

2d. Field data collection.

2e. Laboratory analyses.

2f. Field instrument calibration/accuracy checking.

2g. Preparation of quality control samples.

The balance of the tasks are essentially self-explanatory, with the exception of Task 6 (program revision), which is discussed in Section 7.2.

2.1 SUPPORTING ORGANIZATIONS

During site characterization, the primary organizations in this program will be the Project Office, the T&MSS Contractor (SAIC), and EG&G/EM. Other groups that will be organizations or provide needed support include the DOE/NV Office of Environment, Safety, and Health (DOE/NV-ESH); the EPA Office of Radiation Programs (ORP) (in Las Vegas, Nevada); REECo (the prime contractor at the NTS); DOE/NV; and the State of Nevada. Details of the management of this program are addressed in the EMP (DOE, 1990b).

2.1.1 YUCCA MOUNTAIN PROGRAM OFFICE

The Project Office, particularly the Project and Operations Control Division, has primary management responsibility for the entire radiological monitoring program. The program, future revisions to the program, the budget and schedule for implementation of the program, and the report issued by the program will have to be approved by the Project Office.

2.1.2 TECHNICAL AND MANAGEMENT SUPPORT SERVICES CONTRACTOR

The T&MSS Contractor has primary responsibility for implementation of the radiological monitoring program as indicated in the tasks in Section 2.1 The T&MSS Contractor is completing Task 1 with support from EG&G, DOE/NV-ESH, and the Project Office. The T&MSS Contractor will also implement Task 2, although subcontractors will be used for most of the analytical activities. Note: The T&MSS Contractor has primary responsibility for the radon monitoring program, and will have primary responsibility for the other major tasks (with significant support from EG&G). The T&MSS Contractor will also arrange through the Project Office for support facilities in Area 25.

2.1.3 DOE/NV OFFICE OF ENVIRONMENT, SAFETY, AND HEALTH

The DOE/NV-ESH provides support to the Project Office in implementing radiation safety requirements for the worker, the public, and the environment at the NTS. The DOE/NV-ESH will review the RADMP, all technical procedures, and all reports associated with the program to ensure RADMP activities comply with the standards, requirements, and guidance established by the DOE/NV-ESH, and to ensure minimal impact of the program on other DOE programs. In addition, the organizations in the radiological monitoring program will comply with all applicable DOE/NV-ESH standards and requirements.

2.1.4 EG&G/ENERGY MEASUREMENTS

EG&G/EM, as the Project and the Nevada Test Site Operations Office (NTSO) technical expert in the biological sciences, will be a organization in Task 1; Subtasks 2a, 2b, 2d, 2g; and Tasks 4, 5, and 6 (Section 2.1) with support from T&MSS. The area of participation is associated with the collection and evaluation of biota samples from the environment.

2.1.5 ENVIRONMENTAL PROTECTION AGENCY/LAS VEGAS OFFICE OF RADIATION PROGRAMS

The ORP has agreed to assist the T&MSS team in the preparation of quality concern (QC) control samples and the calibration of equipment for radon monitoring. This activity is consistent with their basic function within the EPA.

2.1.6 REYNOLDS ELECTRICAL AND ENGINEERING COMPANY

REECo is the prime contractor for the NTS. As such, REECo provides the general support services at the NTS. REECo will provide the support services to these radiological monitoring activities, including RAMATROL, general health physics control, emergency support, maintenance, and other services.

2.1.7 DOE NEVADA OPERATIONS OFFICE

The DOE/NV is the organization responsible for NTS operations. The radiological monitoring program will comply with all applicable NTS and DOE/NV requirements and standards. The radiological monitoring program will, through the Project Office, request the DOE/NV to obtain required NTS support services and approvals for the RADMP field activities.

2.1.8 STATE OF NEVADA

It is hoped that the State of Nevada, in the form of the Agency for Nuclear Projects, Nuclear Waste Project Office, or Nevada State Division of Health, may be a organization in this program. Details of this participation have not yet been established. When such details are available, this section will be revised to describe the State's participation. The State of Nevada has been offered an opportunity to be a organization in all monitoring activities consistent with program requirements.

In addition, the local county health officers have been offered the opportunity to observe these activities and/or receive the information generated as a result of these activities.

2.2 ORGANIZATION OF THE RADIOLOGICAL MONITORING PLAN

The radiological monitoring plan activities is broken into 3 basic tasks. One task is field data collection, which is addressed in Section 4.0. The second task is the collection of other supporting data, which is addressed in Section 5.0. The third task is data assessment and analysis, which are addressed in Section 6.0.

The RADMP has eight major parts: Section 1 provides introductory remarks and establishes the framework of the document. Section 2 provides a general discussion of the regulatory and control framework for the document. Section 3 provides a general discussion of the technical requirements and guidance mandating completion of the radiological monitoring activities discussed in the document. Section 4 provides criteria for and a general discussion of the radiological field monitoring activities and the activities related to the requirements in Section 3. Section 5 identifies nonmonitoring data required to support resolution of the issues and discusses how these data will be collected. Section 6 sets the forth the radiological analytical techniques used in collecting data for the resolution of the issues in the issues hierarchy. Sections 7 and 8 address administrative concerns and their resolution within the program. A listing of acronyms and abbreviations, and a glossary for the text are found at the end of the document.

3.0 RADIOLOGICAL COMPLIANCE

Under the requirements of the NWPA of 1982 (NWPA, 1983) as amended (NWPAA, 1987) and Presidential decisions, the DOE is required to site, construct, operate, and decommission a geologic facility for the disposal of commercial and defense high-level radioactive waste, including spent fuel (SF).

Other regulations and requirements are based on criteria established by the NRC (10 CFR Part 60), EPA (40 CFR Part 191), DOE (10 CFR Part 960), and DOE Orders. The State and Indian Tribes, in addition to their rights for consultation and cooperation, enforce certain Federal or State regulations. The applicable regulations, requirements, and guidance that drive the collection and use of radiological monitoring data for this program during the various phases of the Project are addressed in the following sections. The final section addresses how this document fits into the document hierarchy of the Project to support compliance with the applicable regulations and requirements.

The radiological monitoring and data collection activities at Yucca Mountain are intended to

1. Verify that adequate protection of the radiological health and safety of the public and workers and the environment is provided.

2. Support analyses to demonstrate with reasonable assurance that any impact on the health and safety of the public and workers or on the environment are within acceptable limits.

3. Provide data required for the completion of required program documentation (e.g., the Final Environmental Impact Statement (FEIS), SAR, Environmental Monitoring and Mitigation Progress Reports, and annual radiological environmental reports).

4. Provide data needed to demonstrate compliance with applicable requirements for design, construction, and operational activities.

5. Maintain consistency with existing NTS activities, thereby minimizing any potential conflicts and maximizing any potential benefits.

6. Allow for the detection and quantification of unplanned releases of radioactive materials.

7. Verify the accuracy of onsite radiological monitoring systems and release estimates (by comparing the analysis of the dispersion of release estimates with far-field actual field monitoring data to determine if they are consistent).

8. Establish radiological baseline data for the site during site characterization, and monitor the impacts of site characterization activities.

9. Monitor the impact of construction on the baseline until initiation of the preoperational radiological monitoring program.

10. Verify the baseline conditions existing just before operation, which will be done in the preoperational radiological monitoring program.

11. Monitor the impact of the full facility operations, if implemented, as specified in the Operational Radiological Monitoring Plan (to be issued).

12. Monitor the site to assess the impact of decommissioning and verify the effectiveness of the decommissioning process.

13. Monitor (long-term) the facility after closure to verify repository performance.

14. Comply with appropriate technical and scientific guidance, standards, historical precedent, and practices.

3.1 REGULATORY APPLICABILITY

3.1.1 SITING

The activities associated with siting occur in the period preceding the license application (LA). A list of these activities follows:

1. Data are collected to monitor the impacts of site characterization (DOE, 1988c).

2. Data are collected to satisfy requirements identified in the SHP (DOE/NV, 1990) to support siting preparation of the SAR (and other Project documents) and the EMP (DOE, 1990b).

3. Radiological data are collected and analyses performed to determine compliance with applicable regulations and requirements.

4. Radiological data are collected and analyses performed to assist facility design.

The primary regulatory authority during this phase is the DOE. Data collected in accordance with the RADMP will be controlled in a manner consistent with the Project Office QA and regulatory guidelines and requirements for ERM activities. Consideration of future NRC regulatory guidelines will allow inclusion of these data in a data base to support licensing, National Environmental Policy Act (NEPA), and SAR activities. The applicable

radiological protection regulations (public, worker, and environmental) will be addressed and summarized in the Environmental Regulatory Compliance Plan (ERCP) (DOE, 1988a). The applicable radiological protection (not related to environmental protection) requirements and regulations are addressed in the balance of this Section. Note that the NWPA exempts site characterization activities from formalized documentation requirements of NEPA of 1969 (Public Law 91-190) (NEPA, 1969). Instead, the NWPA has been interpreted to require monitoring and mitigation of adverse significant impacts to ensure there is minimal impact from siting-related Project activities.

3.1.2 CONSTRUCTION

Before construction of a repository can commence, an LA must be submitted to, and construction authorization received from, the NRC. Until a license to receive and possess has been issued, the DOE will remain the primary regulatory authority for overall radiological/environmental protection and safety activities, except as indicated in construction authorization constraints. The NRC will become the regulatory authority for facility construction activities through the construction authorization.

3.1.3 OPERATION

If Yucca Mountain is approved and licensed, then the operations phase will need to be addressed. When the NRC licenses the repository to receive high-level waste (HLW), the NRC regulations, 10 CFR Part 21 and 10 CFR Part 60, become applicable. Additional requirements may be included in the license as technical specifications. At this point, the NRC will have primary regulatory authority over all activities. With the exception of the NRC's enforcement authority (10 CFR Part 21), the regulatory environment will be essentially unchanged in any other way. In addition, the implementation of the Clean Air Act will fall under Subpart I of 40 CFR Part 61 and may require reporting to the State, the NRC, and directly to the EPA depending on the statutory requirements in existence at the time. At this time any requirements relative to the Safe Drinking Water Act (SDWA) must be implemented, based on resolution of the regulatory requirements discussed in the ERCP (DOE, 1988a).

3.1.4 PERMANENT CLOSURE AND DECOMMISSIONING

When the NRC authorizes the permanent closure and decommissioning of the Yucca Mountain site, the technical specifications will be modified to reflect the requirements of the decommissioning plan. With the exception of the change in technical specifications, the regulatory requirements will be essentially the same.

3.1.5 POSTCLOSURE

If a repository is built at Yucca Mountain, then the postclosure monitoring phase will need to be addressed. If the NRC license is terminated after the facility is decommissioned, authority will revert to the DOE or, if so determined, to the State of Nevada. If the State of Nevada takes over responsibility, State of Nevada law and the requirements of the legal agreement between the DOE and the State of Nevada will control site activities. Presently, the regulatory environment for this phase is still being developed by other Project organizations, the DOE, the State, the Tribes, and the NRC.

3.2 Yucca Mountain Site Characterization Project REQUIREMENTS

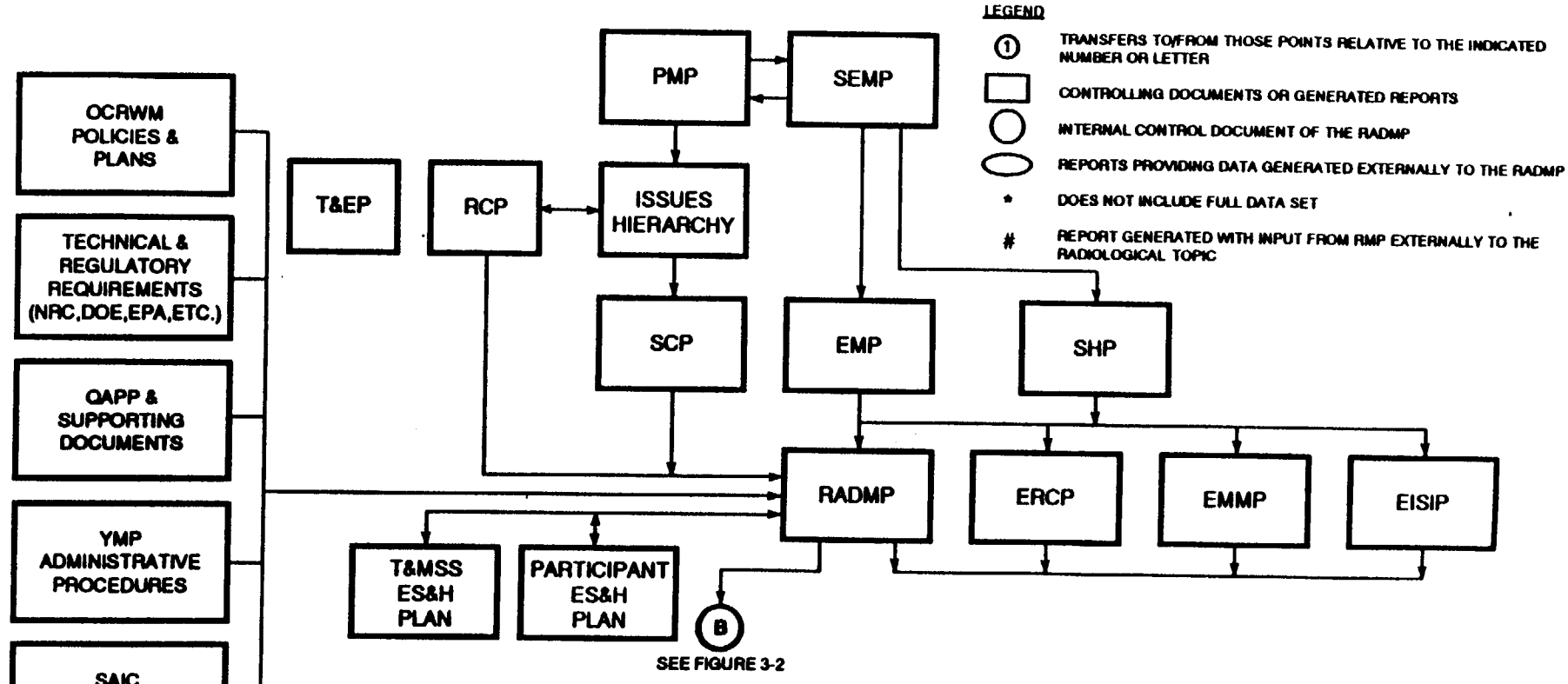
As part of the implementation of the NWPA, the Project has (or will develop) various plans to control Project activities and ensure compliance with the provisions of the NWPA and applicable regulations. The Project document hierarchy for the activities discussed in the RADMP is illustrated in Figures 3-1 and 3-2, with 3-2 providing details on the implementation and supporting documents of the RADMP. The various phases are controlled by different internal documents. The hierarchy shown is for the siting and construction phase. Limited documentation has been identified for later phases. This documentation will be discussed in later revisions of the RADMP.

3.2.1 SITE CHARACTERIZATION AND CONSTRUCTION

The specific plans and documents controlling activities during site characterization and construction are shown in Figure 3-2, although during construction the NRC construction authorization may also provide specific requirements. The RADMP-generated and related documentation is shown in Figure 3-2. The nonradiological technical reports providing input to future RADMP reports are illustrated in Figure 3-3. The primary controlling documents are the SHP (DOE/NV, 1990), the SCP (DOE, 1988b) and the EMP (DOE, 1990b). No NEPA documentation is required for the site characterization and construction phase. Each of the "input documents" specifies data requirements that are provided by this plan. The other documents, which contain technical requirements or constraints on activities to ensure compliance with applicable regulations, orders, and guidance, are also included in this figure.

3.2.2 OPERATION

During this phase, the specific plans and documents controlling activities will be the EIS and LA as shown in Figure 3-4.



DEIS	DRAFT ENVIRONMENTAL IMPACT STATEMENT
DERE	DESCRIPTION OF EXISTING RADIOLOGICAL ENVIRONMENT
DOE	U.S. DEPARTMENT OF ENERGY
EFAPRS	ENVIRONMENTAL FIELD ACTIVITY PLAN FOR RADIOLOGICAL STUDIES
EIS	ENVIRONMENTAL IMPACT STATEMENT
EISIP	EIS IMPLEMENTATION PLAN
EMP	ENVIRONMENTAL MANAGEMENT PLAN
EMMP	ENVIRONMENTAL MONITORING AND MITIGATION PLAN
EPA	ENVIRONMENTAL PROTECTION AGENCY
EPASS	ENVIRONMENTAL PATHWAYS ANALYSIS SCOPING STUDY
EPIP	ENVIRONMENTAL PROTECTION IMPLEMENTATION PLAN
ERCP	ENVIRONMENTAL REGULATORY COMPLIANCE PLAN
ERMTP	ENVIRONMENTAL RADIOLOGICAL MONITORING TRAINING PROGRAM
ES&H	ENVIRONMENT, SAFETY, AND HEALTH
ESHD	ENVIRONMENT, SAFETY, AND HEALTH DOCUMENT
IMS	INFORMATION MANAGEMENT SYSTEM
LA	LICENSE APPLICATION
MMP	METEOROLOGICAL MONITORING PLAN

NRC	NUCLEAR REGULATORY COMMISSION
OCRWM	OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
PMP	PROJECT MANAGEMENT PLAN
PSCRMP	PRELIMINARY SITE CHARACTERIZATION RADIOLOGICAL MONITORING PLAN
QAPD	QUALITY ASSURANCE PROGRAM DOCUMENT
QAPP	QUALITY ASSURANCE PROGRAM PLAN (T&MSS)
RADMP	RADIOLOGICAL MONITORING PLAN
RCP	REGULATORY COMPLIANCE PLAN
RESMP	RADIOLOGICAL ENVIRONMENTAL AND SAFETY MONITORING IMPLEMENTATION PLAN
RMIM	RADIOLOGICAL MONITORING INSTRUCTION MANUAL
RMDS	RADIOLOGICAL MONITORING DATA SUMMARY
SAIC	SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
SAR	SAFETY ANALYSIS REPORT
SCP	SITE CHARACTERIZATION PLAN
SEMP	SYSTEMS ENGINEERING MANAGEMENT PLAN
SENFCA	SURVEY AND EVALUATION OF NUCLEAR FUEL CYCLE ACTIVITIES
SHP	YMP SAFETY AND HEALTH PLAN
T&EP	TEST AND EVALUATION PLAN
T&MSS	TECHNICAL AND MANAGEMENT SUPPORT SERVICES CONTRACTOR
YMP	YUCCA MOUNTAIN PROJECT

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Figure 3-1. Site characterization document hierarchy.

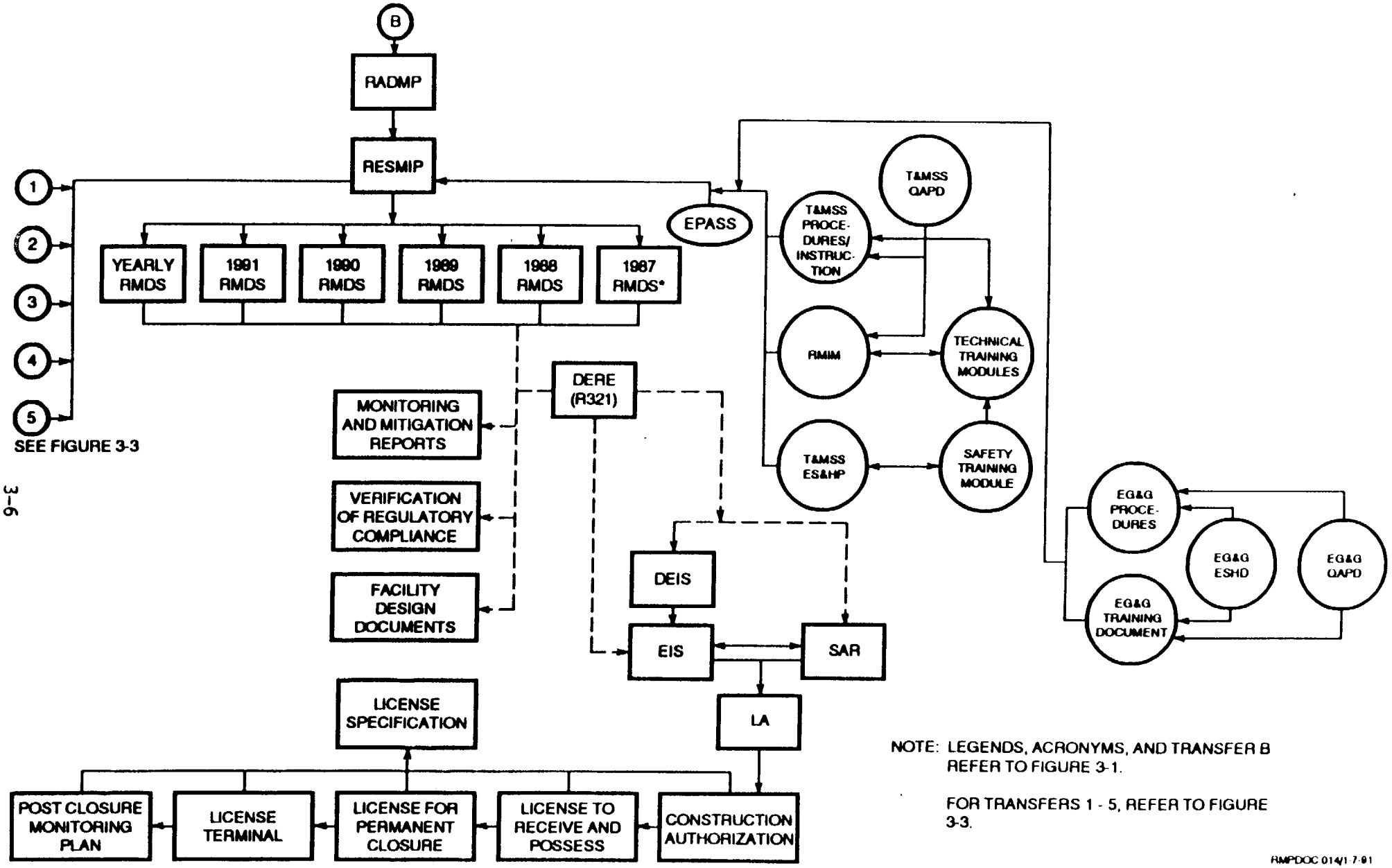

Figure 3-2. Radiological Monitoring Plan documentation.

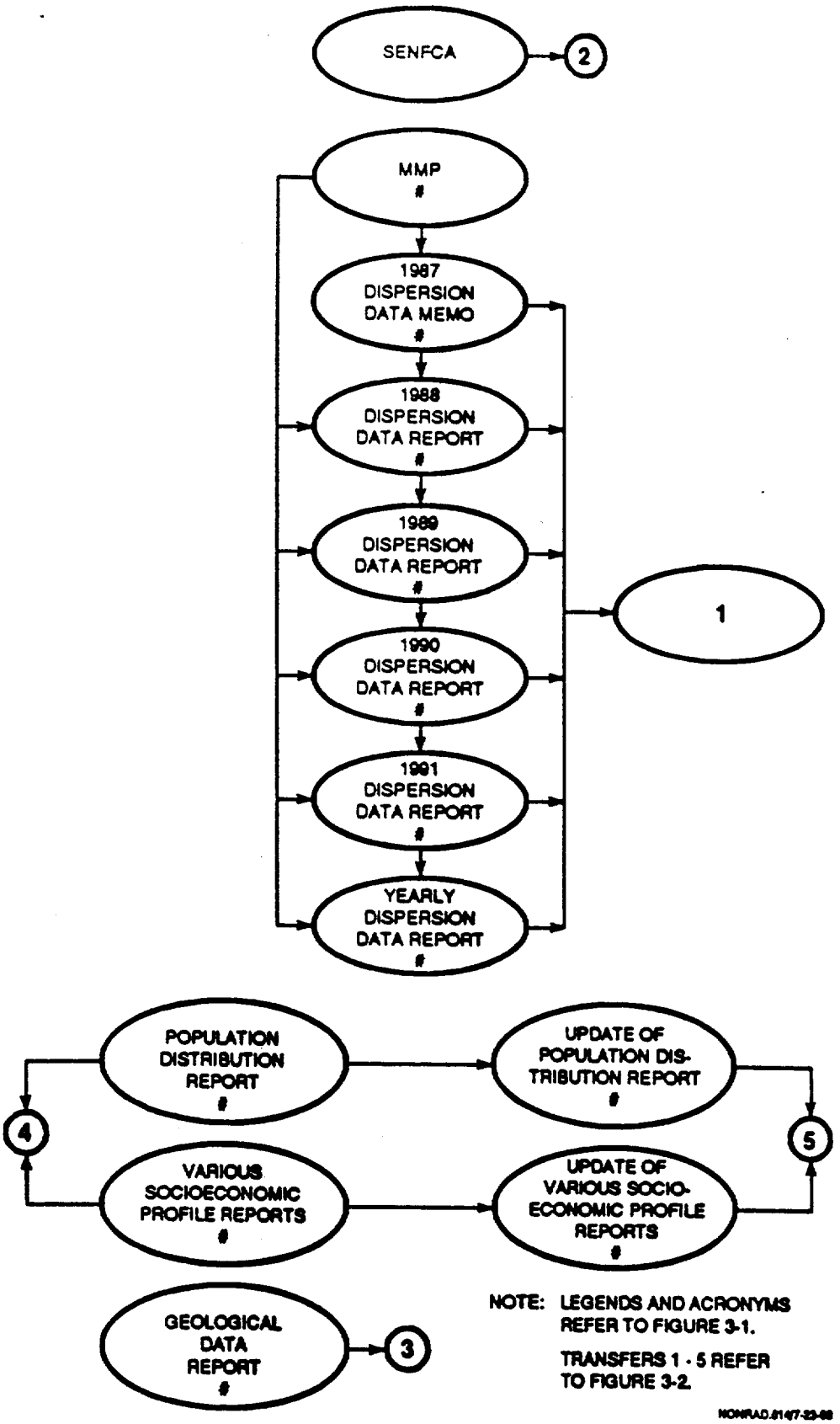

Figure 3-3. Nonradiological supporting technical reports.

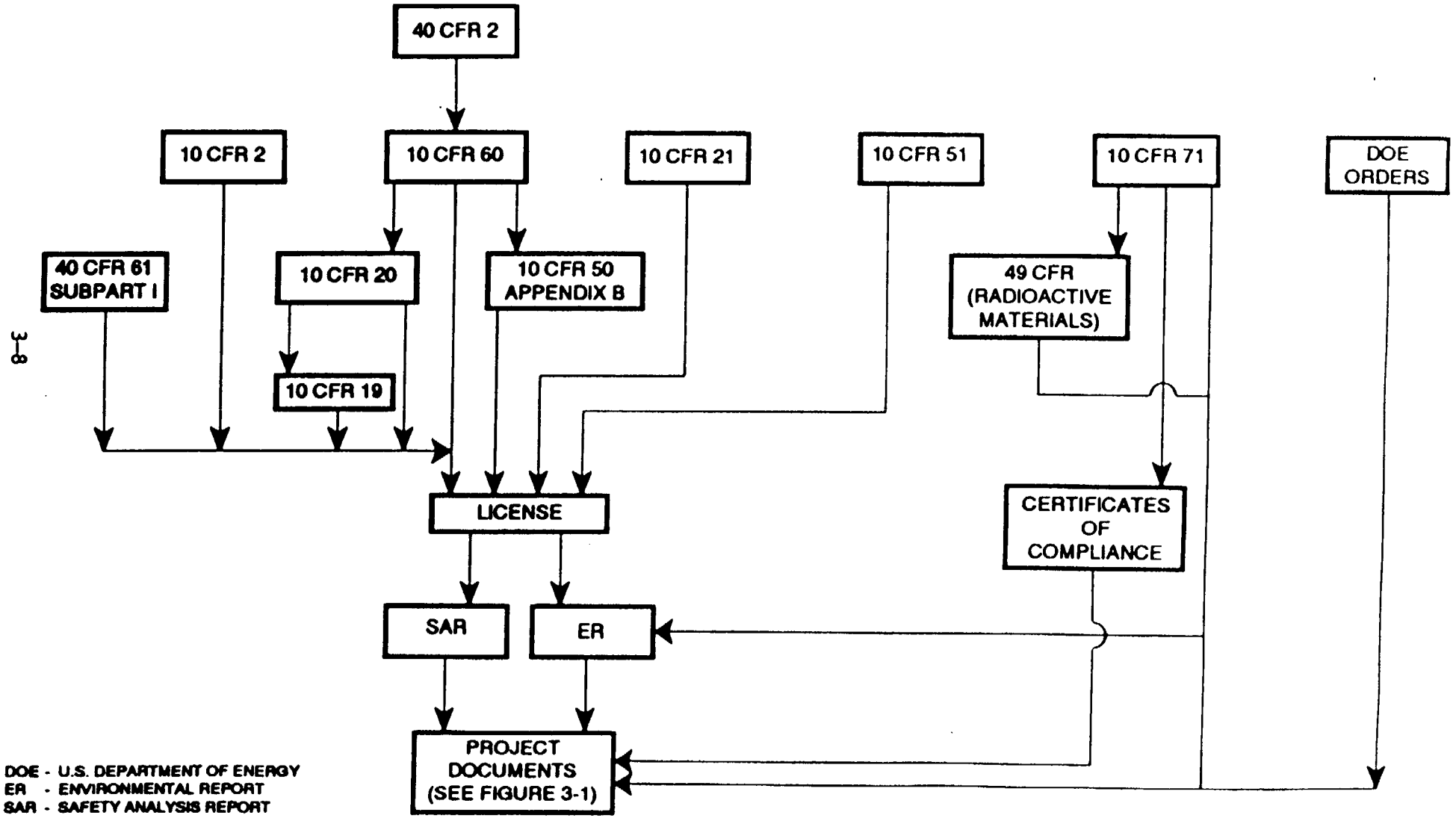

Figure 3-4. Document hierarchy for operations.

3.2.3 PERMANENT CLOSURE AND DECOMMISSIONING

During this phase, revisions to incorporate the decommissioning plans will be made to the controlling documents issued during operations; except for these revisions, the structure will remain basically the same.

3.2.4 POSTCLOSURE MONITORING

Responsibility, requirements, and control for the postclosure monitoring phase are presently not well-defined. As information becomes available, it will be added to this section.

3.3 REGULATORY AND OTHER REQUIREMENTS

This section addresses the various requirements that establish the need and content of the radiological monitoring program. The various regulatory requirements are discussed in the ERCP. The balance of this section addresses the other requirements.

The environmental impact assessment activities use the monitoring data to assess the impact of Project activities on the environment and the health and safety of the workers and the public. The activities will be atypical since this information is for a repository where both the period of interest (about 10,000 years) and the release pathways of interest are substantially longer than is characteristic of other nuclear facilities. The perceived hazards associated with the facility, as indicated by the political and public interest in this siting, are substantially greater than the actual hazards, which are minimal (DOE, 1986b). The perceived hazards must be addressed to the extent practicable, and increased monitoring activities may be necessary. Another atypical characteristic is a significant potential for a time-dependent radiological background in the Yucca Mountain area from past NTS activities. This is because activity is constantly moving from other areas into and out of the area of interest, since there are man-made sources of activity in the surrounding area.

The basic precepts under which the radiological monitoring program was developed are to

1. Meet or exceed all NWPA, NRC, EPA, and DOE requirements for this activity.

2. Collect all environmental radiological data required to support Project activities.

3. Produce and implement a program consistent with existing NTS environmental monitoring programs.

4. Minimize any potential impacts on other DOE activities in the area.

5. Monitor a sufficient range of parameters to identify any build-up, trends, or unexpected effects in the environment.

The following sections provide detailed descriptions of the requirements and scope of this program for each of the eight Project phases mentioned in Section 1.0.

The controlling documents for the Project are the Project Management Plan (PMP) (DOE/NV, 1987a), the Configuration Management Plan (CMP) (DOE, 1989), and the Systems Engineering Management Plan (SEMP) (DOE/NV, 1987b). However, the needs addressed by the RADMP are specifically identified in the Project Issues Hierarchy (DOE, 1986b) and the Regulatory Compliance Plan (RCP) (NNWSI Project, 1988), two Project documents shown in Figure 3-1.

3.3.1 REQUIREMENTS FOR MONITORING

The monitoring requirements and regulations related to environmental protection are addressed in the ERCP (DOE, 1988a).

The NWPA as amended (NWPAA, 1987) mandates that the DOE obtain a license for its commercial repository operations. To support this licensing process, the radiological monitoring program will comply with available NRC requirements and guidance. The DOE will also issue requirements and guidance, which must be met before the filing of the LA. Corley et al. (1981) and Walker (1987) are recommended as appropriate guidance by both the NRC and DOE, and this section relies on those documents as the primary source of the technical justification for the selection of radiological monitoring methodologies. The technical basis presented in these sections is primarily a paraphrase of this DOE guidance.

3.3.1.1 Site characterization

The environmental data collected during the site characterization phase may be used to assist in establishing the baseline environmental radiological condition, monitoring the impacts of site characterization activities, completing Project activities and facility design, and demonstrating regulatory compliance.

Another important reason for a comprehensive RADMP, beyond the regulatory compliance requirements specified in the ERCP (DOE, 1988a), is that it is simply good operational practice. Such a program will provide data for the following:

1. Evaluation of the adequacy and effectiveness of the containment and effluent control systems applied to facilities and operations at the site.

2. Detection of rapid changes and evaluation of long-term trends of concentrations in the environment, with the intent to (a) detect failure or lack of proper control of releases, and (b) initiate appropriate actions.

3. Assessment of the actual or potential doses to man from radioactive materials or radiation released to the environment as a result of DOE operations, or the estimation of the probable limits of such doses.

4. Collection of data bearing on the history of contaminants released to the environment, particularly with the intent of ensuring that the Project analyses did not fail to consider all appropriate pathways, synergistic effects, and modes of exposure.

5. Maintenance of a data base and capabilities for rapid evaluation and response to unusual releases of radioactivity.

6. Detection and evaluation of radioactivity from offsite sources to distinguish and compare the results of site operations.

7. Demonstration of compliance with applicable regulations and legal requirements concerning releases to the environment.

Furthermore, by gathering environmental radiological baseline data before the introduction of radioactivity into a new facility, any existing radiological impact can be correctly attributed. Otherwise, when activities that alter the baseline occur, it may not be possible to demonstrate the source of any radioactivity found outside the facility. By default, the facility would be presumed responsible. Correct attribution of responsibility may significantly reduce future costs and other impacts that could result from incorrectly assuming the source of the release to be the Yucca Mountain facility.

3.3.1.2 Construction

3.3.1.2.1 General

The radiological regulatory requirements applicable to construction remain essentially unchanged from those discussed in Section 3.3.1.1, except for those resulting from the NRC regulation of construction activities through issuance of a construction authorization. The NRC may also regulate other activities through specific conditions placed on the LA. There are no specific requirements for further collection of environmental radiological baseline data before initiation of the preoperational radiological monitoring program, since the required data for the EIS have been collected. However, a limited amount of data will be taken throughout this period to (1) verify compliance with applicable regulations; (2) establish a link between the site characterization data and preoperational monitoring data; and (3) verify the trends in the background variations, if any, identified during the site characterization phase.

3.3.1.2.2 Preoperational monitoring

In addition to the requirements in Section 3.3.1.2.1, the environmental radiological baseline must be verified before initiation of operation. This verification is mandated by DOE Order 5484.1, Chapter III, Section 1 (DOE, 1987b). Currently, there are no requirements specified by the NRC for this kind of mined geologic repository program; however, past NRC practice requires collection of an environmental radiological baseline for all major activities. Examples of such requirements are Regulatory Guide 4.1, Section B, for nuclear power plants (NRC, 1975); and Regulatory Guide 4.14, Section B, for uranium mills (NRC, 1980).

3.3.1.3 Operations

When a license to receive and possess is granted to the DOE (operations phase), the NRC becomes the primary regulatory authority. DOE Orders become internal requirements that may still be implemented. There is also a change to implementation of Subpart I of 40 CFR Part 61 (Clean Air Act) rather than Subpart H. This is essentially a change in the reporting system. In addition, a program must be implemented consistent with the SDWA discussed in the ERCP.

When operations are initiated, the operational environmental radiological monitoring program is implemented. The program is similar to the preoperational program, except the scope is typically reduced after the first year of operation and the environment is well-characterized.

The reduced-scope program is intended to provide a check on normal operations when facility activity has normalized following startup. In the event of actual release, the scope of the program will increase substantially.

The program is an outgrowth of the regulations and other requirements and guidance issued by the DOE and the NRC. Specifically, the operational program is based on the following:

1. DOE Order 5480.11 (DOE, 1988f).
2. DOE Order 5400.5, (DOE, 1990a).
3. The NRC guidance in 10 CFR 60.131(a)(4).
4. The NRC guidance in Regulatory Guides for similar facilities, and those issued for this type of facility.
5. Corley and Corbit (1982) and Walker (1987) with the guidance recognized by both the DOE and the NRC.

3.3.1.4 Decommissioning

The monitoring requirements during the decommissioning phase are unlikely to differ very much from those for the operations phase (Section 3.3.1.3). However, specific activities in such a program would be revised to reflect (1) the change in activities; (2) compliance with the NRC licensing amendment allowing decommissioning; (3) provision of sufficient data to verify adequacy of the decommissioning activities to the NRC, thereby permitting the NRC to terminate the license (10 CFR 60.52 and 10 CFR 60.5); and (4) compliance with other applicable requirements promulgated before the decommissioning activities were initiated.

3.3.1.5 Postclosure monitoring

Monitoring of the decommissioned facility is required for a period of time to be determined. This monitoring cannot impact the integrity or reliability of the repository. The exact program and program organizations have yet to be established. It is possible the program may be implemented by the DOE, the NRC, or some other outside agency, such as the EPA or the State. The monitoring is mandated in 40 CFR 191.14(b) and 10 CFR 60.51(a)(1). The data gathered throughout the program on the radiological conditions at the site, including any variations in the baseline values, will be used to develop this monitoring program.

3.3.2 PROJECT-GENERATED REQUIREMENTS AND COMMITMENTS

The controlling documents for the Project are the PMP (DOE/NV, 1987a), the CMP (DOE, 1989), and the SEMP (DOE/NV, 1987b). However, the needs addressed by the RADMP are specifically identified in the Project Issues Hierarchy (DOE, 1986b) and the RCP (NNWSI Project, 1988), two Project documents shown in Figure 3-1.

3.3.2.1 Issues hierarchy

The general issues hierarchy is prescribed by the OCRWM (DOE, 1986b). Therein key issues "are defined as the questions relating to the performance of the site and design" that must be resolved to demonstrate compliance with the applicable Federal regulations (including 10 CFR Part 60, 10 CFR Part 960, 40 CFR Part 191, and 10 CFR Part 20). Four key issues comprise the programmatic issues hierarchy:

> Key Issue 1: Will the mined geologic disposal system at [Yucca Mountain] isolate the radioactive waste from the accessible environment after closure in accordance with the requirements set forth in 40 CFR Part 191, 10 CFR Part 60, and 10 CFR Part 960?...

Key Issue 2: Will the projected releases of radioactive materials to restricted and unrestricted areas and the resulting radiation exposures of the general public and workers during repository operation, closure, and decommissioning at [Yucca Mountain], meet applicable safety requirements set forth in 10 CFR Part 20, 10 CFR Part 60, 10 CFR Part 960, and 40 CFR Part 191?...

Key Issue 3: Can the mined geologic disposal system at [Yucca Mountain] be sited, constructed, operated, closed, and decommissioned, and can the associated transportation system be sited, constructed, and operated so that the quality of the environment will be protected and waste-transportation operations can be conducted without causing unacceptable risks to public health or safety?

Note: The site-specific issues under Key Issue 3 will be finalized after environmental program planning efforts are complete and after the EIS scoping hearings. The Project Issues Hierarchy will be amended at that time.

Key Issue 4: Will the construction, operation (including retrieval), closure, and decommissioning of the mined geologic disposal system be feasible at [Yucca Mountain] on the basis of reasonably available technology, and will the associated costs be reasonable in accordance with the requirements set forth in 10 CFR Part 960?

Under these key issues are various issues or programs. Each issue or program is further defined at the Project level by sets of information needs or investigations. Note that general issues and information needs refer to environmental issues, while programs and investigations refer to geotechnical site characterization activities.

The RADMP collects a very limited amount of data to support the resolution of Key Issue 1. The data collected will support resolution of the compliance with postclosure standards primarily in the first 1,000 years after closure, and primarily as related to the groundwater systems. These RADMP activities will be closely tied to the Environmental Field Activity Plan for Water Resources (to be issued) and the site characterization study plans for hydrologic studies. The issues in Key Issue 1 for which the RADMP collects data include the following:

1. Will the mined geologic disposal system meet the system performance objective for limiting radionuclide releases to the accessible environment as required by 10 CFR 60.112 and 40 CFR 191.13?

2. Will the mined geologic disposal system meet the requirements for limiting individual doses in the accessible environment as required by 40 CFR 191.15?

3. Will the mined geologic disposal system meet the requirements for the protection of special sources of groundwater as required by 40 CFR 191.16?

4. Will the waste package meet the performance objective for containment as required by 10 CFR 60.113?

5. Will the waste package and repository engineered barrier systems meet the performance objective for radionuclide release rates as required by 10 CFR 60.113?

6. Do the data collected in order to describe the present and expected geohydrologic characteristics provide the information required by the design and performance issues?

A major portion of the data collected in this document will be used to support resolution of the issues that support preclosure radiological safety and compliance with applicable radiation protection limits (Key Issue 2). Limited input is also supplied to the geochemistry program and to support the higher level of findings required by the siting guidelines related to this area in Key Issue 2. The issues in Key Issue 2, for which the RADMP collects data, include the following issues:

1. During repository operation, closure, and decommissioning, will (a) the expected average radiation dose received by members of the public within any highly populated area be less than a small fraction of the allowable limits and (b) the expected radiation dose received by any member of the public in an unrestricted area be less than the allowable limits as required by 10 CFR 60.111, 40 CFR 191 Part A, and 10 CFR Part 20?

2. Can the repository be designed, constructed, operated, closed, and decommissioned in a manner that ensures the radiological safety of workers under normal operations as required by 10 CFR 60.111 and CFR Part 20?

3. Can the repository be designed, constructed, operated, closed, and decommissioned in such a way that credible accidents do not result in projected radiological exposures of the general public at the nearest boundary of the unrestricted area, or workers in the restricted area, in excess of applicable limiting values?

4. Have the characteristics and configurations of the repository been adequately established to (a) show compliance with the preclosure design criteria of 10 CFR 60.130 through 60.133 and (b) provide information for the resolution of the performance issues?

The population density and distribution program discussed in the SCP (DOE, 1988b) will collect the following information to support the resolution of the previous issues:

1. Forecasts of the population of general public/members of the public in any highly populated area and in potential unrestricted areas during operation and closure; and forecasts of population in areas needed to assess public radiation exposures (Section 6 of the RADMP).

2. Forecast of the number of workers during operation and closure, in potential restricted and unrestricted areas (Section 6 of the RADMP, the Conceptual Design Report (SNL, 1987), and future design reports).

The meteorological program will provide the following:

1. Meteorological conditions in the vicinity of the site (the Meteorological Monitoring Plan (DOE/NV, 1989b) and Section 6 of the RADMP).

2. Atmospheric and meteorological phenomena at potential locations of surface facilities (the Meteorological Monitoring Plan (DOE/NV, 1989b) and Section 5 of the RADMP).

3. Location of population centers relative to wind patterns in the general region of the site (the Meteorological Monitoring Plan (DOE/NV, 1989b) and Section 5 of the RADMP).

4. Support data for assessing the potential impacts of nearby installations and operations (Section 4 of the RADMP with monitoring details in Section 4.3).

And, finally, the offsite installations program indicates the need for:

1. Collection of agricultural data required by the design and performance issues (Section 5 of the RADMP).

2. Collection of cultural data required by the design and performance issues (Section 6 of the RADMP).

The information needs associated with Key Issue 3 will not be finalized until the EIS Scoping Hearings are completed; however, as currently planned, the data to be collected include:

1. Potential levels of radionuclides and doses to which regional populations will be exposed for normal and accidental conditions, and their potential effects (Sections 4, 5, and 6 of the RADMP).

2. Potential for environmental and transportation-related impacts to the natural resources, flora, and fauna (outlined in the environmental characterization issues) and to the public health and safety that cannot be mitigated or otherwise avoided (Sections 4, 5, and 6 of the RADMP).

3. A detailed description of all sources of radioactivity associated with normal operations and expected operational occurrences (Section 4 of the RADMP relative to currently existing sources).

4. A detailed description of all onsite and offsite environmental effluent monitoring systems (Section 4 of the RADMP).

5. A detailed description of all solid, liquid, and gas effluents and emissions and associated waste processing systems, including a list of all EPA designated hazardous chemicals to be used at the site (Section 4 of the RADMP for radiological effluents).

6. Present expected levels of background radiation (Section 4 of the RADMP).

Furthermore, a detailed schedule of major site-related milestones and activities from the initiation of site activities through construction and decommissioning to the end of the post-surveillance period, including transportation, must be developed (Sections 1 and 7.1 of the RADMP). The data collected in the radiological monitoring activities and associated analyses will also provide limited support to the resolution of other issues addressed by key issues when finalized.

3.3.2.1.1 Site Characterization Plan

Each of the issues and information needs for Key Issues 1, 2, and 4 are addressed in the SCP (DOE, 1988b). Resolution of the information needs related to radiological monitoring activities is addressed in the RADMP. The RADMP provides either (1) a detailed discussion of the justification and implementation of the activities, or (2) a justification for activities conducted by others to provide required data (Section 6). The data collection mandated by this document will support preparation of the Project Site Suitability Report, EIS, SAR, and other documents.

Table 3-1 presents the data required, as well as the SCP section providing the information.

3.3.2.1.2 Safety and Health Plan

The SHP (DOE/NV, 1990) is Annex 3 of the PMP (DOE/NV, 1987a), as required in DOE Order 4700.1, "Project Management System" (DOE, 1987d). This plan specifies the requirements for the Project safety and health protection implementation program. This document is implemented by (1) various Project-level procedures, (2) lower tier documents (i.e., the RADMP), and (3) various organization safety and health plans. The SHP defines the minimal acceptable program in the area of safety and health protection required to implement the DOE Orders.

Table 3-1. Site Characterization Plan data requirements (page 1 of 2)

Data requirement	SCP section
METEOROLOGICAL DATA	
Wind speeds	8.3.1.12.1, 8.3.1.12.2
Wind direction	8.3.1.12.1, 8.3.1.12.2
Atmospheric stability	8.3.1.12.1, 8.3.1.12.2
Mixing layer depth	8.3.1.12.1, 8.3.1.12.2
Average ambient temperature	8.3.1.12.1, 8.3.1.12.2
Atmospheric moisture	8.3.1.12.1, 8.3.1.12.2
Barometric pressure	8.3.1.12.1, 8.3.1.12.2
Precipitation type, amount, intensity, etc.	8.3.1.12.1, 8.3.1.12.2
Size and distance of topographic features from release points	8.3.1.14.1
Meteorological data for offsite installations	8.3.1.12.1, 8.3.1.12.2
AGRICULTURAL DATAa	
Bioaccumulation of radionuclides in terrestrial flora	8.3.1.13
Bioaccumulation of radionuclides in terrestrial fauna	8.3.1.13
Types and amounts of crops raised	8.3.1.13
Types and amounts of crops consumed locally	8.3.1.13
Types and amounts of animals raised	8.3.1.13
Types and amounts of animals consumed locally	8.3.1.13
Animal consumption of forage locally	8.3.1.13

Table 3-1. Site Characterization Plan data requirements (page 2 of 2)

Data requirement	SCP section
Forage storage time	8.3.1.13
Grazing yield and period	8.3.1.13
Radius of crop and animal area	8.3.1.13

*Collection of these data is part of the planned activities in the Radiological Monitoring Plan (RADMP), and is discussed in Section 8.3.1.13 of the SCP.

3.3.2.1.3 Environmental Protection Implementation Plan

The Environmental Protection Implementation Plan (EPIP) (DOE/NV, 1989a) provides the detailed summary of the implementation of DOE Order 5400.1, "General Environmental Protection Program (DOE, 1988e)," for the Project as required by the Order. This document provides information on the approach the Project implements to satisfy DOE requirements for environmental protection. This approach is implemented through the EMP (DOE, 1990b), Environmental Monitoring and Mitigation Plan (EMMP) (DOE, 1988c), ERCP (DOE, 1988a), RADMP, Reclamation Implementation Plan (to be issued), and the Hazardous Materials Management and Handling Program documents.

3.3.2.1.4 Environmental Management Plan

The U.S. Department of Energy (DOE) is committed to performing its activities in an environmentally safe and sound manner and will comply with all applicable environmental statutes and regulations. To fulfill this commitment, the DOE has established an environmental program for the Yucca Mountain site that plans and performs the activities necessary to satisfy applicable environmental regulatory and programmatic requirements. The environmental program is structured to satisfy the statutory requirements of the Nuclear Waste Policy Act as amended; the National Environmental Policy Act; the Atomic Energy Act; and other applicable statutes, regulations, and DOE Orders. The environmental program is integrated with other programs under the direction of the DOE Office of Civilian Radioactive Waste Management (OCRWM) to evaluate the Yucca Mountain site as a candidate site for a high-level radioactive waste repository. OCRWM environmental programmatic policy requirements (as described in the Mission Plan and Mission Plan Amendment) have also been incorporated into the environmental program.

The techniques used to manage the environmental program are described in this EMP (DOE, 1990b). Systems engineering methodology is used in all aspects of the Yucca Mountain Site Characterization Project, including the environmental program, as described in the System Engineering Management Plan (SEMP) and directed by the Project Management Plan (PMP). The EMMP (DOE, 1988c) and the ERCP (DOE, 1988a) have been developed to assure implementation of the applicable laws and regulations by the EMP activities.

Details on RADMP activities that address implementation of EMMP activities can be found in the Environmental Field Activity Plan (EFAP) for Radiological Studies (DOE, 1988d). This document addresses those activities specifically required as a result of monitoring and mitigation activities in a manner consistent with other Project EFAPs.

3.3.2.2 Regulatory Compliance Plan

The RCP (NNWSI Project, 1988) addresses the licensing-related regulations that apply to the Project and how they are to be implemented. The RCP or support document will summarize other applicable regulations, requirements, and guidance in this area, such as DOE Orders, State regulations, EPA guidance, National Council on Radiation Protection and Measurements (NCRP) guidance, and International Commission on Radiation Protection (ICRP) guidance.

3.3.3 INTERNAL REQUIREMENTS AND DIRECTION

In addition to the technical data needs discussed in Sections 3.3.1 and 3.3.2, these activities are controlled by:

1. OCRWM policies and plans.
2. The OCRWM QARD (OCRWM, 1990a), QAPD (OCRWM, 1990b), and supporting documents.
3. Yucca Mountain Site Characterization Project Office administrative procedures.
4. The Project Technical Data Management System (DMS) and Information Management System (IMS).
5. The Project SEMP (DOE/NV, 1987b).
6. SAIC administrative procedures and policies.

3.3.3.1 Office of Civilian Radioactive Waste Management policies and plans

OCRWM policies and plans establish the basic criteria for all Project activities interacting with the Project Office. The expected milestones for the RADMP are based on the Draft Mission Plan Amendment of January 1987 (DOE, 1987c). The RADMP also implements some of the applicable sections of the OCRWM Safety Plan (DOE, 1986c). The activities completed within the RADMP implement the requirements of the OCRWM QARD (OCRWM, 1990a).

3.3.3.2 Activity-specific quality assurance programs

Implementation of the OCRWM QARD (OCRWM, 1990a) depends on the implementing organization and is discussed below.

3.3.3.2.1 OCRWM Quality Assurance Requirements Document and supporting procedures

All activities implemented by the Project Office are subject to the requirements of the QARD (OCRWM, 1990a) as implemented by the OCRWM QAPD (OCRWM, 1990b) and applicable organization QAPDs (see Section 3.3.3.2.3 and 4).

3.3.3.2.2 OCRWM Quality Assurance Program Description Document and supporting procedures

All activities implemented by the Project Office are subject to the requirements of the QAPD (OCRWM, 1990b) which implements the OCRWM QARD (OCRWM, 1990a). Satisfaction of these requirements is based on the QA grading packages prepared for this activity, consistent with Project Office Administrative Procedure (AP) 5.28Q, Quality Assurance Grading (DOE, 1990c).

3.3.3.2.3 T&MSS Quality Assurance Program Document and supporting procedures

All activities implemented by T&MSS are subject to the requirements of the T&MSS QAPD (SAIC, 1990a) and supporting documents. NRA/EPA 's activities will be conducted in accordance with the T&MSS QAPD (SAIC,1990a). Satisfaction of these requirements is based on the QA grading packages prepared for this activity, consistent with Project Office AP 5.28Q, Quality Assurance Grading (DOE, 1990c).

3.3.3.2.4 EG&G Quality Assurance Program Document and supporting procedures

All activities implemented by EG&G/EM are subject to the requirements of the EG&G QAPD and supporting documents. Satisfaction of these requirements is based on the QA grading packages prepared for this activity, consistent with Project Office AP 5.28Q, Quality Assurance Grading (DOE, 1990c).

3.3.3.3 Yucca Mountain Site Characterization Project administrative procedures

All organization activities are subject to the requirements of the Project APs. Specific APs implement the Project-wide requirements specified in the SHP (DOE/NV, 1990).

3.3.3.4 Project Technical Data Management System and Information Management System

The data collection and reduction activities associated with the radiological monitoring program will be conducted in a manner consistent with the requirements of the DMS. All reports, plans, procedures, and other documents will be controlled, issued, and distributed in a manner consistent with the IMS and the policies and procedures addressed in Sections 3.3.3.2, 3.3.3.3, and 3.3.3.5.

3.3.3.5 Yucca Mountain Site Characterization Project Systems Engineering Management Plan

The SEMP (DOE/NV, 1987b) will ensure that these activities are consistent with Project-wide activities, needs of the various Project organizations, and needs of the Project as a whole. The APs outlined in the SEMP also require baselining (reference to establishing a controlled change system) of the requirements in the RADMP and control of changes to these requirements.

3.3.3.6 Safety and health plans

The details for implementation of the SHP (DOE/NV, 1990) for radiological program activities is provided in safety and health plan documents for the T&MSS contractor (SAIC) and EG&G/EM. The radiological monitoring activities are referenced to the RADMP, whereas the radiological safety activities are specifically addressed in the organization safety and health plan documents. These documents are typically implemented by procedures/instructions.

3.3.3.7 Administrative and technical procedures and policies

The activities in the RADMP are completed as specified in the RESMIP (to be issued), supporting documents, and the supporting organizations' procedures and instructions. The RMIM (SAIC, 1990b) contains most of these T&MSS instructions. The Safety Plan for Project Operations Department Field Activities (SAIC, 1986c) addresses the safety related requirements for T&MSS activities. This safety plan will shortly be replaced by the T&MSS Environment, Safety, and Health Plan (TESHP). Either these documents or equivalent documents will be applied by EG&G/EM. NRA/EPA shall follow the T&MSS documents in implementing Project activities.

3.3.4 IMPLEMENTATION DOCUMENTATION

Based on the requirements in Section 3.3, various documents were issued to control the radiological monitoring activity directly (Figure 3-1). The primary documents are the RADMP and the PSCRADMP (SAIC, 1987a). Further details addressing implementation of the RADMP will be addressed in the RESMIP when issued. The RESMIP will be a T&MSS document that provides implementation clarification for the RADMP.

3.3.4.1 Technical and Management Support Services activities

The requirements specified in these RADMP and the RESMIP are directly controlled by the RMIM (SAIC, 1990b); the Safety Plan for Project Operations Department Field Activities (SAIC, 1986c) for T&MSS activities; and the EMP, TESHP (when issued), and T&MSS QAPD (SAIC, 1990a). This includes specific training of personnel per the environmental radiological monitoring training program.

3.3.4.2 EG&G/Energy Measurements activities

These activities are conducted in a manner consistent with the RADMP and RESMIP. The technical activities are completed as specified in applicable EG&G/EM documents, procedures, and instructions.

4.0 THE RADIOLOGICAL MONITORING FIELD DATA COLLECTION ACTIVITIES

This section addresses the collection of radiological baseline data to satisfy the regulations, requirements, and guidance discussed in Section 3 per the SHP (DOE/NV, 1990). The program described is for the site characterization phase; the program for other phases will be detailed in later RADMP revisions. As well as establishing the radiological background, the proposed program will collect data necessary meet the following objectives:

1. Characterize the work environment at the site.

2. Estimate potential impact of past and future NTS activities on present safety analysis and design activities.

3. Assist facility design (SNL, 1987) and prepare safety analysis reports.

4. Monitor the impacts of site characterization activities on the surrounding environment.

5. Verify the feasibility of monitoring the environment for appropriate radionuclides.

6. Support decontamination and decommissioning of the facility.

7. Verify compliance with NRC, DOE, and NTS requirements.

8. Meet the requirements specified in the SHP (DOE/NV, 1990) in association with the Project APs and applicable safety and health plans for the organizations, particularly the TESHP (when issued).

9. Monitor radioactivity in the environment for trends indicating changes in the existing environment.

The RADMP will be revised, as needed. Specifically, a revision will be needed after the EIS scoping process is completed, to incorporate the environmental baseline data required for the EIS. The entire program will also be evaluated in terms of available data to determine if changes are justified. Several revisions currently planned are detailed in Section 7.2. Some of the data currently being collected may be identical to the data that will be identified during the EIS scoping process. All data will be collected in a manner allowing their use in establishing the EIS environmental baseline. Much of the program in the far-field (beyond 15 kilometers) area already exists as part of the ongoing activities for the EPA Nuclear Radiation Assessment (NRA) to support DOE defense program activities at the NTS. These data are available to the Project. All relevant sampling locations are noted in the RADMP, and any new locations added in support of the Project will be identified. All near-field locations are strictly related to the Project. The monitoring activities during site characterization are designed to characterize the environment and identify and quantify any impacts on it.

4.1 SCOPE OF THE RADIOLOGICAL MONITORING PROGRAM

Data will be collected for this program to satisfy the objectives listed in Section 4.0. Each objective is addressed separately.

4.1.1 CHARACTERIZATION OF THE WORKSITE ENVIRONMENT

Two characteristics of the worksite environment will be addressed in this section: (1) the existing radioactivity concentrations in the background environment at the site, and (2) the potential radon emission from the site.

4.1.1.1 Existing background

The existing radiation levels and radioactivity concentration in the general environment are not expected to have any significant impact on worker health and safety. The radiological monitoring program has been established to determine the validity of these assumptions.

Implementation of the RADMP will evaluate various potential exposure pathways to man:

1. Direct exposure to radiation.
2. The inhalation of resuspended radioactivity.
3. Worker and equipment contamination contribution to the pathways noted in Items 1 and 2.
4. Other indirect pathways such as ingestion of radioactivity.

The direct exposure pathway is not projected to be significant. Various NTS organizations have identified and posted (or decontaminated) contaminated areas. There are presently no posted areas at the Yucca Mountain site. To confirm the insignificance of the direct exposure pathway, an array of passive radiation monitors, TLDs, and gamma radiation monitors will be installed throughout the site to monitor direct radiation. The posted areas within Area 25, which is the base for the Project activities, are very limited in number and contain minimal activity.

Airborne activity has been sampled by a continuous air sampler at the 60-meter meteorological tower located near Yucca Mountain as described in the Meteorological Monitoring Plan (DOE/NV, 1989b). Samplers will be added as part of the radiological monitoring program implementation. Air sampling (Section 4.2.4) for the program will monitor airborne radioactivity present at the site, and will include collection of particulate size data for assessment of the inhalation hazard. Surface soil samples also will be taken to assess the radioactive material available for resuspension.

4.1.1.2 Radon emissions

To comply with DOE Order 5480.4 (DOE, 1987a), requiring adherence to the State of California Mine Safety Orders (30 CFR 57.5-3), it is necessary to monitor radon/radon progenies to ensure worker safety. 30 CFR 57.5-37 is being revised to include the radon from natural thorium as well as uranium decay series. The surface facilities environment, the ambient background, and the exhaust from the underground workings will be monitored for radon and radon progenies from the uranium and thorium series. These data will be used to assess and control potential worker exposure and to demonstrate compliance with the applicable regulations. This activity will fall within the operational health physics program when the facilities are constructed.

4.1.2 CHARACTERIZATION OF NEVADA TEST SITE ACTIVITIES

It is essential to assess the impact of activities in the area surrounding the proposed Yucca Mountain facility to (1) fulfill the requirements of 10 CFR Part 960 (Section 3.3.1.1.3), (2) support preparation of the SAR, and (3) design a facility. NTS activities may have a radiological impact on the proposed Yucca Mountain facility. The radiological monitoring program will provide data to help quantify this impact. The information is needed to support potential design activities. Assessment of radiological conditions at the site will be performed by reviewing available documents, some of which are discussed in Section 4.2.1, and by collecting current data. These two data sets will then be used to document past and present conditions, and to project future conditions. Both data sets will be documented in the Radiological Data Base, currently being developed by T&MSS. Reduced data will be provided by this data base to the Site and Engineering Properties Data Base (SEPDB) and the Reference Information Base (RIB).

The radiological field data collection activities for assessing the impact of NTS include:

1. Determination of ambient airborne radionuclide concentrations in the Yucca Mountain area, including identification of potential sources and particle size distributions. These data will be used to establish intake-air filtration requirements, if any, and to project off-normal conditions for design, safety analysis, and site evaluation.

2. Evaluation of the radioactivity concentrations in the groundwater to verify that the radiological water quality is acceptable for use in the facility. No radioactive material above natural background is expected to be present in the groundwater at Yucca Mountain. These data are being collected for resolution of other needs (discussed in Sections 3, 4.1.4, 4.1.5, and 4.1.6), but can also be used to verify the absence of contamination in the water supply.

3. Surface water and sedimentation analyses of the ephemeral stream in Fortymile Canyon/Wash. These data will be used to project both the impacts of past NTS activities and the radioactivity due to airborne deposition, since this is the source of the man-made activity in excess of normal background, if any, that is present.

4. Performance of soil and driftwall sampling to establish the existing radiation background in the surface and underground work areas to support facility design and safety analysis activities. The primary purpose of driftwall sampling will be for radon and radon progeny product monitoring.

5. Biota sampling in the Yucca Mountain area to support the objectives of Items 2, 3, and 4, and to examine radioactivity already in the human food chain for the purpose of safety analysis and regulatory compliance.

4.1.3 FACILITY DESIGN AND SAFETY ANALYSIS REPORT PREPARATION

The data requirements discussed in Section 4.1.2 and the ambient radiation data are needed for facility design and preparation of the SAR. Collection of these data is discussed in Section 4.2.8.

Radon exposure data will also be needed to design the facility and prepare the SAR. The radon data collected before the construction of the exploratory shaft (SE), during underground mining activities associated with the ES, and during ES activities will be used to assess the radon emission rate in the proposed underground facility at Yucca Mountain. The results from evaluation of these data will then be used in the design of the facility ventilation system and safety analysis activities. The data from soil and driftwall samples will be used to assist in the estimation of the radon emission rates and resuspension of existing radioactivity for ventilation system design. These data can also be used in the design of airborne radioactivity monitoring systems for the facility. Radon progeny products collected by air samplers interfere with accurate assessment of the airborne radioactivity concentrations from other sources.

4.1.4 MONITORING IMPACT(S) OF SITE CHARACTERIZATION

There is a need to monitor site characterization impacts in three major areas. The potential sources of radioactivity are resuspended activity from the soil and sediments around Yucca Mountain, release from a groundwater source to the surface, and radon release resulting from excavation. To assess radioactivity resuspension from the site, particulate air samples will be taken and the source (the soils and sediments) analyzed. Any potential release from groundwater to the surface will be evaluated to assess the potential impact, if any. Finally, radon monitoring will provide data to Project offsite impacts of any radon release resulting from site characterization earth-disturbing activities.

4.1.5 FEASIBILITY OF RADIOLOGICAL MONITORING

Because there may already be a radiological background level in excess of typical background levels at the Yucca Mountain area, it is necessary to quantify existing conditions to determine if they will interfere with the ability to monitor releases from an operating facility. Special problems may exist in accurately performing routine measurements of I-129, Tc-99, and C-14 in environmental samples. This concern will be specifically addressed in later sections. Finally, it will be necessary to choose and characterize a local indicator species. The indicator species is an animal whose range is closely limited to the area of interest and whose characteristics result in significant intake of radionuclides in the environment. This animal can be used to indicate the presence or absence of unsuspected release pathways. A further discussion of this concept will be presented in the RESMIP (when issued).

4.1.6 DATA FOR DECONTAMINATION AND DECOMMISSIONING

Data or samples representing the original condition of the area will be needed for planning of decontamination and decommissioning activities. The required monitoring activities will be the same as those for site characterization except that some locations may be changed and the number of locations altered. Soil, biota, and water samples must be archived specifically for this purpose. Samples will be archived in the Project Sample Management Facility (SMF), where chain-of-custody will be maintained.

4.1.7 COMPLIANCE VERIFICATION

The radiological monitoring activities in the radiological monitoring program will allow the Project to determine compliance with the DOE Orders and NTS requirements during site characterization. These requirements cover the monitoring of effluents generated by the Project, including radiological emissions reporting and compliance requirements for the Clean Air Act.

The DOE Order 5400.5, Radiological Protection of Public and the Environment, (DOE, 1990a) specifically prohibits the use of soil columns for the removal of radioactive material from liquids. No significant quantity of any liquid is allowed to be released to the surface before the characteristics of the liquid are well established. This is mandated by applicable Project procedures. There should be no radioactivity above natural background in the groundwater in the Yucca Mountain area; this will be verified before release of significant quantities (a few gallons) of such water to the surface-water system. Samples will also be analyzed later as part of the routine RADMP activities. The isotope of interest in this determination will be tritium.

4.1.8 COLLECTION OF DATA FOR THE ENVIRONMENTAL IMPACT STATEMENT

The specific data required for preparation of the EIS will be identified during the EIS scoping process. Since approximately five years (or more) of data may be needed to establish any trends in the existing background at Yucca Mountain, the data taken in the activities discussed in Sections 4.1.1 to 4.1.6 should be collected over that interval of time. Given existing schedules, there will not be sufficient time to begin to collect these data after the EIS Scoping Hearings. The data collected for site characterization activities is expected to be similar to the data identified during EIS scoping. The data collected will be used, where appropriate, to supplement the data collected specifically for the EIS radiological baseline. Efforts will be made to keep the radiological monitoring activities discussed in Sections 4.2.1 to 4.2.6 consistent with the projected EIS radiological baseline data collection requirements and guidelines.

4.2 DESCRIPTION OF THE RADIOLOGICAL FIELD MONITORING PROGRAM

The radiological monitoring program is intended to gather environmental radiological data to satisfy the needs identified in the ERCP (DOE, 1988a) requirements. Details of the program are based on applicable DOE, NRC, and EPA guidance and requirements. Guidance from various other groups (e.g., NCRP, ICRP), consensus standards, historical precedent, and industry practice will also be used in the program's development. The program specifically addresses the site characterization phase; later phases will be discussed in subsequent revisions of this document.

4.2.1 SAMPLING INITIATION

The radiological monitoring program recognizes that there may be an elevated background in the Yucca Mountain area from the deposition and resuspension of particulates from past NTS activities. Also, this background may be changing with time because of radioactive decay and the movement of radioactivity into and out of the area from other locations. It is presently unknown whether this source is changing, and, if so, in which direction (increasing or decreasing). Indeed, the direction or rate of any changes may be highly dependent on radionuclide type. Consequently, it is important to characterize any changes in the source term and establish current conditions accurately.

Collection of background data typically requires two years at a pristine site for preparation of the EIS and prior to initiation of operation. This permits characterization of the seasonal, statistical, and spatial variability in the current background (Corley et al., 1981; Walker, 1987; and Regulatory Guide 4.1, Section C.1 (NRC, 1975)). Characterizing the variabilities will take substantially longer if the current background is changing with time. Any significant change in the current background should, however, be identifiable from five years of data. These data will have to be

collected for preparation of the EIS. Also, because it typically requires about one year to implement a program including procurement, training, and operational testing, the total time to establish an environmental background data base may be six years. This discussion does not address possible future unplanned releases at the NTS. Note that site characterization activities are not expected to alter the radiological background conditions in the Yucca Mountain area.

An exception to this time requirement just discussed is the characterization of the radon baseline. Because the radon parents have extremely long half-lives, the radon background at the site has not been affected by past NTS activities that released radionuclides. Consequently, two years of data collection before ES construction and mining activities would be desirable to characterize the radon source term. It is possible that only one year of data may be collected because of Project schedule constraints, and efforts are being made to maximize data collection within these constraints. The radon data collected using passive integrating radon monitors will be supplemented with continuous radon data to ensure adequate background information is obtained. The radon background data collection activities should be finished before shaft construction and mining activities. The effect on radon release rates of the weapons testing induced seismic activity would be characterized by this activity as well, if it exists. Any effect is unlikely to be detected on the surface because of the small size of the effect, the diffusion rate of radon through the soils (Rogers et al., 1984), and the half-life of radon.

Details of the RADMP monitoring activities are discussed in the following sections, and each type of sampling and analysis are addressed separately.

4.2.2 SAMPLING AREA

Based on the regulatory requirements and guidance, technical guidance, present NTS programs, public concern, and historical precedent, the general areas of interest for the radiological monitoring activities are (1) the area surrounding Yucca Mountain, and (2) (based on the 10 CFR 960.5-2-1 requirement for monitoring the newest highly populated urban area) the City of Las Vegas, Nevada. The Project sampling activities will be directed toward monitoring the radiological exposure pathways to man in these areas.

4.2.3 SOURCES OF RADIOACTIVITY

Potential sources of radioactivity in the environment at Yucca Mountain before receipt of nuclear waste are:

1. Resuspended radioactive materials originally present in the soils or attached to the biota.

2. Radioactive particulates released by other NTS activities or resuspended from other NTS locations.

3. Radioactive gases (H-3, C-14, various radioactive iodine isotopes and inert gases) released by NTS activities from other NTS locations that may, with time, become associated with soils, surface water, or the biota.

4. Radioactive releases from the commercial low-level waste disposal activities located near Beatty, Nevada. The major indicators of releases are similar to those from the NTS (Items 2 and 3).

5. Planned releases of short-lived radionuclide tracers and the potential for accidental release of longer-lived radionuclides used during site characterization activities at Yucca Mountain and associated with well-logging and hydrological modeling activities.

6. Radioactive material dissolved or suspended in the groundwater or surface-water systems from past NTS activities. (The groundwater source may be essentially zero due to the travel time required for the water to reach the saturated zone, radionuclide transport rate in the unsaturated and saturated zones, radionuclide decay rates, past NTS data referenced in Table 4-1, and projected groundwater flow paths.)

7. Radioactive material dissolved or suspended in the groundwater or surface-water systems from natural sources of radioactivity.

8. Radon and radon progeny products released to the atmosphere, including existing release rates, enhanced release rates resulting from excavation activities, and enhanced release rates resulting from mining activities.

9. Natural radioactive material present in the soils, in the atmosphere, or incorporated into the biota.

10. Worldwide fallout.

Activity in the Yucca Mountain area is expected to be predominately either naturally occurring or from NTS activities; neither of these is expected to be large. The contribution from the nearby commercial low-level waste disposal activity is also expected to be negligible since it has very limited releases and is 40 kilometers (22 miles) away. The impact of the facility will be verified. The radionuclides of interest are summarized in Table 4-1. The radionuclides were selected based on several criteria:

1. The significant radionuclides based on the EPASS (SAIC, 1989a), which may be derived from the various NTS activities.

2. The significant radionuclides based on the EPASS (SAIC, 1989a) that will be present at the site when operations are initiated.

Table 4-1. Radionuclides of interest[a] (page 1 of 4)

Radionuclides	Source							Reference (See page 4 of table)
	Spent Fuel[b]							
	NTS[d]	> 0.01% 10 years	> 1% 10,000 years	HLW	Naturally[c] occurring	40 CFR 191 Table 2	Emissions[e]	
H-3	x						β (0.0186)	5, 6
Be-7					x		γ	
C-14					x	x	β (.156)	4
K-40					x		β, γ	
Fe-55		x					EC, x-rays	1
Co-60		x		x			β, γ	2
Ni-59			x				EC, x-rays	1
Ni-63		x		x			β (0.067)	1, 2
Kr-85	x	x					β, γ	1, 5, 6
Sr-89	0							5,6
Sr-90/Y-90	x	x		x		x	β	1, 2, 4, 6
Zr-93/Nb-93m				x			β (.06) x-rays	2
Tc-99			x	x		x	β (.292)	1, 2, 4
Ru-106/Rh-106		x					β, γ	1
Sn-126/Sb-126m/ Sb-126						x	γ, β	2, 4
Sb-125/Te-125m		x					β, γ	1
I-129						x	β (.15) γ (.04) x-rays	4
I-131	0						β, γ	6
I-133	0						β, γ	6
I-135	0						β, γ	6
Xe-133	0						β, γ	5, 6
Xe-133m	0						γ	6
Xe-135	0						β, γ	6

Table 4-1. Radionuclides of interest[a] (page 2 of 4)

Radionuclides	Source: Spent Fuel[b] NTS[d]	Spent Fuel[b] > 0.01% 10 years	Spent Fuel[b] > 1% 10,000 years	Spent Fuel[b] HLW	Naturally[c] occurring	40 CFR 191 Table 2	Emissions[e]	Reference (See page 4 of table)
Cs-134		x		x			β, γ	2
Cs-135						x	β (.21)	4
Cs-137/Ba-137m	x	x		x		x	β, γ	1, 2, 4, 6
Ce-144/Pr-144		x					β, γ	1
Pm-147		x					β (.224)	1
Sm-151		x		x			β (.076) γ (.022)	1, 2
Eu-154		x					β, γ	1
Eu-155		x					β, γ	1
Rn-220/D					x		α, β, γ	3
Rn-222/D					x		α, β, γ	2
Ra-226			x		x	x	α	1, 4
Th-230					x	x	α, γ	4
Th-232					x	x	α	4
U-233					x	x	α	4
U-234			x		x	x	α	1, 4
U-235					x	x	α	4
U-236						x	α	4
U-238[f]	x	x	x		x	x	α	4
Np-237						x	α	1, 4
Np-239			x				β, γ	1
Pu-238	x	x		x		x	α	1, 2, 4
Pu-239	x	x	x			x	α	1, 4, 6
Pu-240	x	x	x			x	α	1, 4
Pu-241	x	x		x			β, x-rays	1, 2
Pu-242						x	α	1, 4
Am-241	x	x				x	α	1, 4
Am-243			x				α	1, 4
Cm-243		x					α	1
Cm-244		x					α	1

Table 4-1. Radionuclides of interest[a] (page 3 of 4)

Radionuclides	Source: Spent Fuel[b] NTS[d]	Spent Fuel[b] > 0.01% 10 years	Spent Fuel[b] > 1% 10,000 years	HLW	Naturally[c] occurring	40 CFR 191 Table 2	Emissions[e]	Reference (See page 4 of table)

Footnotes

[a]HLW = High Level Waste; NTS = Nevada Test Site

[b]Percent of total activity per fuel element.

[c]These are naturally occurring radionuclides that must be addressed per 30 CFR 57. Note other naturally occurring radionuclides (K-40 and Be-7) will be included in the analysis to allow evaluation of the analytical techniques.

[d]The "0" indicates these radionuclides are not asssociated with projected Project activities but may be associated with NTS activities and could interfere with projected monitoring activities. Radionuclides not identified with a "0" also occur in potential waste forms for disposal at a repository. This is based on data reported in the annual environmental reports. It is projected that slight concentrations of all isotopes listed may be present.

[e]α = Alpha radiation, β = Beta radiation, and γ = gamma radiation. The energy values in MeV are provided for low energy b radiation as an indication of the difficulty in measurement. Also U and x-ray emitting radionuclides, except the energy (in MeV) indicated, will be detected using gamma spectral measurements.

[f]U-238 is not included in the actual percentage of activity assessment because of its low specific activity. It is, however, a very significant mass fraction, so it is included.

Table 4-1. Radionuclides of Interest (Page 1 of 2)

Reference Number Indicated Above	Source
1	ORNL/TM-9591/V1&2, Tables 3-5, 3-6, 3-7, 3-8, 3-9, 3-10 (ORNL, 1986) NOTE: >0.01% for 10 year old fuel. All listed isotopes for 10,000 year old fuel
2	DP-1606, Rev. 1 (August 1983). Table 5 and Table 11 (Baxter, 1983) NOTE: >0.01%
3	NCRP Report 50, Section 2.3.5 (NCRP, 1976)
4	40 CFR Part 191, Table 2
5	EPA/600/4-86-030. (Source of analytical interferences) (EPA, 1986)
6	EPA/600/4-86/022. (Source of analytical interferences) (EPA, 1986)

3. Radionuclides specifically addressed in the long-term release limits (40 CFR Part 191, Appendix A, Table 1) of the EPA's criteria for geologic disposal of HLW, to provide comparison data for long-term assessments.

4. Radon and radon progeny products per the 30 CFR Part 57 criteria for worker exposure. In addition, the radionuclide concentration will be compared with the public exposure criteria for uranium mills and mill tailings (40 CFR 192.12, 192.32, and 192.41).

5. Radionuclides of significant half-lives or existing in significant quantities in SF or HLW (references noted in Table 4-1).

6. Naturally occurring radionuclides will allow a check of the quality of the sample analysis, since these radionuclides are present in the samples as part of the natural environment (Be-7 in gamma spectroscopy).

4.2.4 AIRBORNE MONITORING

The radiological monitoring program will include activities to monitor airborne radioactive particulates, radioiodine, tritium, and inert gases.

4.2.4.1 Basis for monitoring airborne radioactivity

As indicated in Corley et al. (1981) and Walker (1987), the four categories of airborne radionuclides that should be considered for measurement in air sampling systems are particulates, gases (principally the inert gases), halogens (principally radioiodines), and tritium. Consideration of these airborne categories is important for environmental sampling and measurement because the categories account for most of the radioactive materials released from any site.

4.2.4.2 Location of air monitoring stations

Location of the air monitoring stations requires consideration of various technical factors. These factors included consideration of the location of the future facilities, past activities in the area, meteorology of the area, topography of the area, location of population (onsite and offsite), and others.

4.2.4.3 Sample collection frequency

It is essential that appropriate sampling frequencies be identified. With the exception of particulate size sampling, this discussion addresses sample change frequency, since sample collection activities are essentially continuous.

Based on DOE guidance (Corley et al., 1981; and Walker, 1987), the frequency of collection for air samples is adjusted to take into account the limitations of the sample collectors, the capabilities of the air movers, and the physical problem of retrieving samples from each location on a fixed frequency. Typically, frequency of collection is every one to two weeks. Dust loading of the filter will generally determine the sampling period. Dust loading increases the differential pressure across the filter to a point where the equipment can no longer ensure a constant flow rate.

4.2.4.4 Air sampling and monitoring systems

Six separate activities (based on the characteristics of the media to be collected) will make up airborne radioactivity sampling: airborne particulate sampling, iodine sampling, C-14 sampling (CO_2), tritium sampling, man-made inert-gas and radon/radon sampling/monitoring, and radon/radon progenies sampling and monitoring. Note that the ambient airborne radiation data (Section 4.2.8) will be used for cloud immersion dose assessment.

4.2.5 WATER SAMPLING

Corley et al. (1981) describes and justifies the water surveillance requirements at nuclear facilities. The principal exposure pathways from waterborne radionuclides to individuals (or groups of individuals) in the environment are ingestion of drinking water; consumption of fish, ducks, or other aquatic species; and the consumption of irrigated crops. Of secondary importance are external radiation dose contributions from surface water (swimming, boating, water skiing), sediment deposits along the shoreline, or deposits on an irrigated field. The radiation doses from these external sources are generally orders of magnitude less than doses from ingestion pathways (Denham et al., 1974; Soldat, 1971).

As a consequence of the desert ecosystem within which the site is located, the potential for radioactive material from Yucca Mountain reaching man through the water pathway is very small. Water pathways at Yucca Mountain may include the following:

1. Ephemeral streams and catch basins.
2. Groundwater.
3. Airborne deposition to the Amargosa River or streams.
4. Reservoirs or ponds supplied from groundwater sources.

No liquid effluent will be released to a surface-water source, because there are no through-flowing streams in the Yucca Mountain area. There is a large ephemeral stream (Fortymile Wash) located just east of the site.

Routine laboratory determinations from water samples typically include gross alpha and beta, tritium, radiostrontium, gamma spectrometry, and specific radio-chemical analysis for other selected nuclides. Alpha spectrometry may also be included, depending on potential release of alpha contaminants or the results of the screening. In addition to total activity analysis, it may be desirable to measure the distribution of activity between soluble and suspended materials, as well as the chemical form of a radionuclide.

4.2.5.1 Locations

Collection of water samples at the designated locations discussed in the following sections is based on site-specific conditions and guidance documents from DOE, NRC, and EPA. The proposed Yucca Mountain repository site hydrologic conditions are generally characterized by low precipitation, no perennial streams, few springs, rapid runoff during heavy precipitation (ephemeral streams), limited/intermittent catch basins, and deep underground aquifers (Alkali Flat-Furnace Creek Ranch groundwater basin). Other conditions such as local meteorology and absence of liquid effluent releases to surface-water sources are also important to the selection of water sampling locations.

4.2.5.2 Methods

The major concerns for water sampling are the collection of a representative sample and the preservation of radionuclides in their original concentrations before analysis. Most water measurements are made on samples taken in the environment and returned to the laboratory for analysis. The general problem of the measurement of radioactivity in environmental water samples has been discussed by Kahn (1972). Standardized methodologies for collection and handling of water samples are also discussed in numerous documents, including American Public Health Association (APHA) (1971), American Society for Testing and Materials (ASTM) (1987a,b), Manual of Ground Water Sampling Procedures United States Geologic Survey (USGS) (1977) and EPA (1977). All sampling activities will be consistent with Conti et al. (1978) and applicable NRC guidance.

4.2.5.3 Sampling frequency and analysis

Based on the recommendation of the various reviewers or the RADMP and the characteristics of the flow regime (regional hydrology) in the Yucca Mountain area, the water typically will be sampled annually. A gamma

spectroscopy evaluation will be completed on each sample. Approximately 10 percent of the samples collected will be analyzed for the radionuclides discussed in Section 4.2.3, with four possible exceptions: Fe-55, Ni-59, Ni-63, and Sm-151. Only about 5 percent of the samples typically being subjected to the full suite of analysis will be analyzed for Fe-55, Ni-59, and Ni-63 (these concentrations are expected to remain constant and the analyses are extremely difficult). Since it is very difficult to test for Sm-151, and because the radionuclide will behave in the environment like europium, analysis for Sm-151 will only be conducted when europium is detected. Note: The concentration of europium and samarium in the waste will be similar. Careful evaluation of preliminary results for these two nuclides will eventually determine the future frequency of analysis.

4.2.6 SOIL AND DRIFT SURFACE SAMPLING

The DOE (Corley et al., 1981; Walker, 1987) provides recommendations for soil sampling. The guidance indicates that soil provides an integrating medium that can account for contaminants released to the atmosphere (either directly in gaseous effluents, or indirectly from resuspension of onsite contamination), or through liquid effluents released to a stream that is subsequently used for irrigation. Hence, soil sampling and analysis will be used to evaluate the long-term accumulation trends and to estimate environmental radionuclide inventories. In addition to radionuclides that are specific to a particular operation or facility, naturally occurring and fallout radionuclides can be expected in soil samples.

During underground mining and operation, driftwall sampling will be used to characterize the uranium and thorium sources that produce the radon and radon progeny product inventory emanating from the mine.

4.2.6.1 Location and frequency

Background determinations will be based on soil sampling and analysis at points corresponding to background (or control) air sampling locations. Primary soil sampling locations have been selected to coincide with air sampling stations since the comparability of data may be important in achieving the objectives of the overall environmental sampling program. Soil samples will be collected in association with other sampling locations as appropriate.

4.2.6.2 Sampling methods

Several reports are available that should be used as guidance in sampling, preparing, and analyzing soil for plutonium (AEC, 1974; Sill and Williams, 1971), for radium (Fleischhauer, 1984; Meyer and Purvis, 1985; Myrick et al., 1983), and for other radionuclides (ASTM, 1986; Mohrand and

Franks, 1982). In addition, Healy (1984) has proposed a standard for comparing observed to allowable concentrations of plutonium. Note: Consideration will be given to cost effectiveness in analysis. A limited number of analyses will be completed with very high sensitivity, whereas most analyses will use standard analytical techniques.

4.2.6.3 Soil and drift surface sample analysis

The analyses for the soil and driftwall samples were selected based on the recommendations of the DOE guidance (Corley et al., 1981; Walker, 1987, etc.), good technical practices, and the specific concerns expressed in 40 CFR Part 191.

4.2.7 BIOTA SAMPLING

The DOE (Corley et al., 1981; Walker, 1987) indicates that samples of milk, crops, and animal produce from livestock and game are of greatest importance in environmental surveillance because they provide the most direct basis for assessing the radiation dose to man from ingestion. The principal pathways for radionuclide contamination of food pathways to Homo sapiens are (1) atmospheric deposition onto crops and animal forage crops from airborne releases, and (2) crop irrigation from water bodies receiving liquid effluents.

While this section briefly describes the biota sampling program, many details of the program cannot be presented until a detailed survey of the agricultural, recreational, and cultural activities within the area is conducted. The preliminary data necessary will be collected over the next two years as indicated in Section 6.1 of Corley et al. (1981).

Presently, the biota samples collected under this monitoring plan will represent direct dosage pathways, indirect dosage pathways, and animal indicator species of local environmental contamination. Direct pathways are represented by food items and will include samples of milk, crops (intended for human consumption), beef, poultry, and eggs collected in the far-field area. Near-field samples of game birds may be collected if population densities increase sufficiently. Venison samples from local mule deer will not be collected due to low population density and movement pattern considerations. Indirect pathway samples will include cattle and deer forage species. Several indicator species indigenous to the facility area have been selected to assist in detecting inadvertent releases of radioactivity and to monitor any long-term radionuclide accumulation in the local environment.

4.2.8 AMBIENT (BACKGROUND) RADIATION MONITORING

The exposure of environmental population groups (general public) to external radiation from nuclear facility operations includes exposure from cloud passage of airborne effluents, as well as exposure from previous radionuclide deposition patterns on soil, vegetation, sediment, or structures. External exposure from radionuclides in water should be insignificant during normal operations at a site such as the Yucca Mountain facility, although unique situations may still arise where recreational, commercial, or industrial use of a receiving body of water may incur some direct exposure.

The feasibility of distinguishing an annual incremental exposure even as low as 5 mR at a given location with the best available dosimetry is difficult in view of the variability of background radiation. The methods discussed in the balance of this section describe the range of available techniques, including those selected for use at Yucca Mountain.

4.2.8.1 Thermoluminescent dosimeters

Integrating dosimeters include such commonly used devices as TLDs and ionization chambers. Records of environmental exposure rates for the early years at the NTS were largely based on ionization chamber readings, and are generally not well-suited for comparison at low exposures (in terms of accuracy) with more recent results using TLDs. TLDs are the dosimeters of choice based on demonstrated sensitivity, reproducibility, reliability, and long-term stability. The individual dosimeter is relatively inexpensive, although a complete dosimeter/reader system can involve a large initial cost.

4.2.8.2 Exposure rate

Various instruments are available for continuous monitoring of the exposure rate as a function of time. For the monitoring of intermittent or unplanned releases, characterization of diurnal variations, and better identification of source terms, exposure rate instrumentation should be available.

4.2.8.3 Aerial surveys

Aerial surveys consist of overflights of the near-field area by an aircraft-borne radiation measurement and recording system. The AMS (Doyle, 1974; and Deal and Doyle, 1975) operated for the DOE by EG&G Inc., is the method currently planned for this survey. It provides detailed data analysis from aerial surveys of gamma radiation levels in and around nuclear facilities. Although developed primarily to provide improved radiation accident response capability, results from AMS helicopter surveys of major

DOE sites (Burson, in preparation; and Boyns, 1975) have provided an overview of the location, relative intensity, and identification of gamma-emitting radioactive contaminants. Particularly valuable is the definition of radioactivity levels in areas difficult to measure by ground survey techniques.

4.2.8.4 In situ gamma spectroscopy

In situ gamma spectroscopy will be used to characterize the ambient environment at each soil sampling location (Section 4.2.6). The data collection (site-specific spectral data) will initially occur at each soil sampling location, and will normally be repeated only if there is an indication that the radiological conditions have changed. A limited number of locations will be selected for quarterly reevaluation to provide some idea of the variability of these spectra over time.

The primary driving force for in situ spectroscopy, as for the radiological monitoring program, is the requirements and recommendations in the current draft of Corley et al. (1987). This document specifies in

1. Section 5.4.2 (p 5.12) that "before final placement of any environmental radiation measurement station (background or control and indicator locations), an initial on-the-spot survey should be performed and documented to determine the absence of possible naturally occurring anomalies that could affect interpretation of later measurements....An in situ gamma-ray spectrometer...can be used...."

2. Section 5.4.2 (p 5.14) that "in situ gamma spectroscopy should be used as a method of documenting environmental mixtures of radionuclides...."

3. Section 5.7.3 (p 5.36) that "[u]seful information about soil contamination levels can also be obtained using in situ gamma-ray spectroscopy."

The recommendations of the DOE/Headquarters (HQ) consultants during a review of the status meeting on the RADMP on May 13 and 14, 1987, was that in situ gamma spectral analyses should be included as part of the radiological monitoring program.

In addition to the DOE requirements, NCRP (1976) indicates that "[i]n situ measurements are valuable for the rapid assessment of radiation exposure, identification of radionuclides, and detection of trends in environment radioactivity due to man's activities."

International Atomic Energy Agency (IAEA) (1975) indicates that in situ measurements are extremely useful in evaluating the impacts of unplanned releases. However, this evaluation is only feasible if baseline in situ data have been collected before the release.

The DOE indicates in the Environmental Measurements Laboratory Health and Safety Laboratory (EML-HASL)/300 (Procedure C-02-01) that "[f]ield spectrometric techniques permit the rapid identification of particular radionuclides in the environment....(Harley, 1986)." Furthermore, DOE Environmental Monitoring Laboratory personnel indicated at the Institute of Electrical and Electronic Engineers, Inc. (IEEE) Nuclear Science Symposium (San Francisco, CA, October 21-24, 1981) that "in situ gamma spectroscopy results may be obtained more rapidly than laboratory counting a grab sample, and will generally be more representative of the area." Thus, the technical requirements and guidance indicate that in situ gamma spectroscopy is appropriate.

4.2.8.5 Public monitoring

Based on the precedent established by the existing NTS environmental monitoring program, this RADMP activity may also support the public monitoring activity associated with the NTS. A limited number of individuals in the public (1) are monitored with a personal dosimeter, (2) receive routine bioassay, and (3) receive routine in vivo counting in the NTS program.

4.3 IMPLEMENTATION OF THE RADIOLOGICAL MONITORING PROGRAM

4.3.1 DOE PROCEDURAL REQUIREMENTS AND OPERATIONS

All activities in the radiological monitoring program must be approved by the Project Office and implementation must be consistent with DOE/NV operations, as determined to be applicable by the Project Office. The program will follow all applicable DOE requirements and standards. The program and its major organizations have their own radiological and nonradiological safety requirements, which will be followed. The radiological monitoring program will also comply with the NTS Radiological Safety (DOE/NV, 1988) requirements and applicable organization environment, safety, and health plans, as applicable. These requirements are always applicable when conducting activities on NTS but outside the area of Project Office responsibility.

4.3.2 PROJECT INTERFACES

Activities in the RADMP that overlap with activities of other Project organizations or other organizations will be arranged to prevent duplication of effort. Two basic procedures will be followed: one for other Project organizations and one for within the T&MSS organizations. In both instances, the technical individuals (principal investigators) will meet and establish a

mechanism for sharing information. For activities involving various T&MSS organizations will be addressed within T&MSS. However, for other Project organizations, a Project Office representative may be involved in the technical discussion. Concurrence of the affected Technical Project Officers is required in the decision. Areas where this overlap appears to exist include the following:

1. The Sandia National Laboratories radiological assessment activities.
2. Water sampling for radionuclide constituents.
3. Air quality monitoring (particle size analysis).
4. Fauna and flora sampling for radionuclide analysis.

4.3.3 EQUIPMENT AND SERVICES

The equipment used in implementing the radiological monitoring program will normally be procured as commercial grade items as discussed in "Guidelines for the Utilization of Commercial Grade Items in Nuclear Safety Related Applications" (EPRI, 1988). This is justified, since the equipment used in implementing this activity is

1. Not unique to nuclear facilities.
2. Used in other than nuclear facilities.
3. Can be ordered based on the manufacturer's/supplier's published specifications.

If a requirement is identified, as the program is implemented, for the procurement of unique equipment, this equipment will be addressed on a case-by-case basis. No such equipment has currently been identified.

Equipment purchased as commercial grade will be evaluated for adequacy prior to procurement. Documentation of this evaluation will be in the form of the signature of the requester and the responsible manager on the procurement documentation. Upon receipt, this equipment shall be subject to receipt inspection to provide assurance that the equipment received is the equipment ordered. Before use, the equipment will be subject to an operability test or acceptance testing as appropriate based on the complexity and intended use of the equipment.

5.0 OTHER SUPPORTING RADIOLOGICAL DATA COLLECTION ACTIVITIES

This section briefly discusses the collection of the data required to support radiological analyses. It does not include collection of the radiological monitoring data previously addressed in Section 4 and future Project radiological analytical activities. The specific data collection needs are addressed in the RESMIP (to be issued), based on the criteria in this section.

The primary data needed to support the radiological safety analysis are those data necessary for implementing computer programs. The primary area of emphasis is the calculation of radiation doses to the public using programs such as AIRDOS-EPA. These data will include radiological, meteorological, agricultural, cultural, and general biota data; characteristics of radioactive aerosols; and population demographics. Also required are

1. Resuspension and deposition data for radioactive particulates.
2. Solubility/leachability of radioactive materials.
3. Chemical form of radionuclides.
4. Radon emanation rate for various materials (or characteristics to assess this value).
5. Effects on radon emanation rates of meteorological conditions and expected site activities.
6. Characteristics of off-normal and accident scenarios for the activities (present and future).
7. Ventilation flow characteristics.
8. Environmental sensitivity to the impact of radionuclide uptake.

5.1 DATA REQUIREMENTS OF CALCULATION MODELS FOR USE IN THE ENVIRONMENTAL IMPACT STATEMENT, SAFETY ANALYSIS REPORT, AND OTHER ACTIVITIES

The data required in developing the EIS and SAR are essentially identical to those data required in assessing regulatory compliance and environmental monitoring commitments. The following sections address the collection of these data based on the potential data source. This set of data may require changes following the EIS Scoping Hearings. These data include:

- Radiological data.
- Characteristics of radioactive aerosols.
- Meteorological data.

- Agricultural data.
- Cultural data.
- Population demographics.
- General biota data.

5.2 DATA AVAILABLE IN THE TECHNICAL LITERATURE

A significant amount of the data mentioned in Section 6.1 is available in the technical literature. Major sources of this technical guidance are (1) Regulatory Guide 1.109 (NRC, 1977), which is applicable to nuclear reactors; (2) Till and Meyers, 1983; and (3) Elder et al., 1986. This guidance, however, recommends the use of local data rather than generic data. Because of the arid characteristics of the Yucca Mountain area, site-specific data are very important because most generic data (e.g., Regulatory Guide 1.109 (NRC, 1977)) were developed for non-arid environments. If site-specific data cannot be obtained, the data from Regulatory Guide 1.109 or other sources in the technical literature will be used. Specific details addressing the identification and collection of these data are found in the RESMIP (to be issued).

Should any plant or animal species having a high bioaccumulation factor (relative to assumptions in the Environmental Pathways Analysis Scoping Study (SAIC, 1989a)) or a high biological susceptibility to radiation be identified within the area, special monitoring will be added to that described in Section 4.0. The cited reference documents are intended as examples and should not be interpreted as prescriptive.

The data of interest includes:

- Radiological data.
- Characteristics of radioactive aerosols.
- Meteorological data.
- Agricultural data.
- Cultural data.
- Population demographics.
- General biota data.

5.3 PROCEDURE FOR ACQUIRING DATA NOT AVAILABLE IN THE TECHNICAL LITERATURE

Unavailable technical data are of two types. The first type is site-specific data, which need to be collected in the Yucca Mountain area. The second type is general technical data, which are needed to support these processes and are currently not available. The two types will be discussed separately.

5.3.1 SITE-SPECIFIC DATA

Site-specific data include the characteristics of radioactive aerosols at the site, the meteorology of the site, agricultural and cultural data for the Yucca Mountain area, population demographics, and general biota data for the site.

5.3.1.1 Characteristics of radioactive aerosols at the site

These data will be collected as part of the implementation of airborne monitoring activities discussed in Section 4.2.4. They will then be used to (1) assess the resuspension and deposition of radioactive aerosols at the Yucca Mountain site, and (2) determine the typical particulate size distribution for use in assessing dispersion and deposition of any potential radioactive aerosols and the resultant dose to man.

5.3.1.2 Meteorology of the site

The meteorological data collection needs are addressed in the existing Project Meteorological Monitoring Plan (DOE/NV, 1989b) and the Project Environmental Field Activity Plan for Air Quality Monitoring. Collection and reporting of data are essential to the successful completion of this activity.

5.3.1.3 Agricultural and cultural data for the site

The site-specific agricultural and cultural data for the Yucca Mountain site that are unavailable in the technical literature will be needed between 1991 and 1995. After a review of the technical data currently available, supplemental data will be developed by the T&MSS. When an initial data set is developed, it will require routine updating approximately every five years and just before preparation of the Draft Environmental Impact Statement (DEIS). The agricultural and cultural data collection activities will be separate activities and may also be reported separately.

5.3.1.4 The population demographics for the site and nearest highly populated area

The required demographic data will be developed by the T&MSS ûin cooperation with the EPA NRA Division and other organizations. These data will reflect currently available data(Section 6.2) and new data collected by the NRA or other organizations in support of general NTS activities. The initial data will be needed between 1988 and 1989. To collect changes that occur with time, these data should be updated at least every five years and just before preparation of the DEIS. Also, projections of population changes throughout the licensing and operation phases will be needed.

5.3.1.5 General biota data for the site

The biota data collection supporting the radiological analyses for the site is primarily addressed by those activities described in Section 4.2.7. Ongoing NTS biota monitoring activities and the Project Environmental Field Activity Plan for Terrestrial Ecosystems (to be issued) provide supporting data.

5.3.2 AREAS REQUIRING FURTHER RESEARCH

Presently the only area requiring further research, aside from the collection of site-specific data, is routine environmental sample analysis methods for Tc-99, C-14, and I-129. These isotopes are specified in 40 CFR Part 191, but have not (to date) been included in the routine analysis programs. The development of sampling techniques for these isotopes is underway at the SAIC with Project support. This work is expected to be completed in late FY 91 or early FY 92. The analytical technique for I-129 will involve gamma and beta anti-coincidence counting. The radionuclide analyses for Tc-99 and C-14 will use various wet chemical concentration techniques and existing counting and analysis methodologies.

6.0 RADIOLOGICAL DATA ASSESSMENT

In addition to the activities in Section 4, various computational and analytical methodologies are required to support the radiological monitoring program and various other Project site characterization radiological assessment activities. These methodologies can be relatively uncomplicated calculation models, or more comprehensive computer programs with varying degrees of complexity.

The analytical methods required to implement the radiological assessment element of the RADMP are partly determined by the reporting and analytical needs of the Project during site characterization. Most of the methodologies will be directed toward the estimation of potential radiation doses to the worker and the public, or the dispersion of activity into the environment from existing or planned activities. A limited number of computational methodologies are needed to support (1) resolution of other radiological issues, such as shielding design verification and impact analysis; (2) review of safety analysis, etc.; and (3) other assessment activities. The methodologies presently identified are briefly discussed in this section. The criteria for selecting methodologies for use in Project radiological impact assessments are also addressed. In addition, the probabilistic risk assessment methodology (PRAM) activities ongoing at various OCRWM organizations are considering many of these same analytical methods for use in repository design and licensing. Every effort will be made to ensure consistency of this activity with the PRAM activities.

6.1 REQUIREMENTS FOR THE METHODS

All radiological assessment methodologies require various types of input data. In many instances, the development of input data itself may require various levels of analytical effort. This activity would include the development of the basic analytical methodologies, the various inputs, or the assessment techniques necessary to support the required analyses. The analytical areas that should be addressed include the following:

- Source term assessment.
- Public radiation dose assessment.
- Worker radiation dose assessment.
- Risk assessment.
- Radon source terms.

6.2 SELECTION AND VERIFICATION, VALIDATION, OR DOCUMENTATION OF METHODS

All assessment methodologies/programs used in this task will be evaluated against a set of defined considerations. The T&MSS Contractor or other supporting organization will evaluate these methodological programs for use in assessing compliance during the site characterization and construction phases (and other phases as needed). When the evaluations are conducted by an organization others than T&MSS, the organization will attempt to obtain the concurrence of T&MSS on this evaluation. These evaluations will be submitted to the Project Office for approval when completed. These considerations include, but are not necessarily limited to, the following questions:

1. To what extent does the methodology/program provide the required data from available input?

2. How feasible is it to modify the methodology/program to provide the required data from available input?

3. Are there alternate methodologies/programs that can provide the required data from available input?

4. Has the methodology/program been accepted in NRC licensing proceedings?

5. Has the methodology/program been accepted (or will it be accepted) by the EPA, NRC, OCRWM, or other DOE organizations?

6. Is adequate documentation available for use of the methodology/program?

7. Has the methodology/program been verified?

8. Has the methodology/program been validated?

9. If the answer to Item 7 or 8 is no, can verification and validation be accomplished?

10. Can site-specific data be used in these methodologies/programs?

11. Does the methodology/program produce answers within an acceptable level of uncertainty?

12. Is the methodology/program consistent with statutory requirements, regulatory criteria, and technical guidance?

13. Is the methodology/program consistent with the other OCRWM programs, and is it consistent with state-of-the-art technology?

Evaluations of the various methodologies/programs within these constraints and considerations will rely on completion of the following activities:

1. Obtaining and reviewing a copy of documentation for the methodology of interest.

2. Performing a test case implementation of the methodology.

3. Documenting the selection process for a methodology. (Software documentation is discussed in the Project and/or T&MSS Software QA Plan (SQAP) and applicable procedures or the equivalent documentation for the applicable organization.)

4. Verification and validation, as appropriate.

5. Implementing QA and configuration management controls as described in the applicable SQAP and associated documents.

After completion of the evaluation activities, the methodology is approved for use. The evaluation process may be terminated at any step if it is determined that no significant benefit to the Project will result from completion of the process.

7.0 SCHEDULE AND REVISIONS

This section provides the needed administrative data to support implementation of the radiological monitoring program. These administrative data emphasize the future planning for the program.

7.1 SCHEDULE (MILESTONES)

The basic schedule for RADMP activities is summarized in Figure 1-1. The network reflects RADMP implementation, issuance of annual data reports each May, preparation of a summary data report in 1993, revision of the RADMP to reflect major changes in Project activities, and preparation of other relevant reports.

Supplementing the basic schedule, Table 7-1 provides a summary of the detailed initial RADMP implementation. The schedule described in Table 7-1 is based on expected procurement time, funding, land access, site activities, and perceived need. Most of the expected scheduling relates to potential procurement delays and to uncertainty in the scheduling of other Project activities.

7.2 REVISIONS

Planned revisions of the RADMP are shown in Figure 1-1. These revisions relate to presently identified changes in Project activities. If future Project activities or the data collection results indicate a need for additional revisions, the revisions may be initiated by the RFPD Manager or any individual. In addition to the planned and other revisions to the RADMP, modifications to the field activities may also occur. These changes will be documented by letters to the PM, QA, and RADMP organizations. These letters will be added to T&MSS Sample Location Document controlled copies as they are issued. This will allow the program to respond to needed changes in a timely and fully documented manner.

The planned revisions are expected to be primarily changes in scale of the activities. The revision following the EIS scoping hearings will reflect both recommendations from these hearings and results of the human food chain study discussed in Section 4.2.7.

The revision at the time of EIS preparation (October 1993) will reflect a reduction in the program and represent completion of major data collection. The program will be used to maintain data continuity and to monitor any changes in site conditions. This revision will also affect the current facility design.

Table 7-1. Implementation plan for Radiological Monitoring Plan activities (page 1 of 2)

Activity	Initiation	Completed[a]
Air sampling (60-meter tower/ particulate iodine only)	9/87	—
Air sampling/near field	1/91 to 6/91	—
Air sampling/far field	6/88 to 3/91	—
Water sampling (general)	1/91 to 9/91	—
Catch basin survey	6/91	10/91
Water sampling (catch basins)	10/91 to 10/91	—
Inert gas and tritium sampling	7/88 to 9/91	—
Radon integrating samplers	9/87	—
Radon continuous monitoring	3/91	—
Initiate analysis capability development for Tc-99, C-14, and I-129	3/91	7/91
Soil/sediment sampling	1/91 to 6/91	—
In situ gamma spectral analysis	1/91 to 9/91	—
Milk sampling	Ongoing[b]	—
Near-field biota sampling	5/88 to 2/89	—
Survey of far-field biota in human food chain	1/91	12/91
Preliminary assessment of sampling needs in the biota (human food chain)	10/91	3/91
Thermoluminescent dosimeter monitoring implemented	4/88 to 6/91	—

Table 7-1. Implementation plan for Radiological Monitoring Plan activities (page 2 of 2)

Activity	Initiation	Completed[a]
High pressure ion chamber monitoring	7/88 to 6/91	—
ARM survey	—	1/91 to 1/95
Public personnel monitoring	Ongoing[b]	—

[a] "—" indicates that this activity will continue throughout the program.
[b] This is simply an ongoing NTS activity from which data will be obtained.

A potential revision is expected to occur with construction authorization. This revision would reflect any changes made in the program as a consequence of the construction activities and the detailed knowledge of the facility's design at this stage. This revision is expected to be a relatively minor variation in planned activities.

8.0 OPERATIONS AND SAFETY

The radiological monitoring program will be conducted in a manner consistent with the SHP (DOE/NV, 1990); specific supporting organizations (e.g. T&MSS, EG&G/EM) environment, safety, and health plan(s); procedures/instructions; administrative procedures; and other applicable requirements. Requirements are documented in the procedures and instructions. Before initiating a field data collection activity, an internal hazards analysis and technical readiness evaluations will be conducted and documented. Personnel will receive appropriate and verified training for those activities which involve hazards significantly higher than those encountered in a normal office environment. The safety training portion will address the information in the hazards analysis and will be mandatory for all personnel involved.

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ACRONYMS AND ABBREVIATIONS

ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
AMS	aerial measurement system
AP	Administrative Procedure
APHA	American Public Health Association
ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
CMP	Configuration Management Plan
DEIS	Draft Environmental Impact Statement
DERE	Description of Existing Radiological Environment
DMS	Project Technical Data Management System
DOE	U.S. Department of Energy
DOE/HQ	DOE Headquarters
DOE/NV	DOE, Nevada Operations Office
DOE/NV-ESH	DOE/NV Office of Environment, Safety, and Health
EA	Environmental Assessment
EFAP	Environmental Field Activity Plan
EG&G/EM	EG&G Energy Measurements
EIS	Environmental Impact Statement
EISIP	EIS Implementation Plan
EML	Environmental Measurements Laboratory
EMP	Environmental Management Plan
EMMP	Environmental Monitoring and Mitigation Plan
EPA	U.S. Environmental Protection Agency
EPASS	Environmental Pathway Analysis Scoping Study for the Yucca Mountain Site
EPIP	Environmental Protection Implementation Plan
ER	Environmental Report
ERCP	Environmental Regulatory Compliance Plan
ERDA	Environmental Research and Development Administration
ERM	Environmental Radiological Monitoring
ES	exploratory shaft
ES&H	Environmental Health and Safety
ES&HP	Environment, Safety, and Health Plan
ESHD	Environmental Safety and Health Document
FEIS	Final Environmental Impact Statement
FY	fiscal year
HLW	high-level waste
HASL	Health and Safety Laboratory
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiation Protection
IMS	NNWSI Project Information Management System

KeV	thousands of electron volts
LA	License Application
MeV	millions of electron volts
MDL	minimum detection level
MMP	Meteorological Monitoring Plan
MREM	1 rem x 10^{-3}
NBS	National Bureau of Standards
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Protection Act
NNWSI	Nevada Nuclear Waste Storage Investigations
NRA	Nuclear Radiation Assessment Division (EPA)
NRC	U.S. Nuclear Regulatory Commission; National Research Council
NRDA	Nevada Research and Development Area
NTS	Nevada Test Site
NTSO	Nevada Test Site Support Office
NWPA	Nuclear Waste Policy Act of 1982
NWPAA	Nuclear Waste Policy Amendments Act of 1987
OCRWM	Office of Civilian Radioactive Waste Management
OESH	Office of Environment, Safety, and Health
OR	Office of Radiation Programs
ORNL	Oak Ridge National Laboratory
PIC	pressurized ionization chamber
PMP	Project Management Plan
POCD	Project Operations Control Division
PRAM	Preclosure Risk Assessment Methodology
Project Office	Yucca Mountain Site Characterization Project Office
PSCRADMP	Preliminary Site Characterization Radiological Monitoring Plan
QA	Quality Assurance
QAPD	Quality Assurance Program Document
QAPP	Quality Assurance Program Plan
QC	Quality Control
R	roentgen
rad	See Glossary
RADMP	Radiological Monitoring Plan
RAMATROL	Radioactive Material Control Group (REECo)
RCP	Regulatory Compliance Plan
REECo	Reynolds Electrical and Engineering Company
rem	See Glossary
RMIM	Radiological Monitoring Instruction Manual
RESMIP	Radiological Environmental and Safety Monitoring Implementation Manual
RFPD	Radiological Field Programs Department
RIB	Reference Information Base
RMDS	Radiological Monitoring Data Summary
RSED	Regulatory and Site Evaluations Division

SAIC	Science Applications International Corporation
SAR	safety analysis report
SCP	site characterization plan
SEMP	Systems Engineering Management Plan
SENFCA	Survey and Evaluation of Nuclear Fuel Cycle Activities
SEPDB	Site and Engineering Properties Data Base
SF	spent fuel
SHP	Safety and Health Plan
SMF	Sample Management Facility
SNL	Sandia National Laboratory
T&MSS	Technical and Management Support Services Contractor
TESHP	T&MSS Environmental, Safety, and Health Plan
TLD	thermoluminescent dosimeter
TRU	transuranic waste
TSLD	T&MSS Sample Location Document
USGS	United States Geological Survey
W	Westinghouse Electric Corporation
WHO	World Health Organization
WIPP	Waste Isolation Pilot Plant
WL	working level
WLM	working level month
YMP	Yucca Mountain Site Characterization Project
YMPO	Yucca Mountain Site Characterization Project Office
a	alpha particle
b	beta particle
g	gamma ray
χ/Q	atmospheric dispersion coefficient (Atomic Energy and Meteorology)
μCi	1 curie x 10^{-6}
μR	1 roentgen x 10^{-6}