Mined Geologic Disposal System (MGDS)
Annotated Outline Skeleton Text
for the Preparation of a License Application

September 30, 1992
Volume I of II
Revision 1

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2) Advise the DOE Office of Civilian Radioactive Waste Management, Office of Systems and Compliance (RW-30) of changes in location, name, etc.

3) Return the manual when no longer needed or upon termination from employment, to DOE's Office of Civilian Radioactive Waste Management, Office of Systems and Compliance (RW-30).

Instructions/Remarks

Remove and discard the cover pages, spines and ALL the contents from your MGDS Annotated Outline Skeleton Text for the Preparation of a License Application Volume I and II. Place the cover sheet and spine marked MGDS Annotated Outline Skeleton Text for the Preparation of a License Application Volume I into the corresponding plastic sleeves of one of the empty binders. Place the identification page stamped with your Controlled Copy number and the contents of Volume I into the binder. Place the cover sheet and spine marked MGDS Annotated Outline Skeleton Text for the Preparation of a License Application Volume II into the corresponding plastic sleeves of the remaining empty binder. Place the identification page stamped with your Controlled Copy number and the contents of Volume II into the binder.

Mined Geologic Disposal System (MGDS) Annotated Outline Skeleton Text for the Preparation of a License Application

September 30, 1992

Volume I of II

Revision 1

U.S. Department of Energy
Office of Civilian Radioactive Waste Management
Washington, DC

Prepared by:

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Under Contract Number DE-AC01-91RW00134

CRWMS M&O Document Number
TSO.920219.0187

NOTICE

THIS DOCUMENT CONTAINS TEXT AND PLANNING PACKAGE MATERIAL FOR THE FUTURE DEVELOPMENT OF AN MGDS LICENSE APPLICATION. THIS MATERIAL IS NOT FULLY DEVELOPED, DOES NOT MEET ALL REGULATORY REQUIREMENTS, AND MAY CONTAIN BLANK SPACES WHERE INFORMATION HAS NOT BEEN OBTAINED.

THIS DOCUMENT ALSO CONTAINS STATEMENTS ENCLOSED IN BRACKETS TO HIGHLIGHT THE FACT THAT THESE CONCLUSIONS, ALTHOUGH PREMATURE NOW, WILL ULTIMATELY HAVE TO BE MADE TO DEMONSTRATE REGULATORY COMPLIANCE FOR ANY SITE.

OVERVIEW OF THE ANNOTATED OUTLINE DEVELOPMENT PROCESS

Background

Part 60 of Title 10, Code of Federal Regulations, Disposal of High-Level Radioactive Wastes in Geologic Repositories, specifies the information to be covered in an application for a license to dispose of high-level radioactive waste, including spent nuclear fuel.

One of the regulatory strategies the DOE is using to support the licensing of a geologic repository is the Annotated Outline initiative. The Annotated Outline for the Preparation of a License Application will serve as guidance for the eventual development of the geologic repository License Application.

The Annotated Outline is being prepared on the basis of guidance contained in a Draft Regulatory Guide DG-3003 Format and Content for the License Application for the High-Level Waste Repository.

Annotated Outline Development Process

The Annotated Outline development process consists of two phases. Creation of the Annotated Outline Planning Packages is the first phase in the Annotated Outline development process. The Planning Packages are developed by the lead authors designated for each section of the Annotated Outline. Specific forms are utilized to guide the Annotated Outline development process. The authors begin to conceptualize the layout of their respective sections and begin drafting a limited amount of document text as well as identifying required figures and tables. References to be used by the lead authors are also identified. The lead authors then begin to identify information needed from other groups.

The Skeleton Text is the second phase of the Annotated Outline development process. The lead authors begin to write the proposed text and guidance for the future development of a License Application, building upon the Planning Package framework. All the information has not been obtained for the final document; therefore, the Skeleton Text is not fully developed, does not currently meet all regulatory requirements, and may contain blank spaces where the information has not been obtained. As issues are identified that need to be resolved for the successful licensing of the repository, they are also incorporated into the Annotated Outline, as necessary.

Throughout the two phases of Annotated Outline development described above, there will be an iterative process of development, review, and rework. As the repository design effort progresses, more information will become available to incorporate into the Annotated Outline.

Figure 1, Annotated Outline Development Process, illustrates the relationship of the Annotated Outline to the eventual development of the License Application. The relationship of the Annotated Outline Planning Packages to Skeleton Text is also represented.

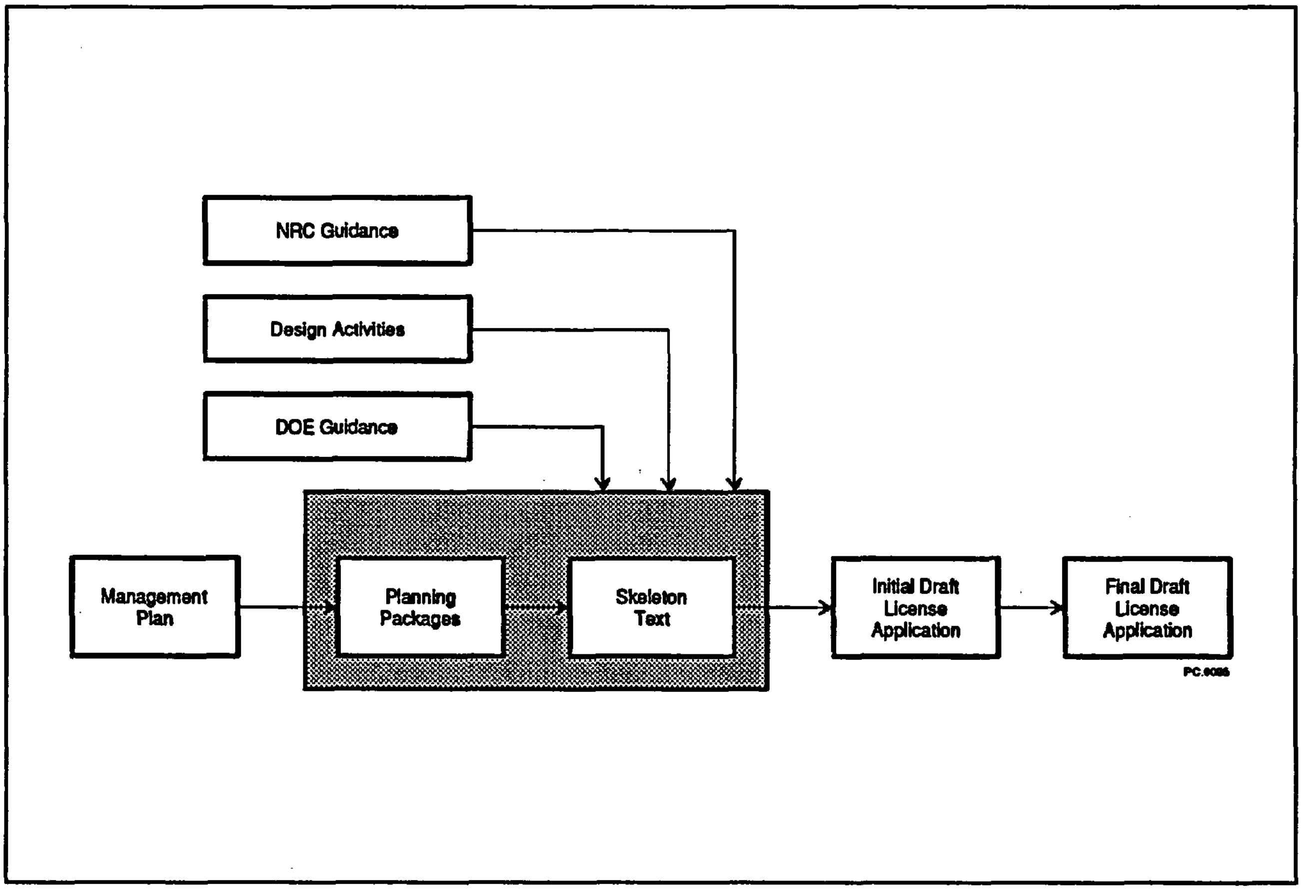

Figure 1. Annotated Outline Development Process

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Chapter 1.0 General Information

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1.0 GENERAL INFORMATION

[Note: The following material is written in the present tense to represent the language that may be used in a potential license application for the Yucca Mountain Site.]

[Pursuant to 10 CFR 60.21, the Department of Energy (DOE) hereby makes application for the necessary license to construct, own, use, and operate a mined geologic repository for the disposal of high-level radioactive waste. This application for the proposed repository contains information as required by 10 CFR 60, and has been prepared in accordance with the guidance provided by Regulatory Guide XX [Number will be inserted when RG is issued.], "Format and Content for the Application for the High-Level Waste Repository", dated XXXX XX, XXXX [Date will be inserted when RG is issued]. The license application consists of the following parts:]

[A. The license application which is set out herein]

[B. The technical information and safety analysis report required by 10 CFR 60, which is set out in a separate document entitled, "DOE Yucca Mountain High Level Waste repository Safety Analysis Report", SEL-1A is forwarded herewith as Chapters 2 through 11, and made a part hereof]

[C. The physical security information required by 10 CFR 60 and 10 CFR 73, which is set forth in a separate document entitled "DOE Yucca Mountain High Level Waste repository Physical Security and Safeguards Plan", SEL-1C forwarded herewith and made part hereof to be withheld from public disclosure pursuant to 10 CFR 2.790(d)(1)]

[D. The emergency planning information required by 10 CFR 60, which is set forth in a separate document entitled "DOE Yucca Mountain High Level Waste Repository Emergency Preparedness Plan", **SEL-1D** forwarded herewith and made a part hereof.]

[The Final Environmental Impact Statement required by the Nuclear Waste Policy Act, as amended, which is set forth in a separate document entitled "DOE Yucca Mountain High Level Waste Repository Environmental Impact Study", **SEL-1B** is also forwarded herewith to accompany the LA.]

On December 22, 1987, the United States Congress enacted the Nuclear Waste Policy Amendments Act of 1987 (NWPA), which directed the DOE to characterize one site as a candidate for the first mined geologic repository for the disposal of high-level radioactive waste. Yucca Mountain, located in Nye County, in southern Nevada aprproximately 100 miles northwest of Las Vegas (Figure 1.0A) **SEL-2,** has been characterized for development as the first geologic repository for the disposal of high-level radioactive waste. As shown on Figure 1.0A, Yucca Mountain is located on land managed by the Bureau of Land Management (BLM) of the Department of the Interior, Nellis Air Force Base, and the Nevada Test Site (NTS) which has been withdrawn from the public domain and reserved for use by the DOE. [In order to comply with all applicable regulatory requirements, it must be substantiated by supporting information that the proposed facility may be constructed and operated without unreasonable risk to the health and safety of the public.]

The proposed Yucca Mountain repository, hereafter referred to as the repository, will consist of surface facilities that include systems designed, constructed, and tested to receive and prepare the waste for disposal. [The waste packaging and handling system that will be used is described in Topical Report SEL-3A, dated SEL-3B, and was accepted by the Nuclear Regulatory Commission (NRC).] [Reference Safety Evaluation Report dated ____ which was provided by NRC.] [Underground facilities have also been designed,] and will be constructed and tested the emplacement of the waste, and will be connected to the surface by ramps and shafts. Upon permanent closure, seals will be constructed for the ramps, shafts, and exploratory bore holes (Figure 1.0B) SEL-4. Additionally, see Figure 1.0C SEL-5, for a topographical view of the repository. [A detailed description and safety analysis for the repository is contained in the Safety Analysis Report (SAR) contained herein.]

It is requested that all communications pertaining to the license application be transmitted to SEL-8A. It is also requested that a copy of each communication be sent to SEL-8B. [Recommend DOE general council, lead project manager for OCRWM, and CRWMS M&O Licensing Manager].

I, [Name of Secretarial Officer], state that on behalf of the Department of Energy; I am authorized to sign and file with Nuclear Regulatory Commission this application and exhibits attached thereto; and that all of the statements contained in such application and exhibits attached thereto and made part thereof are true and correct to the best of my knowledge, information, and belief.

Signature____

Name
[Insert Office Position]
[Office of Civilian Radioacative Waste Management]
[Department of Energy]

Subscribed and sworn to before me this ______ day of ____________________ .

Signature_____________________

Notary Public

My commission expires: ____________________

1.0.1 Overview of the Proposed repository

Yucca Mountain site characterization began in 1977, when the U.S. Government investigated the possibility of siting a repository at the Nevada Test Site (NTS). The NTS was proposed for the following reasons:

A. [In the southern Nevada area, groundwater does not discharge into rivers that flow into major bodies of surface water]

B. [The NTS has geochemical characteristics that are favorable for waste isolation, i.e., retardation of radionuclide migration]

C. [The paths of groundwater flow between the repository and the points of groundwater discharge are long]

D. The region is arid causing the rate at which groundwater is recharged to be very low [with the potential movement of groundwater, in unsaturated rock, also very low.]

To facilitate weapons testing at the NTS, site characterization was limited to the southwestern portion of the NTS and the adjacent land; therefore, three locations were identified for preliminary testing. One of these locations was Yucca Mountain which contained a formation of tuff that appeared to be large enough for a repository. Tuff had not previously been considered as a potential host rock for a repository; therefore, the National Academy of Sciences (NAS) was consulted for its views on investigating the tuff as a host rock. The NAS responded favorably.

The U.S. Geological Survey (USGS) also recommended Yucca Mountain as a potential site, about the same time, based on the results of preliminary explorations at all three locations. In 1980, a formal analysis of 15 potential locations indicated Yucca Mountain was preferred, with several potentially suitable horizons within the mountain. Following the preparation of an environmental assessment, (EA) the Secretary of the DOE nominated Yucca Mountain as one of five sites suitable for characterization, and recommended it be characterized as one of three candidate sites for the repository. This recommendation was approved by the U.S. President. Subsequently, on December 22, 1987, the U.S. Congress enacted the Nuclear Waste Policy Amendments Act of 1987, which directed the DOE to characterize only one site, Yucca Mountain. [The characterization was completed on SEL-9.]

The Yucca Mountain site is located in Nye County, Nevada, approximately 100 miles by road, northwest of Las Vegas (see Figure 1.0A). [As shown in Figure 1.0A,] the repository is located on various federal lands: Public lands managed by the BLM; Nellis Air Force Range (withdrawn from the public domain for use by the U.S. Air Force [Department of Defense]), and managed by the BLM; and, the NTS, (withdrawn from the public domain and reserved for use by the DOE). The site lies in the southwest part of the Great Basin, an arid region with linear mountain ranges and intervening valleys. This region receives little precipitation and has sparse vegetation and sparse population. Yucca Mountain is approximately 5000 feet above sea level, 1200 feet above the western edge of Jackass Flats to the east, and more than 1000 feet above the eastern edge of Crater Flats to the west.

Yucca Mountain is part of a group of northern ridges that extend southward from Beatty Wash northwest to U.S. Highway 95 in the Amargosa Desert (Figure 1.0A). Steep slopes of 15 to 30 degrees are found on the western side of Yucca Mountain and along some of the valleys that cut into the more gently sloping (5 to 10 degrees) east side of Yucca Mountain. North of Yucca Mountain is the high terrain of Timber Mountain. Along the west side of Crater Flats, fans of stream deposited sediments extend from valleys that have been cut into Bare Mountain. A few basalt cones and small lava flows are present on the surface of the southern half of Crater Flats. The water table at Yucca Mountatin is approximately 2500 feet below the land surface. Due to limited rainfall and a high evaporation rate, there is very little percolation of water downward through the unsaturated rocks above the water table.

1.0.2 General Layout and Design

The repository consists of surface and underground facilities connected by ramps and shafts. [Seals have been designed and tested,] and will be constructed for the ramps, shafts, and exploratory bore holes when the repository is permanently closed. [A statement similar to the following should be made in a potential license application: The repository facilities have been designed to comply with all applicable functional and regulatory requirements. The design of the repository is based upon the waste management program that includes the DOE Monitored Storage Facility located in SEL-11A, licensed by the NRC on SEL-11B.]

[The surface facilities of the repository will be designed to receive the waste and prepare it for permanent disposal in the underground facility.] These facilities are located on the **SEL-12** of Yucca Mountain and consist of central facilities, outlying support facilities, and facilities that provide access and ventilation for the underground repository (Figure 1.0E) **SEL-13**. The central surface facilities area is divided into **SEL-14A** functional areas used for **SEL-14B** [waste receipt and inspection, waste handling operations, and general support facilities?]. The surface facilities are connected to the underground repository through **SEL-15A** ramps and **SEL-15B** shafts [a number of ramps and shafts will be added]. A rail spur and a road will be constructed for waste that will be shipped by rail or truck.

[The waste ramp will be designed for transporting the waste containers to the underground emplacement area and to provide a fresh air intake for the waste emplacement area. A tuff ramp will be designed for use in the excavation and construction of the underground repository to facilitate removal of mined rock from the repository to the surface where the rock will be stockpiled. Additionally, this ramp will be designed to house the main electrical feeder for the underground facilities and to provide the primary exhaust airway for the underground development area.] All **SEL-15C** shafts and ramps are located **SEL-15D** [east/west?] of the central surface facilities area. **SEL-15E** of these shafts were used as exploratory shafts during site characterization. [These shafts are also to be used as fresh air intakes for the waste emplacement area, and will be described in Chapter 4. Additionally, one of these shafts will be used as an emergency exit from the underground facility.]

The underground repository, where the waste will ultimately be emplaced, will be constructed at a depth of approximately [240 to 340 meters] [may change with design revisions]. The primary horizon for the repository is in the welded tuff formation of the SEL-16A [currently believed to be a Topopah Spring Member]. The boundaries of this area are shown in Figure 1.0E SEL-16B. [The host rock in the primary area is sufficiently thick over an area large enough to accommodate the equivalent of 70,000 metric tons of heavy metal waste.] An area of SEL-16C [currently believed to be 2,095] acres is available underground for waste emplacement. The [current] repository [conceptual] design calls for using SEL-16D acres [Current plans call for 1,380 acres]. The layout consists of SEL-17 parallel main entry drifts that would extend southwest through the underground facility to provide access to the waste emplacement areas, called emplacement panels. [One of the main drifts will be designed and dedicated to transport waste, another for moving rock and large materials, and another to serve as a main drift ventilation and electrical distribution systems.] The primary component of the underground layout is the emplacement panel which is the area excavated for waste package emplacement (or storage). An emplacement panel is approximately SEL-18A feet wide and SEL-18B feet long and will contain the emplacement drifts, in which boreholes will be drilled SEL-18C [vertical or horizontally], for waste emplacement. The development of the waste panels will begin in the SEL-18D and progress in a SEL-18E direction as shown in SEL-18F Figure 1.0F. Waste emplacement operations will be conducted in a programmatic sequence following the order of waste panel development.

Waste emplacement will begin after SEL-19A panels have been completely developed. This method will provide a safe distance between development mining and waste emplacement operations to protect the development personnel from exposure to radiation. [The waste packages will be designed to be placed SEL-19B [vertically/horizontally] in boreholes drilled into the floors/walls of the emplacement panels as shown in SEL-19C Figure 1.0G. A description of the borehole and emplacement techniques will be contained in Chapters 4 and 5.]

[Two independent ventilation systems will be designed to serve the underground repository.] One will satisfy ventilation needs for the development and construction of the repository and the other will satisfy ventilation needs for waste emplacement operations. The basic layout of the ventilation system (Figure 1.0H SEL-20A) consists of SEL-20B shafts, SEL-20C ramps, and SEL-20D main airways emplacement areas on each side of the main airways and a perimeter airway that will encircle the repository. [A detailed description of the ventilation system will be contained in Chapter 4.]

[Tunnel boring machines SEL-21A (TBMs) will be used to excavate the waste and tuff ramps as part of the Exploratory Studies Facility (ESF). TBMs will also be used for long-drive drifts, the waste main, and the perimeter drift. Drilling and blasting will be used to excavate the shorter drifts.] Waste emplacement boreholes will be excavated using a SEL-21B. [A detailed description of these plans and methods will be contained in Chapter 5.]

Waste will be retrievable for the emplacement period plus 50 years at any time after the start of waste emplacement. Following the waste emplacement period, which is scheduled for SEL-22A years, the caretaker period of SEL-22B years will begin. During both of these periods, tests will be conducted to confirm the repository is performing as designed. At the end of the caretaker period, the repository will be prepared for permanent closure. [Plans for backfilling and sealing will be contained in Chapter 5.] Surface facilities will be decontaminated and dismantled, as required. The site will then be returned to its natural state as provided in the reclamation plan. [A plan for permanent closure of the repository and decontamination and dismantlement of surface facilities will be provided as an attachment to this report.]

The waste package design is comprised of the waste form and the container. The waste package, like the site and the repository, is an element of the repository system, and is the principal engineered barrier. [The waste package will be designed to meet the requirements of 10 CFR 60.] Figure 1.0I SEL-23A is a general drawing of the components that constitute the waste package. [Chapter 5 will provide a detailed description of the waste package as accepted by the NRC in Topical Report SEL-23B.] [Reference SER dated ____ provided by NRC.] The waste form will be either spent fuel from commercial reactors, both pressurized water (PWR) and boiling water (BWR) types, or high-level waste from defense or commercial sources. The spent fuel will be SEL-24A [consolidated at the repository or before shipment and/or disposed of as intact assemblies]. The spent fuel from PWRs will be greater than SEL-24B years old and spent fuel from BWRs will be greater than SEL-24C years old. [A description of the spent fuel, its burn-up time at discharge, its nominal burn-up time, and the thermal output calculation methods will be contained in Chapter 5.]

[The waste container with spent fuel will be designed so the gamma dose rate at the outer surface of the container will be approximately SEL-24D Rads per hour.] The neutron dose rate on the outer surface of the container will be approximately SEL-24E neutrons per square centimeter. [Spent fuel packages will be designed for thermal decay rates as low as SEL-24F kilowatts and as high as SEL-24F kilowatts.] The high level waste from both commercial and defense sources will be in the form of borosilicate glass solidified in stainless steel canisters. The high level waste containers have been designed for thermal decay rates that will range between SEL-25A kilowatts depending on the source and age of the wastes in the glass matrix. [A description of the thermal output calculation methods will be contained in Chapter 5.]

The gamma dose rate on the surface of the container will be approximately SEL-25B Rads per hour, and the neutron dose rate at the surface of the container will be approximately SEL-25C. The disposal container for both waste forms is a SEL-26A. Figure 1.0J SEL-26B provides a general drawing of the waste forms in the appropriate disposal containers. After the waste is loaded into the disposal container, it will be filled with an inert gas SEL-26C to provide a non-oxidizing environment, and the top will then be welded shut. The top of the container has a fixture for lifting and lowering the container. A loaded container will weigh from SEL-26D to SEL-26D pounds depending on the quantity and type of waste. The containers for spent fuel will contain components/compartments to maintain the spent fuel in a stable position for container loading. These mechanisms have been designed to accommodate SEL-26E [the different types of spent fuel, and to accommodate consolidated and non-consolidated fuel].

[The partially saturated portion of the SEL-27A tuff, as shown in Figure 1.0K, SEL-27B will provide a waste emplacement environment acceptable for the permanent storage and long-term performance of the waste package.] The pressure exerted on the disposal containers has been calculated to be approximately SEL-27C pounds per square inch. There will be no hydrostatic pressure because the repository is above the water table, [and the waste packages will not be subject to loads induced by potential creeping of the rock.] The potential water available for corrosion of containers and the dissolution of the waste package or form is limited to very small amounts SEL-27D. [A detailed description of the physical conditions in the waste emplacement environment is contained in Chapter 5.]

[The proposed site, facility design, plans for construction, operation, and permanent closure have been presented to meet the requirements set forth in the previously mentioned regulatory documents. The above material has discussed whether all requirements have been met and an acceptable level of risk with respect to the health and safety of the public has been demonstrated.]

1.0A General Location of Yucca Mountain Site in Southern Nevada

1.0B General Location Map of Site Surface and Underground Facilities

1.0C Topographical Map of Surface and Underground Facilities

1.0D General Location Map of Repository Site Relative to Las Vegas

1.0E General Location of Central Facilities

1.0F General Drawing of Waste Panel Development

1.0G General Drawing of Waste Emplacement Boreholes

1.0H General Drawing of Underground Facility Ventilation System

1.0I General Drawing of Waste Package and Components

1.0J General Drawing of Disposal Containers for Both Waste Types

1.0K General Drawing of Topopah Tuff and Waste Emplacement Area

REFERENCES

1.0A Nuclear Regulatory Commission, 10 CFR 60, Code of Federal Regulations, 1986, Title 10, "Energy," Part 60, "Disposal of High Level Waste in Geologic Repositories," U.S. Government Printing Office, Washington, D.C.

1.0B Department of Energy, Office of Civilian Radioactive Waste Management, 1988, "Yucca Mountain Site Characterization Plan," DOE/RW-0199, Washington, D.C.

1.0C Nuclear Waste Policy Act, 1983, "Nuclear Waste Policy Act of 1982," Public Law 97-425, 42 USC 10101-10225, Washington, D.C.

1.0D Nuclear Waste Policy Amendments Act, 1987, "Nuclear Waste Policy Amendments Act of 1987," H.R. 3545, Washington, D.C.

1.0E Department of Energy, Office of Civilian Radioactive Waste Management, 1988, "Yucca Mountain Site Characterization Plan Overview," DOE/RW-0199, Washington, D.C.

1.0F Department of Energy, Yucca Mountain Project Office, 1990, "Yucca Mountain Site Characterization Plan Overview," YMP/90-33, Washington, D.C.

1. Section No. & Title: **1.0 GENERAL INFORMATION**

2. Lead Author & Phone No. Marshall Weaver (702) 794-1871

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
   (Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   This section provides an introduction to the License Application. It includes a general description of the high-level waste repository and an overview of the proposed project. A description is given of the location, the general layout and design of the repository, and supporting information for the license application.

6. Opening Statement:

   [A statement similar to the following should be made in a potential license application: The proposed site for the high-level waste repository has been studied and characterized. It has been substantiated by supporting information, that the proposed facility may be constructed and operated at the candidate location without unacceptable adverse effects on the public.]

7. Main Body Outline:

   - Introduction to the report
   - General description of the repository
   - Overview of the proposed project
   - Description of the location (see Figure 1.0A)
   - General layout and design
   - Supporting information for the license application.

8. Conclusion:

[A statement similar to the following should be made in a potential license application: The proposed site, facility design, and plans for construction, operation, and permanent closure, have been shown to be an optimum selection, with an acceptable level of risk to the public.]

9. Support Authors & Their Assignments:

MGDS Annotated Outline Planning Package Date: 9/30/92
Form 2: Figures & Tables

Section No. & Title: **1.0 GENERAL INFORMATION**

Lead Author & Phone No. Marshall Weaver (702) 794-1871

A. Figure No. **1.0A**

Caption: **General Location of Yucca Mountain Site in Southern Nevada**

Content:

Map showing location relative to Las Vegas, State Boundary, Nellis AFB, NTS, BLM land, etc. Probably the existing map Figure 2-3 from the SCP will satisfy this.

B. Figure No. **1.0B**

Caption: **General Map of Site Surface and Underground Facilities**

Content:

Map showing repository site, both above ground and underground facilities and interconnection, i.e., ramps, railroad, tuff pile, etc.

C. Figure No. **1.0C**

Caption: **Topographical Map of Site Surface and Underground Facilities**

Content:

See SEL-5, Form A, No. 4.

D. Figure No. **1.0D**

Caption: **General Map of Repository Site Relative to Las Vegas**

Content:

See SEL-10, Form A, No. 4.

E. Figure No. 1.0E

Caption: **General Drawing of Central Facilities**

Content:

See SEL-13, Form A, No.4.

F. Figure No. 1.0F

Caption: **General Drawing of Waste Panel Development**

Content:

See SEL-18, Form A, No. 4.

G. Figure No. 1.0G

Caption: **General Drawing of Waste Panel Development**

Content:

General drawing showing location, dimensions, orientation of boreholes.

H. Figure No. 1.0H

Caption: **General Drawing of Underground Facility Ventilation System**

Content:

See SEL-20, Form A, No. 4.

I. Figure No. 1.0I

Caption: **General Drawing of Waste Package and Components**

Content:

Need drawing of package showing components with dimensions, materials, and how package and waste fit together.

J. Figure No. 1.0J

Caption: **General Drawing of Waste Forms in Disposal Containers**

Content:

Drawing to show high-level waste and spent fuel disposal containers, dimensions, orientation, material, etc. SEL-26, Form A, No.4.

K. Figure No. 1.0K

Caption: **General Drawing of Topopah Tuff and Waste Emplacement Area**

Content:

Need drawing of rock formation depicting where waste emplacement will be located with respect to Topopah and Calico Hills.

MGDS Annotated Outline Planning Package Date: 9/30/92
Form 3: References

Section No. & Title: **1.0 GENERAL INFORMATION**

Lead Author & Phone No.: Marshall Weaver (702) 794-1871

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

1.

2.

3.

4.

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6.

7.

8.

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: SEL-1
2. Section no. & title: 1.0 GENERAL INFORMATION
3. Lead author & phone no. S. E. LeRoy (702) 794-7836
4. Information request date: 2/21/92
5. Work location: M&O - Las Vegas
6. Type of information needed:

   1A **Need DOE name for SAR**
   1B **DOE name for Environmental Report**
   1C **Need DOE name for Security Plan**
   1D **Need DOE name for Emergency Plan.**

7. What is the information needed for?

   Section 1.0.

8. What group is the probable information supplier?

   DOE HQ.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):
12. Response date:
13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **SEL-2**
2. Section no. & title: **1.0 GENERAL INFORMATION**
3. Lead author & phone no: **S. E. LeRoy (702) 794-7836**
4. Information request date: **2/21/92**
5. Work location: **M&O - Las Vegas**
6. Type of information needed:

   A drawing of the U.S. identifying the NTS, NAFB, and BLM lands in southern Nevada. Included should be an enlargement of the area identifying Yucca Mountain with the boundary of the repository identified.

7. What is the information needed for?

   Figure 1.0A.

8. What group is the probable information supplier?

   Conceptional Design Report - Jim Clark.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    SCP Overview Figure 2-3 is an example of the drawing needed.

---

11. Response by (name):
12. Response date:
13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: SEL-3
2. Section no. & title: 1.0 GENERAL INFORMATION
3. Lead author & phone no. S. E. LeRoy (702) 794-7836
4. Information request date: 2/21/92
5. Work location: M&O - Las Vegas
6. Type of information needed:

   3A Name of Waste Package System/Topical Report
   3B Date NRC approved.

7. What is the information needed for?

   Section 1.0.

8. What group is the probable information supplier?

   Waste Package Design Group.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):
12. Response date:
13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **SEL-4**

2. Section no. & title: **1.0 GENERAL INFORMATION**

3. Lead author & phone no. **S. E. LeRoy (702) 794-7836**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Drawing to be used as Figure 1.0-B in License Application to provide a general description of the repository site, both above ground and underground facilities and their interconnection, i.e., ramps, railroad, tuff pile, major buildings, etc.

7. What is the information needed for?

   Figure 1.0B.

8. What group is the probable information supplier?

   Design Group - Jim Clark.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    SCP overview Figure 3.1 is an example of the drawing needed.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **SEL-5**

2. Section no. & title: **1.0 GENERAL INFORMATION**

3. Lead author & phone no. **S. E. LeRoy (702) 794-7836**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Drawing to be used as Figure 1.0-C in License Application to provide a topographical view of Yucca Mountain depicting the aboveground and underground facilities. This drawing should also include a contour interval legend.

7. What is the information needed for?

   Figure 1.0C.

8. What group is the probable information supplier?

   Design Group - Jim Clark.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    Reference SCP overview Figure 3.2 is an example of the drawing needed.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **SEL-6**

2. Section no. & title: **1.0 GENERAL INFORMATION**

3. Lead author & phone no. **S. E. LeRoy (702) 794-7836**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   8A DOE Contact for NRC Licensing Application
   8B DOE also needs to identify others to receive NRC License Application correspondence.
   Note: Recommend DOE copy General Council, Lead PM for OCRWM, and CRWMS M&O Licensing Manager.

7. What is the information needed for?

   General information section of the License Application.

8. What group is the probable information supplier?

   DOE HQ.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: SEL-7

2. Section no. & title: 1.0.1 OVERVIEW OF PROPOSED REPOSITORY

3. Lead author & phone no: S. E. LeRoy 702-794-7836

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Date Site Characterization is completed.

7. What is the information needed for?

   Section 1.0.1.

8. What group is the probable information supplier?

   YMPO - DOE HQ.

9. When is the information needed?

   Prior to License Application submittal date.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **SEL-8**
2. Section no. & title: **1.0.1 DESCRIPTION OF PROPOSED REPOSITORY**
3. Lead author & phone no: **S. E. LeRoy (702) 794-7836**
4. Information request date: **2/21/92**
5. Work location: **M&O - Las Vegas**
6. Type of information needed:

   11A - Need location of MRS
   11B - Date MRS is licensed.

7. What is the information needed for?

   Section 1.0.1.

8. What group is the probable information supplier?

   MRS Siting Group and DOE HQ.

9. When is the information needed?

   Prior to License Application submittal date.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):
12. Response date:
13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **SEL-9**

2. Section no. & title: **1.0.2 GENERAL LAYOUT AND DESIGN**

3. Lead author & phone no: **S. E. LeRoy (702) 794-7836**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Need location of surface facilities, i.e., east face, west slope of Yucca Mountain.

7. What is the information needed for?

   General information section of License Application

8. What group is the probable information supplier?

   Design Group - Jim Clark.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):

12. Response date:

13. Response:

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **SEL-10**

2. Section no. & title: **1.0.2 GENERAL LAYOUT AND DESIGN**

3. Lead author & phone no: **S. E. LeRoy (702) 794-7836**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Drawing of surface facilities.

7. What is the information needed for?

   Figure 1.0E.

8. What group is the probable information supplier?

   Design Group - Jim Clark

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    Figure 3-5 of SCP overview is example of drawing needed.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **SEL-11**

2. Section no. & title: **1.0.2 GENERAL LAYOUT AND DESIGN**

3. Lead author & phone no: **S. E. LeRoy (702) 794-7836**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   14A - Number of functional areas in the central surface facility
   14B - Need to identify the activities to be performed in the surface facilities, i.e., waste receipt, inspection, segregation, etc.

7. What is the information needed for?

   Section 1.0.2.

8. What group is the probable information supplier?

   Design Group - Jim Clark.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: SEL-12

2. Section no. & title: 1.0.2 GENERAL LAYOUT AND DESIGN

3. Lead author & phone no: S. E. LeRoy (702) 794-7836

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   15A - Number of ramps in the repository
   15B - Number of shafts in the repository
   15C - Same as 15A
   15D - Need location of shafts
   15E - Need identification of shaft(s) used for exploratory studies.

7. What is the information needed for?

   Section 1.0.2.

8. What group is the probable information supplier?

   Design Group - Jim Clark

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **SEL-13**

2. Section no. & title: **1.0.2 GENERAL LAYOUT AND DESIGN**

3. Lead author & phone no: **S. E. LeRoy (702) 794-7836**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   16A - Identification of repository emplacement area and location in Yucca Mountain
   16B - Need drawing identifying boundary of emplacement areas
   16C - Number of acres available for emplacement of waste
   16D - Number of acres called for in conceptual design.

7. What is the information needed for?

   Section 1.0.2.

8. What group is the probable information supplier?

   Design Group - Jim Clark.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **SEL-14**

2. Section no. & title: **1.0.2 GENERAL LAYOUT AND DESIGN**

3. Lead author & phone no: **S. E. LeRoy (702) 794-7836**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Need description or number of main entry drifts that will extend into underground facility.

7. What is the information needed for?

   Section 1.0.2.

8. What group is the probable information supplier?

   Design Group - Jim Clark.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: SEL-15

2. Section no. & title: 1.0.2 GENERAL LAYOUT AND DESIGNS. E. L

3. Lead author & phone no: S. E. LeRoy (702) 794-7836

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   18A - Need width of emplacement panels
   18B - Need length of emplacement panels
   18C - Need to know if vertical or horizontal boreholes will be used for emplacement
   18D - Date(s) when emplacement panel excavation will occur
   18E - Direction (SW, NW, NE, ITC.) panels will progress
   18F - General drawing of waste emplacement panels.

7. What is the information needed for?

   General information section of License Application.

8. What group is the probable information supplier?

   Design Group - Jim Clark.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **SEL-16**

2. Section no. & title: **1.0.2 GENERAL LAYOUT AND DESIGN**

3. Lead author & phone no: **S. E. LeRoy (702) 794-7836**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   19A - Need date when waste emplacement will begin
   19B - Need decisions as to whether vertical or horizontal waste emplacement will be utilized
   19C - Need general drawing of waste emplacement boreholes.

7. What is the information needed for?

   General information section of License Application.

8. What group is the probable information supplier?

   Design Group - Jim Clark.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **SEL-17**

2. Section no. & title: **1.0.2 GENERAL LAYOUT AND DESIGN**

3. Lead author & phone no: **S. E. LeRoy (702) 794-7836**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   20A - Need general drawing of underground facility ventilation system
   20B - Need number of shafts in underground facility
   20C - Need number of ramps in underground facility
   20D - Need number of main airways in underground facility.

7. What is the information needed for?

   Section 1.0.2, and Figure 1.0H.

8. What group is the probable information supplier?

   Design Group - Jim Clark.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **SEL-18**

2. Section no. & title: **1.0.2 GENERAL LAYOUT AND DESIGN**

3. Lead author & phone no: **S. E. LeRoy (702) 794-7836**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   21A - Need determination as to what type of excavating technique will be used for waste and tuff ramps, long drives, waste main, and perimeter drift
   21B - Need to know technique that will be used for emplacement boreholes.

7. What is the information needed for?

   Section 1.0.2.

8. What group is the probable information supplier?

   Mining Contractor - REECO.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):

12. Response date:

13. Response:

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **SEL-19**
2. Section no. & title: **1.0.2 GENERAL LAYOUT AND DESIGN**
3. Lead author & phone no: **S. E. LeRoy (702) 794-7836**
4. Information request date: **2/21/92**
5. Work location: **M&O - Las Vegas**
6. Type of information needed:

   22A - Need number of years planned for waste emplacement
   22B - Need number of years caretaker period will last and beginning date.

7. What is the information needed for?

   General information section of license Application.

8. What group is the probable information supplier?

   Design Group - Jim Clark.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):
12. Response date:
13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **SEL-20**

2. Section no. & title: **1.0.2 GENERAL LAYOUT AND DESIGN**

3. Lead author & phone no: **S. E. LeRoy (702) 794-7836**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   23A - Need general drawing of waste package and components
   23B - Need information on topical report for waste package, name, date, submittal/approval dates.
   23C - Need SER approval date.

7. What is the information needed for?

   Section 1.0.2, and Figure 1.0I.

8. What group is the probable information supplier?

   Design Group - Jim Clark.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: SEL-21
2. Section no. & title: 1.0.2 GENERAL LAYOUT AND DESIGN
3. Lead author & phone no: S. E. LeRoy (702) 794-7836
4. Information request date: 2/21/92
5. Work location: M&O - Las Vegas
6. Type of information needed:

   24A - Need to know whether fuel will be consolidated or not
   24B - Need limit on minimum age of PWR spent fuel or disposal
   24C - Need information on topical report for waste package, name, date, submittal/approval dates
   24D - Need spent fuel gamma dose on outer surface of container
   24E - Need spent fuel neutron dose on outer surface of container
   24F - Kilowatt thermal decay rate for spent fuel packages, hi t low.

7. What is the information needed for?

   Section 1.0.2.

8. What group is the probable information supplier?

   Sandai National Lab.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):
12. Response date:
13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **SEL-22**

2. Section no. & title: **1.0.2 GENERAL LAYOUT AND DESIGN**

3. Lead author & phone no: **S. E. LeRoy (702) 794-7836**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   25A - Need thermal kilowatt thermal decay rates for high level waste packages
   25B - Need gamma dose rate on surface of container for waste package
   25C - Need neutron dose rate on surface of container for high level waste package.

7. What is the information needed for?

   Section 1.0.2.

8. What group is the probable information supplier?

   Design Group - Jim Clark.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: SEL-23
2. Section no. & title: 1.0.2 GENERAL LAYOUT AND DESIGN
3. Lead author & phone no: S. E. LeRoy (702) 794-7836
4. Information request date: 2/21/92
5. Work location: M&O - Las Vegas
6. Type of information needed:

   26A - Need description of disposal container, dimensions, materials
   26B - Need general drawing of waste forms in disposal containers
   26C - Need to know which gas(es) will be used to pressurize container as oxidizing inhibiter
   26D - Need to know what type of mechanisms will be used inside container for each type of waste for shielding, stability, etc.

7. What is the information needed for?

   General information section of License Application.

8. What group is the probable information supplier?

   Design Group - Jim Clark.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):
12. Response date:
13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **SEL-24**

2. Section no. & title: **1.0.2 GENERAL LAYOUT AND DESIGN**

3. Lead author & phone no: **S. E. LeRoy (702) 794-7836**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   27A - Need names of unsaturated rock that will be used for waste environment, i.e., Calico Hills, Topopah
   27B - Need general drawing of rock formations depicting where the waste emplacement environment will be located with respect to the various formations in 27A
   27C - Need to know pressure that will be exerted upon waste container
   27D - Need to know the amount of water waste environment will be exposed to.

7. What is the information needed for?

   Section 1.0.2.

8. What group is the probable information supplier?

   Design Group - Jim Clark.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form B: Information Response

1. Section No. & Title: **1.0 GENERAL INFORMATION**

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester): Marshall Weaver (702) 794-1871

   Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

Section 1.1 General Facility Description

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: CJG-1
2. Section no. & title: 1.1 GENERAL FACILITY DESCRIPTION
3. Lead author & phone no: Clem Goewert (702) 794-1859
4. Information request date: 2/21/92
5. Work location: M&O - Las Vegas
6. Type of information needed:

   Map or drawings with manmade boundaries.
7. What is the information needed for?

   Manmade boundaries: Figure 1.2D.
8. What group is the probable information supplier?

   Surface facilities design group (lead author for Section 4.1).
9. When is the information needed?
10. What kind of related information is already available in references, etc.?

---

11. Response by (name):
12. Response date:
13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **CJG-2**

2. Section no. & title: **1.1 GENERAL FACILITY DESCRIPTION**

3. Lead author & phone no: **Clem Goewert (702) 794-1859**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Map location of site, including roads and other transportation links.

7. What is the information needed for?

   State Map: Figure 1.2A.

8. What group is the probable information supplier?

   Surface facilities design group (lead author for Section 4.1).

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.1 GENERAL FACILITY DESCRIPTION

This section presents a general description of the high-level nuclear waste (HLW) repository including its location, general layout and design.

[Note: This section essentially is an executive summary of the project. Items discussed in this section will be detailed in other sections. As these sections are developed, the text in this section will be more fully developed.]

1.1.1 Site Description

[Note: This section will be developed when the proposed facility design is completed.]

1.1.1.1 General Description

[Note: This section will present a general description of the site location.]

1.1.1.2 Geologic Setting

[Note: This section will present a synopsis of the of the geologic setting, and will be developed after Section 3.1 is prepared.]

1.1.1.3 Geologic Repository Operations Area (GROA)

[Note: This section will present a summary of the Geologic Repository Operations Area, and will be written after Section 4.0 has been developed so as to provide sufficient details on the proposed design.]

1.1.1.4 Boundaries

1.1.1.4.1 Natural Boundaries

1.1.1.4.2 Manmade Boundaries

1.1.1.5 Site Features

1.1.1.6 Engineered Barriers

1.1.1.7 Roads

[Note : This section will present a brief description and location map(s) of the roads. Details of the roads system will be developed in Section 4.1.1.8, Onsite Transportation System.]

1.1.1.8 Transportation Link

1.1.1.9 Natural System

[Note: This section will present a very brief summary of the natural system characteristics, and will be prepared after Section 3.1 is developed.]

[General Discussion]

1.1.1.9.1 Geology

1.1.1.9.2 Hydrology

1.1.1.9.3 Geochemistry

1.1.1.9.4 Meteorology and Climate

1.1.2 Design of Major Structures

1.1.2.1 Above Ground Structures

1.1.2.1.1 Permanent

1.1.2.1.2 Temporary

1.1.2.2 Below Ground Structures

1.1.2.2.1 Permanent

1.1.2.2.2 Temporary

1.1.3 Summary of Activities ("Plans")

1.1.3.1 Operation

1.1.3.2 Decommissioning

1.1.3.3 Permanent Closure

REFERENCES

MGDS Annotated Outline Planning Package Date: 9/30/92
Form 1: Text

1. Section No. & Title: **1.1 GENERAL FACILITY DESCRIPTION**

2. Lead Author & eNo. Clem Goewert
(702) 794-1859

3. First Phase Planning Package Due: 6/21/91

Second Phase Planning Package Due: 10/18/91

First Phase Skeleton Draft Due: 1/30/92

Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

This section will present a general description of the high-level nuclear waste (HLW) repository including its location, general layout and design.

6. Opening Statement:

[Same as summary].

7. Main Body Outline:

1.1 General Facility Description

1.1.1 Site Description

1.1.1.1 General Description (4.0)

Utilize map in Figure 1.2A include site location.

1.1.1.2 Geologic Setting (3.0) Figure 1.2F

1.1.1.3 Geologic Repository Operations Area (GROA) (4.1)

Utilize plot plan in Figure 1.2B.

1.1.1.4 Boundaries

7. Main Body Outline (Continued)

1.1.1.4.1 Natural Boundaries (3.0)

Utilize map (and/or drawings) in Figure 1.2C.

1.1.4.1.2 Manmade Boundaries (4.1)

Discuss purposes of boundaries. Utilize map and drawings in Figures 1.2D, and 1.2H.

1.1.1.5 Site Features

1.1.1.6 Engineered Barriers (5.1), Figure 1.2H

1.1.1.7 Roads (4.1.1)

Utilize maps in Figures 1.2A and 1.2E.

1.1.1.8 Transportation Links (4.1.1)

Utilize maps in Figure 1.2A and 1.2E.

1.1.1.9 Natural System

General discussion of outstanding features.

1.1.1.9.1 Geology (3.1.1), Figure 1.2F

1.1.1.9.2 Hydrology (3.1.2), Figure 1.2G

1.1.1.9.3 Geochemistry (3.1.3), Table 1.2C

1.1.1.9.4 Meteorology (3.1.4), Table 1.2B, Figure 1.2J and Climate (3.1.4)

1.1.2 Design of Major Structures, Figure 1.2B, 1.2I

1.1.2.1 Above Ground (4.1.1)

1.1.2.1.1 Permanent

1.1.2.1.2 Temporary

1.1.2.2 Below Ground (4.1.2, 4.1.3)

1.1.2.2.1 Permanent

1.1.2.2.2 Temporary

1.1.3 Summary of Activities ["Plans"]

1.1.3.1 Operation (7.0)

1.1.3.2 Decommissioning (4.1.1.11, 4.1.2.6)

1.1.3.3 Permanent Closure (4.1.3.9)

8. Conclusion:

[A statement similiar to the following should be made in a potential License Application: The proposed site, facility design, and plans for construction, operation, and permanent closure have been shown to be an optimum selection, with an acceptable level of risk to the public.]

9. Support Authors & Their Assignments:

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 1.1 GENERAL FACILITY DESCRIPTION

Lead Author & Phone No. Clem Goewert
(702) 794-1859

A. Figure No. 1.2A

Caption: High-Level Waste Repository Site

Content: State map-

Location of site
Roads (improved, unimproved) and transportation links (rail lines, air access, etc.)
Show site boundary, Nevada test site, Bureau of Land Management, Nellis Air Force Base range, etc.

[CJG-2]

B. Figure No. 1.2E

Caption: High-Level Waste Repository Site

Content: County map
Site location
Roads and Transportation Links

[CJG-4]

C. Figure No. 1.2B

Caption: Site Plot Plan

Content: Layout of GROA

Differentiate permanent and temporary facilities, include underground and above ground structures.

[CJG-5]

Section No. & Title: **1.1 GENERAL FACILITY DESCRIPTION**

Lead Author & Phone No. Clem Goewert
(702) 794-1871

A. Figure No. 1.2C

Caption: **Natural Site Boundaries**

Content: Natural site boundaries: drawings or maps

Include longitudinal cross section through proposed repository showing natural boundaries.

[CJG-6]

B. Figure No. 1.2D

Caption: **Manmade Boundaries**

Content: Manmade boundaries: drawings or maps

[CJG-1]

C. Table No. 1.2A

Title: **Site Structures**

Content: Listing of site structures (reference to Safety Analysis Section with detailed description).

[CJG-3]

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: **1.1 GENERAL FACILITY DESCRIPTION**

Lead Author & Phone No. Clem Goewert
(702) 794-1871

A. Figure No. **1.2F**

Caption: **Geologic Setting**

Content: Geologic Map showing surface (bedrock) geology, include relief (contours).

B. Figure No. **1.2G**

Caption: **Hydrologic Features**

Content: Surface map (drainage) and cross section (unsaturated zone, saturated zone, direction of flow in aquifer with estimated rate, aquatards, playas). This will probably be a double figure, showing the same area with about a ten mile radius (map) and linear extent of the same distance along the axis of maximum flow (cross section).

C. Figure No. **1.2H**

Caption: **Engineered Barriers**

Content: Two views (top and cross section).
Sufficient area coverage to show all manmade barriers related to the repository, perhaps isometric graphic, also. Consider inset (or additional figure) showing wasteform encapsulation, containers, and packaging.

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: **1.1 GENERAL FACILITY DESCRIPTION**

Lead Author & Phone No. Clem Goewert
(702) 794-1871

A. Figure No. 1.2I

Caption: **Structures**

Content: Drawing of surface and sub-surface structures. Either in one composite figure, or if needed, to clearly show structures, additional figure(s).

B. Figure No. 1.2J

Caption: **Wind Rose**

Content: Show wind rose - or change reference in text to other section showing same.

C. Table No. 1.2B

Caption: **Meteorological Features**

Content:

Meteorological Features

Feature	Strength	Frequency of Occurrence	Comments
Tornado	220 mph	Once every 310 years	No adverse impact (monitoring equipment adequately protected)
Thunder Storm	2 inch/hr	Once every 2 years	Enhanced drainage features (manmade). See Section__.
Hurricane	80 mph+	Once every 50 years	------------------
Hail	Golf balls+	Once every 40 years	------------------
Snow	16 inches or more/hr	Once every 20 years	------------------
Snow	2 feet or more accumulation	Once every 15 years	------------------

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: **1.1 GENERAL FACILITY DESCRIPTION**

Lead Author & Phone No. Clem Goewert
(702) 794-1871

A. Table No. 1.2C

Title: Geochemical Features

Content:

Feature	Impact on Repository?	Discussion
Zeolite	Yes	Absorbs radionuclides, etc.

B. Figure No.

Caption:

Content:

C. Figure No.

Caption:

Content:

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title: **1.1 GENERAL FACILITY DESCRIPTION**

Lead Author & Phone No. Marshall Weaver (702) 794-1871

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

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The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

. Log number: **CJG-3**

2. Section no. & title: **1.1 GENERAL FACILITY DESCRIPTION**

3. Lead author & phone no: **Clem Goewert (702) 794-1859**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   List of structures on site.

7. What is the information needed for?

   Table 1.2A.

8. What group is the probable information supplier?

   Surface facilities design group (lead author for Section 4.1).

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **CJG-4**

2. Section no. & title: **1.1 GENERAL FACILITY DESCRIPTION**

3. Lead author & phone no: **Clem Goewert (702) 794-1871**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Map location of site, including roads and other transportation links.

7. What is the information needed for?

   County map: Figure 1.2E.

8. What group is the probable information supplier?

   Surface facilities design group (lead author for Section 4.1).

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **CJG-5**
2. Section no. & title: **1.1 GENERAL FACILITY DESCRIPTION**
3. Lead author & phone no: **Clem Goewert (702) 794-1859**
4. Information request date: **2/21/92**
5. Work location: **M&O - Las Vegas**
6. Type of information needed:

   Plot plan of GROA with structures identified.
7. What is the information needed for?

   Plot plan: Figure 1.2B.
8. What group is the probable information supplier?

   Surface facilities design group (lead author for Section 4.1).
9. When is the information needed?
10. What kind of related information is already available in references, etc.?

---

11. Response by (name):
12. Response date:
13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **CJG-6**
2. Section no. & title: **1.1 GENERAL FACILITY DESCRIPTION**
3. Lead author & phone no: **Clem Goewert (702) 794-1859**
4. Information request date: **2/21/92**
5. Work location: **M&O - Las Vegas**
6. Type of information needed:

   Map or drawings with natural site boundaries.

7. What is the information needed for?

   Natural boundaries: Figure 1.2C.

8. What group is the probable information supplier?

   Surface facilities design group (lead author for Section 4.1).

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):
12. Response date:
13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form B: Information Response

1. Section No. & Title:

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester): Marshall Weaver (702) 794-1871

   Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

MGDS Annotated Outline

Section 1.2 Basis for Licensing Authority

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1.2 BASIS FOR LICENSE AUTHORITY

Pursuant to Section 8(c) of the Nuclear Waste Policy Act of 1982, (42 USC 10107), the Department of Energy (DOE), as an applicant for a license to construct and operate a Mined Geologic Disposal Site (MGDS) is subject to federal law and Nuclear Regulatory Commission (NRC) regulations applicable to the siting and construction of an MGDS, and the transfer, possession, and disposal of high-level radioactive waste. The following is a chronological history of how the responsibility of final disposition of high-level waste was assigned to the DOE, and how the NRC received licensing authority for high-level waste.

An amendment to the Atomic Energy Act of 1946, identified as the Atomic Energy Act of 1954, initiated the establishment of policies to:

A. Assist and foster research and development, and encourage maximum scientific and industrial progress

B. Disseminate unclassified scientific and technical information to encourage scientific and industrial progress

C. Provide government control of the possession, use, and production of atomic energy and special nuclear material owned by the government and others, as to make maximum contribution to the common defense and security, and enforce agreements with nations and groups of nations for the control of atomic weapons

D. Encourage widespread participation in the research and utilization of atomic energy for peaceful purposes to the maximum extent possible, consistent with the common defense and security, and with concern for the health and safety of the public

E. Provide a program for international cooperation to pursue the benefits of peaceful applications of atomic energy

F. Provide a program of administration to fulfill the requirements of the Act, and to keep the Congress informed if further legislative action is required on their part.

The Energy Reorganization Act of 1974 as amended abolished the Atomic Energy Commission and repealed Sections 21 and 22 of the Atomic Energy Act of 1954, as amended (U.S.C. 2031 and 2032). All other functions, with the exception of certain items related to regulatory authority discussed further in this section, were transferred to the newly established Energy Research and Development Administration. Pursuant to Sections 202(1) through (4) all licensing and regulatory functions of the Atomic Energy Commission were transferred to NRC for liquid metal fast breeder reactors, demonstration nuclear reactors, and facilities for the receipt and storage of high-level radioactive waste, and for retrievable subsurface storage facilities. Later, pursuant to the Nuclear Waste Policy Act of 1982, this authority was extended to DOE high-level waste disposal facilities. The NRC's Office of Nuclear Reactor Regulation was established to license and provide regulatory oversight of facilities and materials licensed under the Atomic Energy Act of 1954. The NRC's Office of Nuclear Material Safety and Safeguards was established to provide regulatory oversight for activities associated with the processing, transport, and handling of nuclear materials and to review safety and safeguards of facilities and materials licensed under the Atomic Energy Act of 1954, as amended.

The Department of Energy Organization Act of 1977, established the DOE as an executive branch within the Federal government to promote the general welfare by ensuring a coordinated and effective administration of Federal energy policy and programs. Among the purposes of this Act was to:

A. Address the increasing shortage of non-renewable energy resources

B. Decrease the dependence of the U.S. on foreign energy supplies

C. Assure that a strong national energy program is established to meet future energy demands

D. Assume responsibility for energy policy, regulation, research and development

E. Provide a comprehensive, centralized coordination and control of energy supply and conservation programs

F. Advance the goals of restoring, protecting, and enhancing environmental quality, and ensure that public health and safety is maintained.

The Nuclear Waste Policy Amendments Act (NWPA) of 1982 provided for the development of repositories for the disposal of high-level radioactive waste and spent nuclear fuel, and established a program for the research, development, and demonstration regarding the disposal of high-level radioactive waste and spent nuclear fuel.

Congress found that a national problem had been created by the accumulation of spent nuclear fuel from nuclear reactors, radioactive waste from nuclear fuel reprocessing, radioactive waste from medical research and testing, and other sources. Subtitle A of the Act assigned the Federal government the responsibility to provide permanent disposal of high-level radioactive waste and spent nuclear fuel. The costs of such disposal would be the responsibility of the generators and owners of such waste and spent fuel. The owners would also have the responsibility to provide and carry the costs of interim storage until such waste is accepted by the Secretary of Energy for permanent disposal. Subtitle A requires the Secretary of Energy to establish a schedule for the siting, construction, and operation of high-level radioactive waste repositories that will provide assurance that the public and environment be adequately protected. Five candidate sites were to be established.

Subsequently, the Nuclear Waste Policy Amendments Act of 1987 (42 USC 10101) redirected the nuclear waste program. This amendment designated Yucca Mountain as the only candidate site for the DOE to expend characterization efforts upon. Accordingly, the Secretary of Energy directed the DOE to complete the site characterization of Yucca Mountain. [A statement similar to the following should be made in a potential license application: Following completion of the characterization of the site, the DOE has prepared and submitted this License Application.]

REFERENCES

MGDS Annotated Outline Planning Package
Form 1: Text

Date: 9/30/92

1. Section No. & Title: **1.2 BASIS FOR LICENSING AUTHORITY**

2. Lead Author & Phone No. Marshall Weaver (702) 794-1871

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/92

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
   (Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   This section specifies the basis for licensing authority.

6. Opening Statement:

   The DOE is subject to Federal law and NRC regulations applicable to the proposed high-level waste repository.

7. Main Body Outline:

   1.2 BASIS FOR LICENSING AUTHORITY

   Atomic Energy Act of 1954, as amended
   Energy Reorganization Act of 1974, as amended
   Nuclear Waste Policy Act of 1982, as amended
   10CFR 60.

8. Conclusion:

   [A statement similiar to the following should be made in a potential license application: The license application and its supporting documents are responsive to the requirements specified in the basis for Licensing Authority as delineated in this section.]

9. Support Authors & Their Assignments:

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 1.2 BASIS FOR LICENSING AUTHORITY

Lead Author & Phone No. Marshall Weaver (702) 794-1871

A. Figure No. **1.2A**

Caption: **Basis for Licensing Authority-Evolution and Hierarchy of Documents**

Content:

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title:

Content:

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title: **1.2 BASIS FOR LICENSING AUTHORITY**

Lead Author & Phone No. Marshall Weaver (702) 794-1871

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

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MGDS Annotated Outline Information Need Form
Form A: Information Request

Log No.
Date 9/30/92

1. Section No. & Title: **1.2 BASIS FOR LICENSING AUTHORITY**

2. Lead Author & Phone No.: Marshall Weaver (702) 794-1871

3. Work Location:

4. Type of information needed:

5. Type of format needed: County maps.

6. What is the information needed for? (e.g., Safety Analysis Section 3.2):

7. What group is the probable information supplier?

8. When is the information needed?

9. What kind of related information is already available in references, etc.? (List any known, related information sources):

10. Response by (name): Date:

11. Response:

Note: Attach additional sheets if necessary.

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form B: Information Response

1. Section No. & Title: **1.2 BASIS FOR LICENSING AUTHORITY**

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester): Marshall Weaver (702) 794-1871

Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

MGDS Annotated Outline

Section 1.3 Schedules

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1.3 SCHEDULES

Skeleton Text Has Not Been Developed For This Section

REFERENCES

1. Section No. & Title: **1.3 SCHEDULES**

2. Lead Author & Phone No. Jim Tiapale (702) 794-1831
by Bill Leonard, placeholder

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   This section presents the proposed schedules for construction, operation, receipt of waste, first emplacement of waste, and permanent closure of the high-level waste repository. [Coordinate with 7.7].

6. Opening Statement:

   [A statement similiar to the following should be made in a potential license application: The proposed schedule for key phases of activities associated with the high-level waste repository is presented in this section.]

7 Main Body Outline:

1.3 SCHEDULES

- Proposed schedules for construction (See Figure 1.3A)
- Proposed schedule for operations (See Figure 1.3B)
- Proposed schedule for receipt of waste (See Figure 1.3C)
- Proposed schedule for first emplacement of waste (See Figure 1.3D)
- Proposed schedule for permanent closure (See Figure 1.3E)
- Proposed overall schedule (See Figure 1.3F)
- Time requirements information from the Nuclear Waste Policy Act, as amended
- Information from DOE's mission plans
- Information from DOE's project decision schedules.

8. Conclusion:

[A statement similiar to the following should be made in a potential license application: The schedules represent realistic, achievable milestones for accomplishing key activities in a safe manner.]

9. Support Authors & Their Assignments:

MGDS Annotated Outline Planning Package Date: 9/30/92
Form 2: Figures & Tables

Section No. & Title: **1.3 SCHEDULES**

Lead Author & Phone No. Jim Tiapale (702) 794-1831
by Bill Leonard, placeholder

A. Figure No. **1.3A**

Caption: **Proposed Schedule for Construction**

Content:

Graphic representation of proposed schedule for construction, including prerequisite activities, material controls, quality controls, and certification(s) of completion/useability.

B. Figure No. **1.3B**

Caption: **Proposed Schedule for Operations**

Content:

Graphic representation of proposed schedule for operations, including prerequisite activities, training and qualification of personnel, etc.

C. Figure No. **1.3C**

Caption: **Proposed Schedule for Receipt of Waste**

Content:

Graphic representation of proposed schedule for receipt of waste, including prerequisite activities, completion and certification of waste container/packaging, transportation mode, surface facilities and repository, receipt and handling procedures (including quality control).

Section No. & Title: **1.3 SCHEDULES**

Lead Author & Phone No. Jim Tiapale (702) 794-1831
by Bill Leonard, placeholder

A. Figure No. 1.3D

Caption: **Proposed Schedule for First Emplacement of Waste**

Content:

Graphic representation of proposed schedule for first emplacement of waste, including prerequisite activities.

B. Figure No. 1.3E

Caption: **Proposed Schedule for Permanent Closure**

Content:

Graphic representation of proposed schedule for permanent closure of the repository, including prerequisite activities, acceptability of monitoring results, decontamination, and decommissioning of surface activities other than security and monitoring.

C. Figure No. 1.3F

Caption: **Proposed Overall Schedule**

Content:

Graphic representation of proposed schedule for all activities associated with the repository, including completion and acceptance of design, permitting and licensing, construction, operation, decontamination, closure, and decommissioning.

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title: **1.3 SCHEDULES**

Lead Author & Phone No.: Jim Tiapale (702) 794-1831
by Bill Leonard, placeholder

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

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MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Section No. & Title: **1.3 SCHEDULES**

2. Lead Author & Phone No.: Jim Tiapale (702) 794-1831
   by Bill Leonard, placeholder

3. Work Location:

4. Type of information needed:

5. Type of format needed:

6. What is the information needed for? (e.g., Safety Analysis Section 3.2):

7. What group is the probable information supplier?

8. When is the information needed?

9. What kind of related information is already available in references, etc.? (List any known, related information sources):

10. Response by (name): Date:

11. Response:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form
Form B: Information Response

Date: 9/30/92

1. Section No. & Title: **1.3 SCHEDULES**

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester): Jim Tiapale (702) 794-1831
   by Bill Leonard, placeholder

Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

Section 1.4 Certification of Safeguards

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1.4 CERTIFICATION OF SAFEGUARDS

Skeleton Text Has Not Been Developed For This Section [WJL-1]

REFERENCES

MGDS Annotated Outline Planning Package
Form 1: Text

Date: 9/30/92

1. Section No. & Title: **1.4 CERTIFICATION OF SAFEGUARDS**

2. Lead Author & Phone No. Marshall Weaver
(M.D. Ceraldi 704-382-1655)

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   This section is unique in that the details of Safeguards to physically protect the facility are exempt from disclosure to the public in accordance with 10 CFR 2.790(d). A separate submittal includes such items as area and facility maps detailing locations of safeguards, individual safeguards system descriptions, and evaluations of the adequacy of the safeguards in relation to the specific site. For purposes of the MGDS Safety Analysis Section and public disclosure, this section certifies that the resultant MGDS facility will be comparable to similar DOE surface facilities. These comparable facilities are be identified in this section.

6. Opening Statement:

   [A statement similiar to the following should be made in a potential license application: The Safeguards needed to protect the MGDS from intrusion, sabotage, and destructive acts are described along with the Physical Security Plan (Section 1.5) in a separate submittal.]

7. Main Body Outline:

1.4 Certification of Safeguards

- See opening statement.

8. Conclusion:

[A statement similiar to the following should be made in a potential license application: In accordance with 10 CFR 2.790(d), disclosure of information relating to security and facility safeguards may be withheld from the public. This section states this fact, and then it certifies that the resultant facility will contain adequate safeguards and protective security commensurate with other similar DOE surface facilities.]

9. Support Authors and Their Assignments

M.D. Ceraldi (DE & S)

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title:

Lead Author & Phone No.

A. Figure/Table No.

Caption/Title:

Content:

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title:

Content:

D. Figure/Table No.

Caption/Title:

Content:

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title: **1.4 CERTIFICATION OF SAFEGUARDS**

Lead Author & Phone No. Bill Leonard, placeholder for TBD
(702) 794-1821

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

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MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **WJL-1**

2. Section no. & title: **1.4 CERTIFICATION OF SAFEGUARDS**

3. Lead author & phone no: **W. J. Leonard (702) 794-1821**
   placeholder for TBD

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Names and locations of DOE surface facilities whose established safeguards programs offer protection against radiological sabotage that are considered to be suitable at the Yucca Mountain GROA.

7. What is the information needed for?

   YMP Licensing Application section 1.4.

8. What group is the probable information supplier?

   DOE OCRWM office of systems and compliance (RW-30).

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form B: Information Response

1. Section No. & Title: **1.4 CERTIFICATION OF SAFEGUARDS**

2. Lead Author & Phone No. Bill Leonard, placeholder for TBD
(702) 794-1821

3. Phone No.:

4. Lead Author (Requester): Marshall Weaver (702) 794-1871

Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Oultine Information Need Form Date: 9/30/92
Form C: Information Request Tracking Log

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

MGDS Annotated Outline

Section 1.5 Physical Security Plan

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1.5 PHYSICAL SECURITY PLAN

[The (to be developed) Mined Geologic Disposal System Physical Security Plan (PSP) will address physical security planning, safeguards contingency planning, design for physical security and security guard training pursuant to 10 CFR 60.21(b)(3) and 10CFR 60.21(b)(4). It will be comparable to other DOE surface facilities to promote common defense and security. The PSP will incorporate the applicable requirements of the Department of Energy Safeguards and Security Orders and will be designed to implement the protection program as described in the Master Safeguards and Security Agreement (MSSA) based on the vulnerability/risk analysis. [This may change and MSSA will not be used based upon current exemption request which has not been approved as of 08/25/92.] The PSP will be withheld from public disclosure, protected, and controlled in accordance with 10 CFR 2.790(d), and 10 CFR 73.21. The PSP will be submitted with the license application and made a part thereof.]

The plan will describe the safeguards and security program encompassing:

A. Protection program planning/MSSA
B. Protection program operations
C. Information security program
D. Operations security program
E. Computer security program
F. Testing and inspection program
G. Security and safeguards survey and facility approval

H. Local law enforcement agency (LLEA) interface

I. Nuclear material control and accounting program.

REFERENCES

1.5A Nuclear Regulatory Commission, 10 CFR, Code of Federal Regulations, 1986, Title 10, "Energy", Part 60. "Disposal of High Level Waste in Geologic Repositories," U.S. Government Printing Office, Washington, D.C.

1.5B Nuclear Regulatory Commission, 10 CFR, Code of Federal Regulations, 1986, Title 10, "Energy", Part 50, "Domestic Licensing of Production and Utilization Facilities", U.S. Government Printing Office, Washington, D.C.

1.5C Nuclear Regulatory Commission, 10 CFR, Code of Federal Regulations, 1986, Title 10, "Energy", Part 2, "Rules of Practice for Domestic Licensing Proceedings", U.S. Government Printing Office, Washington, D.C.

1.5D U. S. Department of Energy, Security and Safeguards Orders, 1988, DOE Order 5630.11, "Safeguards and Security Program", U. S. Government Printing Office, Washington, D.C.

1. Section No. & Title: 1.5 PHYSICAL SECURITY PLAN

2. Lead Author & Phone No. Steven E. LeRoy 702-794-7836
(Ron R. Eller-Support Author)

3. First Phase Planning Package Due: 6/21/91

Second Phase Planning Package Due: 10/18/91

First Phase Skeleton Draft Due: 12/30/91

Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

This section describes the plan for security measures for physical protection. The MGDS Physical Security Plan (PSP) will describe how the requirements of 10 CFR 60.21 (b) (3) are met. The PSP will describe tests and inspections that are performed to demonstrate compliance with the applicable requirements. The PSP is safeguards material and is a separate manual. Section 1.5.30 will describe how the Nuclear Material Control and Accounting Program (Section 1.5.30) interfaces with the MGDSPSP. Section 1.5.30 is written in a manner such that sensitive information is not compromised.

6. Opening Statement:

[A statement similar to the following should be made in a potential license application: The purpose of the PSP is to establish and maintain a physical security program that provides the capabilities for the protection of radiological materials stored in the MGDS. Title 10 Code of Federal Regulations Part 60 "Disposal of High Level Waste in Geological Repositories" Subpart B "License Applications" contains 60.21 "Content of Application". Title 10, Part 60, Section 60.21(b)(3) states that (The application must contain) " A certification that DOE will provide at the geologic repository operations area such safeguards as it requires at comparable surface facilities (of DOE) to promote the common defense and security." The MGDSPSP provides this assurance by having incorporated the applicable requirements of the Department of Energy Safeguards and Security Orders and is designed to implement the protection program as is described in the Master Safeguards and Security Agreement (MSSA) based on the vulnerability/risk analysis.]

7. Main Body Outline:

1.5 INTRODUCTION
- 1.5.1 DESIGN FOR PHYSICAL PROTECTION
- 1.5.2 SITE LOCATION AND DESCRIPTION
  - 1.5.2.1 SITE LOCATION
  - 1.5.2.2 SITE DESCRIPTION
  - 1.5.2.3 GENERAL SITE AREA ARRANGEMENT
  - 1.5.2.4 ACTIVITIES WITHIN THE SITE AREA BOUNDARY
  - 1.5.2.5 EARLY WARNING DETECTION SYSTEMS
- 1.5.3 DESIGN CRITERIA
- 1.5.4 DESIGN BASIS
- 1.5.5 PHYSICAL SECURITY PLAN
- 1.5.6 FACILITY DESCRIPTION
  - 1.5.6.1 STORAGE SYSTEM DESCRIPTION
- 1.5.7 FACILITY ENVIRONS
  - 1.5.7.1 LAYOUT
  - 1.5.7.2 MGDS PROTECTED AREA PERIMETER AND ISOLATION ZONE
  - 1.5.7.3 ILLUMINATION
  - 1.5.7.4 ASSESSMENT
  - 1.5.7.5 POWER SYSTEMS
  - 1.5.7.6 MOBILE PATROLS
  - 1.5.7.7 MGDS PROTECTED AREA GATES
  - 1.5.7.8 ACCESS CONTROL AND SEARCHES
  - 1.5.7.9 ESCORTS
  - 1.5.7.10 CONTROL OF VEHICLES WITHIN THE MGDS PROTECTED AREA
  - 1.5.7.11 COMMUNICATIONS
- 1.5.8 ALARM STATION(S)
  - 1.5.8.1 LOCATION AND LAYOUT
  - 1.5.8.2 PHYSICAL STRUCTURE
  - 1.5.8.3 ALARM MONITORING HARDWARE
- 1.5.9 SECURITY ORGANIZATION
- 1.5.10 SECURITY RESPONSE
- 1.5.11 LOCAL AND OTHER LAW ENFORCEMENT AGENCIES
- 1.5.12 SAFEGUARDS CONTINGENCIES
- 1.5.13 BACKGROUND
  - 1.5.13.1 MASTER SAFEGUARDS AND SECURITY AGREEMENT (MSSA)
  - 1.5.13.2 PERCEIVED DANGER
  - 1.5.13.3 PURPOSE
  - 1.5.13.4 SCOPE

1.5.14 GENERAL PLANNING BASE
- 1.5.14.1 EVENT 1 DAMAGE OR DEGRADATION OF SECURITY BARRIERS
- 1.5.14.2 EVENT 2 LOSS OR DEGRADATION OF MGDS PROTECTED AREA LIGHTING
- 1.5.14.3 EVENT 3 LOSS OR DEGRADATION OF SECURITY COMMUNICATIONS SYSTEMS
- 1.5.14.4 EVENT 4 LOSS OR DEGRADATION OF INTRUSION DETECTION HARDWARE
- 1.5.14.5 EVENT 5 LOSS OR DEGRADATION OF ALARM STATION
- 1.5.14.6 EVENT 6 ATTEMPTED OR CONFIRMED INTRUSION AT MGDS PROTECTED AREA PERIMETER
- 1.5.14.7 EVENT 7 DISCOVERY OF UNAUTHORIZED PERSONNEL, VEHICLES WITHIN THE MGDS PROTECTED AREA
- 1.5.14.8 EVENT 8 CIVIL DISTURBANCE
- 1.5.14.9 EVENT 9 UNAVAILABILITY OF SECURITY FORCE

1.5.15 LICENSEE PLANNING BASE
- 1.5.15.1 MGDS MANAGEMENT ORGANIZATION
- 1.5.15.2 LOCAL AND OTHER LAW ENFORCEMENT AGENCIES
- 1.5.15.3 ACCESS AUTHORIZATION

1.5.16 RESPONSIBILITY MATRIX

1.5.17 SECURITY PERSONNEL TRAINING PROGRAM

1.5.18 INSPECTIONS AND TESTS

1.5.19 INSPECTIONS

1.5.20 TESTS

1.5.21 SECURITY RECORD RETENTION

1.5.22 SECURITY PATROLS AND INSPECTIONS

1.5.23 MAINTENANCE

1.5.24 UNESCORTED AND ESCORTED ACCESS TO THE MGDS PROTECTED AREA
- 1.5.24.1 VEHICLES
- 1.5.24.2 PERSONNEL

1.5.25 MGDS PA KEY CONTROL

1.5.26 COMPENSATORY MEASURES

1.5.27 PERSONNEL SCREENING FOR UNESCORTED ACCESS AUTHORIZATION

1.5.28 SECURITY AUDITS

1.5.29 QUALITY OF THE SECURITY SYSTEM

1.5.30 NUCLEAR MATERIAL CONTROL AND ACCOUNTING PROGRAM (NMC&AP)

1.5.31 GENERAL DESCRIPTION OF NMC&AP

1.5.32 STANDARDS FOR QUALITY ASSURANCE OF RECORDS

1.5.33 QUALIFICATIONS FOR PERSONNEL RESPONSIBLE FOR PROGRAM IMPLEMENTATION AND OVERSIGHT

1.5.34 AUDITS OF RECORDS

1.5.35 ARCHIVING OF RECORDS

APPENDICES
GLOSSARY OF TERMS
ILLUSTRATIONS

8. Conclusion:

[A statement similar to the following should be made in a potential license application: In accordance with 10 CFR 2.790(d), disclosure of information relating to security and facility safeguards may be withheld from the public. This section states this fact and then describes in adequate detail the MGDS Physical Security Plan , which will not compromise the security of the facility by public disclosure. The requirements of this section meet the requirements of 10CFR 60.21(b)(3).]

9. Support Authors and Their Assignments

Ron R. Eller, Duke Power Company

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: **1.5 PHYSICAL SECURITY PLAN**

Lead Author & Phone No. Bill Leonard, placeholder for TBD
(702) 794-1871

A. Figure/Table No.

Caption/Title:

Content:

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title:

Content:

D. Figure/Table No.

Caption/Title:

Content:

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title: 1.5 PHYSICAL SECURITY PLAN

Lead Author & Phone No. Bill Leonard, placeholder for TBD
(702) 794-1821

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

1.

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6.

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The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: SEL-28
2. Section no. & title: 1.5 PHYSICAL SECURITY PLAN
3. Lead author & phone no: S. E. LeRoy (702) 794-7836
4. Information request date: 2/21/92
5. Work location: M&O - Las Vegas
6. Type of information needed:

7. What is the information needed for?

8. What group is the probable information supplier?

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):
12. Response date:
13. Response:

MGDS Annotated Outline Information Need Form
Form B: Information Response

Date: 9/30/92

1. Section No. & Title: **1.5 PHYSICAL SECURITY PLAN**

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester): Marshall Weaver (702) 794-1871

   Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Oultine Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

MGDS Annotated Outline

Section 1.6 Site Characterization Program Review

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1.6 SITE CHARACTERIZATION PROGRAM REVIEW

1.6.1 Site Characterization Work Conducted

The purpose of this section is to summarize the site characterization work conducted at the Yucca Mountain site. [The characterization will be conducted for the purposes of developing the design for the repository and the waste package; demonstrating the suitability of the site for a repository; preparing an environmental impact statement; and obtaining from the NRC an authorization to construct the repository via this license application.]

The Site Characterization Plan (SCP), reference 1.6A was developed in accordance with the requirements of the NWPA and the regulations promulgated by the NRC in Title 10, Code of Federal Regulations, Part 60 (10 CFR). The SCP includes a description of the Yucca Mountain site, a conceptual design for the repository, a description of the packaging to be used for the waste to be emplaced in the repository, and a description of the planned site characterization.

The SCP is divided into two parts. Part A of the SCP consists of Chapters 1 to 7, and provides a description of the site, the waste package, and the repository design. Part B consists of Chapter 8 and presents the DOE's plans for the site characterization program.

During site characterization at the Yucca Mountain site, the DOE reported every six months to the NRC, as well as to the governor and the legislature of the state of Nevada, on the nature and extent of site characterization activities, the information developed from such activities, and the progress on waste form and waste package research and development. These reports included the results of site characterization studies, the identification of new issues, plans for additional studies to resolve new issues, the identification of decision points reached, and modifications to schedules where appropriate. The reports also described progress in developing the repository design, noting when key design parameters or features depend on the results of site characterization will be established.

The Site Characterization Plan (SCP)(DOE/RW-0199) was issued on December 28, 1988. The public comment period for the SCP expired on June 1, 1989. The DOE received comments from the NRC on July 31, 1989, and from the state of Nevada on May 30, 1989, and September 1, 1989. Comments were also received from other federal agencies, interested parties, and the general public. All SCP comments were evaluated, and responses to the comments have been made. Formal responses to their comments have been published for the following organizations:

- California Energy Commission
- Environmental Protection Agency
- Edison Electric Institute
- U. S. Department of Interior
- State Of Nevada
- Lincoln County Board of Commissioners.

The reports which present these responses to comments on the SCP are listed with references for this section.

1.6.1.1 Summary of Site Characterization Work

This subsection summarizes the DOE's site characterization program actually conducted at the Yucca Mountain Site.

[NOTE: Work to be conducted as described in the SCP and its study plans will be summarized here. Those summaries will be revised to reflect actual work performed after it is completed.]

1.6.1.1.1 Site Program (SCP Section 8.3.1)

The site program was designed and performed to acquire the information about the site that is needed to resolve the design and performance issues.

1.6.1.1.1.1 Geohydrology (SCP Section 8.3.1.2)

This section presents a summary of the site characterization of the regional and local geohydrology. The program was developed and designed to understand the present and expected geohydrologic characteristics of each of the saturated and unsaturated flow regimes, and of the gaseous and water-vapor flow processes.

1.6.1.1.1.1.1 Investigation: Studies to provide a description of the regional hydrologic system (SCP Sec. 8.3.1.2.1)

1.6.1.1.1.1.1.1 Study: Characterization of the meteorology for the regional hydrology

A. Activity: Precipitation and meteorological monitoring. (SCP Sec. 8.3.1.2.1.1.1)

[The precipitation and meteorological monitoring study will be conducted to provide site specific information on precipitation at and near the network streamflow measurement sites.]

The parameters for the study are as follows:

- Precipitation amounts
- Surface temperatures
- Atmospheric pressure and pressure variability
- Relative humidity and diurnal humidity cycles and a seasonal variability
- Incoming and outgoing short wave radiation and its diurnal and seasonal variability
- Wind speed and direction and diurnal, seasonal, and storm-specific variability

The activities conducted to collect these parameters include: [To be added]

1.6.1.1.1.1.1.2 Study: Characterization of runoff and streamflow (SCP Sec. 8.3.1.2.1.2)

A. Activity: Surface runoff monitoring

B. Activity: Transport of debris by severe runoff (SCP Sec. 8.3.1.2.1.2.2)

1.6.1.1.1.1.1.3 Study: Characterization of the regional ground-water flow system (SCP Sec. 8.3.1.1.1.3)

A. Activity: Assessment of the regional hydrogeological data needs in the saturated zone. (SCP Sec. 8.3.1.2.1.3.1)

B. Activity: Regional potentiometric-level distribution and hydrogeologic framework studies (SCP Sec. 8.3.1.2.1.3.2)

C. Activity: Fortymile Wash recharge study (SCP Sec. 8.3.1.2.1.3.3)

D. Activity: Evaporatransporation studies (SCP Sec. 8.3.1.2.3.4).

1.6.1.1.1.1.1.4 Study: Regional hydrologic system synthesis and modeling (SCP Sec. 8.3.1.1.1.4).

A. Activity: Conceptualization of regional hydrologic flow models (SCP Sec. 8.3.1.1.1.4.1)

B. Activity: Subregional two-dimensional areal hydrologic modeling (SCP Sec. 8.3.1.2.1.4.2)

C. Activity: Subregional two-dimensional cross section hydrologic modeling (SCP Sec. 8.3.1.2.1.4.3)

D. Activity: Regional three-dimensional hydrologic modeling (SCP Sec. 8.3.1.2.1.4.4).

1.6.1.1.1.1.2 Investigation: Studies to provide a description of the unsaturated zone hydrologic system at the site. (SCP Sec. 8.3.1.2.2)

1.6.1.1.1.1.2.1 Study: Characterization of unsaturated-zone infiltration (SCP Sec. 8.3.1.2.2.1)

A. Activity: Characterization of hydrologic properties of surficial materials (SCP Sec. 8.3.1.2.2.1.1)

B. Activity: Evaluation of natural infiltration (SCP Sec. 8.3.1.2.2.1.2)

C. Activity: Evaluation of artificial infiltration (SCP Sec. 8.3.1.2.2.1.3).

1.6.1.1.1.1.2.2 Study: Water movement tracer tests using chloride and chlorine-36 measurements of percolation at Yucca Mountain (SCP Sec. 8.3.1.2.2.2).

A. Activity: Matrix hydrologic properties testing (SCP 8.3.1.2.2.3.1)

B. Activity: Site vertical borehole studies (SCP Sec. 8.3.1.2.2.3.2)

C. Activity: Solitario Canyon horizontal borehole study (SCP Study 8.3.1.2.2.3).

1.6.1.1.1.1.2.3 Study: Characterization of Yucca Mountain percolation in the unsaturated zone exploratory facility study (SCP Sec. 8.3.1.2.2.4).

A. Activity: Intact-fracture test in the exploratory studies facility (ESF) SCP Sec. 8.3.1.2.2.4.1)

B. Activity: Percolation tests in the ESF (SCP Sec. 8.3.1.2.2.4.2)

C. Activity: Bulk-permeability test in the ESF (SCP Sec. 8.3.1.2.2.4.3)

D. Activity: Radial borehole tests in the ESF (SCP Sec. 8.3.1.2.2.4.4)

E. Activity: Excavation effects test in the ESF SCP Sec. 8.3.1.2.2.4.5)

F. Activity: Calico Hills testing in the ESF (SCP Sec. 8.3.1.2.2.4.6)

G. Activity: Perched water test in the ESF (SCP Sec. 8.3.1.2.2.4.7)

H. Activity: Hydrochemistry tests in the ESF (SCP Sec. 8.3.1.2.2.4.8)

I. Activity: Multi purpose borehole testing (SCP Sec. 8.3.1.2.2.4.9)

J. Activity: Hydrologic properties of major faults encountered on main test level of the exploratory studies facility (SCP 8.3.1.2.2.4.10).

1.6.1.1.1.1.2.4 Study: Diffusion tests on the ESF (SCP Sec. 8.3.2.2.5)

A. Activity: Diffusion tests in the ESF (SCP Sec. 8.3.1.2.2.5.1)

1.6.1.1.1.1.2.5 Study: Characterization of gaseous-phase movement in the saturated zone (SCP Sec. 8.3.1.2.2.6).

A. Activity: Gaseous-phase circulation study (SCP Sec.8.3.1.2.2.6.1)

1.6.1.1.1.1.2.6 Study: Hydrochemical characterization of the unsaturated zone (SCP Sec. 8.3.1.2.2.7)

A. Activity: Gaseous-phase chemical investigations (SCP Sec. 8.3.1.2.2.7.1)

B. Activity: Aqueous-phase chemical investigations (SCP Sec. 8.3.1.2.2.7.2).

1.6.1.1.1.1.2.7 Study: Fluid Flow in Unsaturated Fractured Rock (SCP Sec. 8.3.1.2.8).

A. Activity: Development of conceptual and numerical models of fluid flow in unsaturated, fractured rock (SCP Sec. 8.3.1.2.2.8.1).

B. Activity: Validation of conceptual and numerical models of fluid flow through unsaturated, fractured rock (SCP Sec. 8.3.1.2.2.8.2)

1.6.1.1.1.1.2.8 Study: Site Unsaturated-zone Modeling and Synthesis (SCP Sec. 8.3.1.2.2.9)

A. Activity: Conceptualization of the unsaturated zone hydrogeologic system (SCP Sec. 8.3.1.2.2.9.1)

B. Activity: Selection, development, and testing of hydrologic-modeling computer codes (SCP Sec. 8.3.1.2.2.9.2)

C. Activity: Simulation of the natural hydrogeological system (SCP Sec. 8.3.1.2.2.9.3)

D. Activity: Stochastic modeling and uncertainty analysis (SCP Sec. *.3.1.2.2.9.4)

E. Activity: Site unsaturated zone integration and synthesis (SCP 8.3.1.2.2.9.5).

1.6.1.1.1.1.3 Investigation: Studies to provide a description of the saturated zone hydrologic systems (SCP Sec. 8.3.1.2.3)

1.6.1.1.1.2 Geochemistry (SCP 8.3.1.3)

1.6.1.1.1.2.1 Investigation: Studies to provide information on water chemistry within the potential emplacement horizon and along flow paths (SCP Sec. 8.3.1.3.1)

1.6.1.1.1.2.2 Investigation: Studies to provide information on mineralogy, petrology, and rock chemistry within the potential emplacement horizon and along flow paths (SCP Sec. 8.3.1.3.2)

1.6.1.1.1.2.3 Investigation: Studies to provide information required on stability of minerals and glasses (SCP Sec. 8.3.1.3.3)

1.6.1.1.1.2.4 Investigation: Studies to provide the information required on radionuclide retardation by sorption processes along flow paths to the accessible environment (SCP Sec. 8.3.1.3.4)

1.6.1.1.1.2.5 **Investigation: Studies to provide the information required on radionuclide retardation by precipitation processes along flow paths to accessible environment (SCP Sec. 8.3.1.3.5)**

1.6.1.1.1.2.6 **Investigation: Studies to provide the information on radionuclide retardation by dispersive, diffusive, and advective transport processes along flow paths to the accessible environment (SCP Sec. 8.3.1.3.6)**

1.6.1.1.1.2.7 **Investigation: Studies to provide the information required on radionuclide retardation by all processes along flow paths to the accessible environment (SCP Sec. 8.3.1.3.7)**

1.6.1.1.1.2.8 **Investigation: Studies to provide the required information on retardation of gaseous radionuclides along flow paths to the accessible environment (SCP Sec. 8.3.1.3.8)**

1.6.1.1.1.3 Rock Characteristics (SCP Sec. 8.3.1.4)

1.6.1.1.1.3.1 Investigation: Studies to develop an integrated drilling program and integration of geophysical activities (SCP Sec. 8.3.1.4.1)

1.6.1.1.1.3.2 Investigation: Studies on the geologic framework of the Yucca Mountain Site (SCP Sec. 8.3.1.4.2)

1.6.1.1.1.3.3 Investigation: Investigation of three dimensional models of rock characteristics at the repository site (SCP Sec. 8.3.1.4.3)

1.6.1.1.1.4 Climate Program (SCP Section 8.3.1.5)

1.6.1.1.1.4.1 Investigation: Studies to provide the information required on nature and rates of change in climatic conditions to predict future climates (SCP Sec. 8.3.1.5.1)

1.6.1.1.1.4.2 Investigation: Studies to provide the information required on the potential effects of future climatic conditions on hydrologic characteristics (SCP Sec. 8.3.1.5.2)

1.6.1.1.1.5 Erosion (SCP Sec. 8.3.1.6)

1.6.1.1.1.5.1 Investigation: Studies to determine to determine present locations and rates of surface erosion (SCP Sec. 8.3.1.6.1)

1.6.1.1.1.5.2 Investigation: Potential effects of future climatic conditions on locations and rates of erosion (SCP Sec. 8.3.1.6.2)

1.6.1.1.1.5.3 Investigation: Studies to provide the information required to determine the potential effects of future tectonic activity on locations and rates of erosion (SCP Sec. 8.3.1.6.3)

1.6.1.1.1.5.4 Investigation: Potential effects of erosion on hydrologic, geochemical, and rock characteristics (SCP Sec. 8.3.1.6.4)

1.6.1.1.1.6 Rock Dissolution (SCP Section 8.3.1.7

1.6.1.1.1.6.1 Investigation: Rates of dissolution of crystalline and noncrystalline components in tuff (SCP Sec. 8.3.1.7.1)

1.6.1.1.1.7 Tectonics (SCP Section 8.3.1.8)

1.6.1.1.1.7.1 Investigation: Studies to provide information required on direct releases resulting from volcanic activity (SCP Sec. 8.3.1.8.1)

1.6.1.1.1.7.2 Investigation: Studies to provide information required on rupture of waste packages due to tectonic events (SCP Sec. 8.3.1.8.2)

1.6.1.1.1.7.3 Investigations: Studies to provide information required on changes in unsaturated and saturated zone hydrology due to tectonic events (SCP Sec.8.3.1.8.3)

1.6.1.1.1.7.4 Investigation: Studies to provide information required on changes in rock geochemical properties resulting from tectonic processes (SCP Sec. 8.3.1.8.4)

1.6.1.1.1.7.5 Investigation: Studies to provide the information required by the analysis and assessment investigations of the tectonics program (SCP Sec. 8.3.1.8.5)

1.6.1.1.1.8 Human Interference (SCP Section 8.3.1.9)

1.6.1.1.1.8.1 Investigation: Studies to provide the information required on natural phenomena and human activities that might degrade surface markers and monuments (SCP Sec. 8.3.1.9.1)

1.6.1.1.1.8.2 Investigation: Studies to provide the information required on present and future value of energy, mineral, land, and groundwater resources (Sec. 8.3.1.9.2)

1.6.1.1.1.8.3 Investigation: Studies to provide the information required on potential effects of exploiting natural resources on hydrologic, geochemical, and rock characteristics (Sec. 8.3.1.9.3)

1.6.1.1.1.9 Population (SCP Section 8.3.1.10)

1.6.1.1.1.10 Land Ownership (SCP Section 8.3.1.11)

1.6.1.1.1.11 Meteorology (SCP Section 8.3.1.12)

1.6.1.1.1.11.1 Investigation: Studies to provide data on regional meteorological conditions (SCP Sec. 8.3.1.12.1)

1.6.1.1.1.11.2 **Investigation: Studies to provide data on atmospheric and meteorological phenomena at potential locations of surface facilities (SCP Sec. 8.3.1.12.2)**

1.6.1.1.1.11.3 **Investigation to provide data on the location of population centers relative to wind patters in the general region of the site (SCP Sec. 8.3.1.12.3)**

1.6.1.1.1.11.4 **Investigation: Studies to provide data on potential extreme weather phenomena and their recurrence intervals (SCP Sec. 8.3.1.12.4)**

1.6.1.1.1.12 **Offsite Installation and Operations Program (SCP Section 8.3.1.13)**

1.6.1.1.1.12.1 **Investigation: Determination of nearby industrial, transportation, and military installations and operations (nuclear and nonnuclear) (SCP Sec. 8.3.1.13.1)**

1.6.1.1.1.12.2 **Investigation: Potential impacts of nearby installations and operations (SCP Sec. 8.3.1.13.2)**

1.6.1.1.1.13 Surface Characteristics (SCP Section 8.3.1.14)

1.6.1.1.1.13.1 Investigation: Studies to provide the topographic characteristics of potential locations of surface facilities (SCP Sec. 8.3.1.14.1)

1.6.1.1.1.13.2 Investigation: Studies to provide soil and rock properties of potential locations of surface facilities (SCP Sec. 8.3.1.14.2)

1.6.1.1.1.14 Thermal And Mechanical Rock Properties (SCP Section 8.3.1.15)

1.6.1.1.1.14.1 Studies to provide the required information for spatial distribution of thermal and mechanical properties (SCP Sec. 8.3.1.15.1)

1.6.1.1.1.14.2 Studies to provide the required information for spatial distribution of ambient stress and thermal conditions (SCP Sec. 8.3.1.15.2)

1.6.1.1.1.15 Preclosure Hydrology Program (SCP Section 8.3.1.16)

1.6.1.1.1.15.1 Investigation: Flood recurrence intervals and levels at potential locations surface facilities (SCP Sec. 8.3.1.16.1)

1.6.1.1.1.15.2 Investigation: Location of adequate water supplies (SCP Sec. 8.3.1.16.2)

1.6.1.1.1.15.3 Investigation: Ground-water conditions within and above the potential host rock (SCP Sec. 8.3.1.16.3)

1.6.1.1.1.16 Preclosure Tectonics (SCP Section 8.3.1.17)

1.6.1.1.1.16.1 Investigation: Studies to provide required information on volcanic activity that could affect repository design or performance (SCP Sec. 8.3.1.17.1)

1.6.1.1.1.16.2 **Investigation: Studies to provide required information on fault displacement that could affect repository design or performance (SCP Sec. 8.3.1.17.2)**

1.6.1.1.1.16.3 **Investigation: Studies to provide required information on vibratory ground motion that could affect repository design or performance (SCP Sec. 8.3.1.17.3)**

1.6.1.1.1.16.1 **Investigation: Preclosure tectonics data collection and analysis (SCP Sec. 8.3.1.17.4)**

1.6.1.1.2 Repository Program (SCP Section 8.3.2)

1.6.1.1.3 Seal Program (SCP Section 8.3.3)

1.6.1.1.4 Waste Package Program (SCP Section 8.3.4)

1.6.1.1.5 Performance Assessment (PA) Program (SCP Section 8.3.5)

1.6.1.2 Differences Between Characterization Work and the SCP

[If the characterization work conducted differs from the SCP, a statement similiar to the following will be made: Portions of the site characterization work conducted differed from the work described in the Site Characterization Plan (SCP). These changes were generally the result of additional information providing different direction or design considerations. These changes have been reported semi-annually in progress reports and in the study report. Table 1.6.1A lists the changes in the program. The table identifies the area in the SCP that the work occurred, the cause of the change, and if the change has not been previously reported.]

1.6.2 Status of DOE Resolution of NRC Objections

No Skeleton Text Developed.

Table 1.6.1A. SCP PROGRAM CHANGES [CJG-7]

SCP Section	SCP Activity	Change of Activitiy	Cause of Activity Change	Result of Activity Change	Remarks
8.1.1X					

REFERENCES

1.6A DOE (U.S. Department Of Energy), December 1988, Site Characterization Plan, Yucca Mountain Site, Nevada Research and Development Area, Nevada, 8 Volumes, DOE/RW--0199, Washington, DC.

1.6B DOE (U.S. Department Of Energy), February 1990, Progress Report on the Scientific Investigation Program for the Nevada Yucca Mountain Site, September 15, 1988 - August 15, 1989, April 16 - September 30, 1989, DOE/RW-0217P, Washington DC.

1.6C DOE (US Department of Energy), 1990a. Responses to California Energy Commission Comments on the Site Characterization Plan, YMP90-97, Yucca Mountain Project Office, Las Vegas, 46p.

1.6D DOE (U.S. Department of Energy), 1990b. Responses to Lincoln County Board of Commissioners' Comments on the Site Characterization Plan, YMP90-103, Yucca Mountain Project Office , Las Vegas, 11p.

1.6E DOE (U.S. Department of Energy), 1990c. Responses to Environmental Protection Agency Comments on the Site Characterization Plan, YMP90-101, Yucca Mountain Project Office, Las Vegas, 16p.

1.6F DOE (U.S. Department of Energy), 1990d. Responses to Edison Electric Institute Comments on the Site Characterization Plan, YMP90-99, Yucca Mountain Project Office, Las Vegas, 42p.

1.6G DOE (U.S. Department of Energy), 1990e. Responses to U.S. Department of Interior Comments on the Site Characterization Plan, YMP90-98, Yucca Mountain Project Office, Las Vegas, 43p.

1.6H NRC (U.S. Nuclear Regulatory Commission), August 1990, NRC Staff Site Characterization, Analysis of the Department of Energy's Site Characterization Plan, Yucca Mountain Site, Nevada, NUREG-1347.

1. Section No. & Title: 1.6 SITE CHARACTERIZATION PROGRAM REVIEW

2. Lead Author & Phone No. Clem Goewert
(702) 794-1859

3. First Phase Planning Package Due: .6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   This section summarizes site characterization work actually conducted at the site, compares the work done to the work planned, and discusses differences, if any, between the two. In addition, the status of DOE resolution of NRC objections to license application submittals is detailed.

6. Opening Statement:

   [A statement similiar to the following should be made in a potential license application: This summary includes site characterization work actually conducted at the site, compares the work done to the work planned, and discusses differences, if any. The status of DOE resolution of NRC objectives to license application submittals is also discussed.]

7. Main Body Outline:

   1.6 Site Characterization Program Review

   1.6.1 Site Characterization Work Conducted
   1.6.1.1 Summary of site Characterization Work
   1.6.1.1.1 Site Work
   1.6.1.1.1.1 Geohydrology
   1.6.1.1.1.2 Geochemistry
   1.6.1.1.1.3 Rock Characteristics
   1.6.1.1.1.4 Climate Program
   1.6.1.1.1.5 Erosion
   1.6.1.1.1.6 Rock Dissolution

7. Main Body Outline (Continued)

1.6.1.1.1.7 Tectonics
1.6.1.1.1.8 Human Interference
1.6.1.1.1.9 Population
1.6.1.1.1.10 Land Ownership
1.6.1.1.1.11 Meteorology
1.6.1.1.1.12 Offsite Installation and Operations Program
1.6.1.1.1.13 Surface Characteristics
1.6.1.1.1.14 Thermal And Mechanical Properties
1.6.1.1.1.15 Preclosure Hydrology Program
1.6.1.1.1.16 Preclosure Tectonics
1.6.1.1.2 Repository Program
1.6.1.1.3 Seal Program
1.6.1.1.4 Waste Package Program
1.6.1.1.5 Performance Assessment Program

1.6.1.2 Differences Between Characterization Work and the SCP

8. Conclusion:

[A statement similiar to the following should be made in a potential license application: The site characterization work actually performed at the site was either accomplished as planned or satisfactory rationale is provided to support the variance from the plan. The status of DOE resolution of NRC objections to license application submittals either describes the resolution or satisfactorily explains progress towards resolution.]

9. Support Authors & Their Assignments:

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 1.6 SITE CHARACTERIZATION PROGRAM REVIEW

Lead Author & Phone No. Clem Goewert
(702) 794-1859

A. Figure/Table No.

Caption/Title:

Content:

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title:

Content:

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title: 1.6 SITE CHARACTERIZATION PROGRAM REVIEW

Lead Author & Phone No. Clem Goewert
(702) 794-1859

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer' Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

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The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: CJG-7

2. Section no. & title: 1.6.2 DIFFERENCES BETWEEN CHARACTERIZATION WORK AND THE SCP

3. Lead author & phone no: Clem Goewert (702) 794-1859

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   A summary report on all differences between work performed and work described in the SCP. The information is preferred to be provided in a table. It is recommended that all changes in work described in the SCP be documented and tracked as changes throughout the studies and work.

7. What is the information needed for?

   This information is needed in order to meet the reporting requirements in the FCRG Section 1.6.1, Site Characterization Work Conducted. "If the completed work differs from that described in the Site Characterization Plan, semi-annual progress reports, and study plans, DOE should identify the differences and explain why such work differed."

8. What group is the probable information supplier?

9. When is the information needed?

   6 months prior to filing the License Application.

10. What kind of related information is already available in references, etc.?

    No information is available since only limited site characterization is available.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form B: Information Response

1. Section No. & Title: **1.6 SITE CHARACTERIZATION PROGRAM REVIEW**

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester): Clem Goewert
(702) 794-1859

Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

Section 1.7 Statement of Compliance with the Performance Objectives of 10 CFR 60 and Summary of Performance Assessment Results

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1.7 STATEMENT OF COMPLIANCE WITH THE PERFORMANCE OBJECTIVES OF 10 CFR 60 AND SUMMARY OF PERFORMANCE ASSESSMENT RESULTS

[The following discussions describe whether the respository systems meet the performance objectives of 10 CFR 60.111, 112, and 113. A summary of the performance assessment discussed in Chapter 6 will also be provided. SEL-29]

REFERENCES

1. Section No. & Title: 1.7 STATEMENT OF COMPLIANCE WITH THE PERFORMANCE OBJECTIVES OF 10 CFR 60 AND SUMMARY OF PERFORMANCE ASSESSMENT RESULTS

2. Lead Author & Phone No. Bill Leonard, placeholder for TBD
(702) 794-1821

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   This section contains brief discussions, based on the information in the System Analysis sections, Chapters 3 through 6, describing how the repository systems meet the performance objectives contained in 10 CFR 60.112, 113, and 114. It also summarizes the results of the performance assessment in Safety Analysis Section Chapter 6.

6. Opening Statement:

   [A statement similiar to the following should be made in a potential license application: The following discussions describe whether the repository systems meet the performance objectives of 10 CFR 60.112, 113, and 114. Also summarized are the results of the performance assessment in Chapter 6.]

7. Main Body Outline:

   - Descriptions of how the repository systems meet the performance objectives of 10 CFR 60.112, .113, and .114.

   - Overall System Performance

     - Selection of geologic setting assures that releases of radioactive materials to accessible environment following permanent closure meet applicable environmental standards.

7. Main Body Outline (Continued)

    - Design assures that releases of radioactive materials to accessible environment following permanent closure meet applicable environmental standards.

- Engineered Barrier Systems (EBS) Performance

    - Substantially complete containment of high-level wastes within the waste packages for a period not less than 300 years nor more than 1000 years following repository closure

    - Gradual process of radionuclide release from EBS resulting in small fraction released to the geologic setting over long times

    - For disposal in the saturated zone, both the partial and complete filling with ground water of available void spaces in the underground facility have been appropriately considered and analyzed among the anticipated processes and events in designing the engineered barrier system.

    - Containment of high-level waste within the waste packages will be substantially complete for a period TBD by NRC, but not less than 300 years nor more than 1,000 years after permanent closure of the repository.

    - The release rate of any radionuclide from the engineered barrier system following the containment period will not exceed one part in 100,000 per year of the inventory of that radionuclide calculated to be present 1,000 years following permanent closure, or such other fraction of the inventory as may be specified or approved by NRC.

    - This requirement does not apply to any radionuclide which is released at a rate less than 0.1% of the calculated total release rate limit.

- Geologic Setting

    - The geologic repository is located so that pre-waste emplacement ground water travel time along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment shall at least 1,000 years or such other travel time as may be specified or approved by NRC.

- Summary of results of the performance assessment described in Chapter 6.

8. Conclusion:

9. Support Authors and Their Assignments

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 1.7 STATEMENT OF COMPLIANCE WITH PERFORMANCE OBJECTIVES OF 10 CFR 60 AND SUMMARY OF PERFORMANCE ASSESSMENT RESULTS

Lead Author & Phone No. Bill Leonard, placeholder for TBD
(702) 794-1821

A. Figure/Table No.

Caption/Title:

Content:

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title:

Content:

MGDS Annotated Outline Planning Package Date: 9/30/92
Form 3: References

Section No. & Title: **1.7 STATEMENT OF COMPLIANCE WITH THE PERFORMANCE OBJECTIVES OF 10 CFR 60 AND SUMMARY OF PERFORMANCE ASSESSMENT RESULTS**

Lead Author & Phone No. Bill Leonard, placeholder for TBD
(702) 794-1821

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer' Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

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MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: SEL-29
2. Section no. & title: 1.7 STATEMENT OF COMPLIANCE WITH THE PERFORMANCE OBJECTIVES OF 10 CFR 60 AND SUMMARY OF PERFORMANCE ASSESSMENT RESULTS
3. Lead author & phone no: S. E. LeRoy (702) 794-7836
4. Information request date: 2/21/92
5. Work location: M&O - Las Vegas
6. Type of information needed:

   Text generated based upon the results of that contained in Chapters 3, 4, 5, and 6. This text should be written to demonstrate the overall theme/approach used throughout the license application. See attachment for example.

7. What is the information needed for?

8. What group is the probable information supplier?

   Jim Duguid.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None identified.

---

11. Response by (name):
12. Response date:
13. Response:

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

Attachment to Information Request Form SEL-29

Example

[The MGDS safety arguments are based upon system components which are shown to be robust using a conservative performance assessment approach. The waste package is shown to exceed the required life of 300 to 1000 years by a factor of 33 to 10. The engineered barrier surrounding the waste package is shown to retard radionuclide transport for ? years should a package fail. The repository has been designed to prevent liquid from contacting the waste package. The natural barrier system has been shown to significantly retard radionuclide migration to the accessible environment under scenarios that could cause premature waste package failure. The multbarrier system has been shown using conservative analyses to provide complete containment, and each component (e.g., the engineered barrier system and the natural barrier system) have been shown to independently meet the requirement of waste containment for 10,000 years. The defense in depth approach is demonstrated throughout this license application.]

MGDS Annotated Outline Information Need Form
Form B: Information Response

Date: 9/30/92

1. Section No. & Title: **1.7 STATEMENT OF COMPLIANCE WITH THE PERFORMANCE OBJECTIVES OF 10 CFR 60 AND SUMMARY OF PERFORMANCE ASSESSEMENT RESULTS**

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester): Marshall Weaver (702) 794-1871

Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

Chapter 2.0 General Information for the Safety Analysis Report

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2.0. GENERAL INFORMATION FOR THE SAFETY ANALYSIS REPORT

2.0.1 Overview And Summary Of MGDS Project

2.0.2 SAR Organization

2.0.3 Supporting Information

Skeleton Text Has Not Been Developed For This Section

1. Section No. & Title: 2.0 GENERAL INFORMATION FOR THE SAFETY ANALYSIS REPORT

2. Lead Author & Phone No. T. M. Williamson 702-794-1821
(Marshall Weaver 702-794-1871)
(M.D. Ceraldi 704-382-1655)

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

This section consists of a brief overview and summary of the Mined Geologic Disposal System (MGDS) Project, including the organization of the safety analysis sections, and it will also discuss supporting information for the safety analysis sections. The information presented in this section is general in nature; other safety analysis sections will provide appropriate detail for the license application process. A general description of the MGDS is provided in Section 1.1.

6. Opening Statement:

The Mined Geologic Disposal System (MGDS) is a U.S. Department of Energy (DOE) project aimed at providing a workable geologic repository for radioactive High Level Waste (HLW) produced by the U.S. domestic commercial nuclear industry and the U.S. defense industries.

7 Main Body Outline:

2.0.1 Overview and Summary of MGDS Project

- Brief history of Project. This gives the reader an appreciation of what follows and sets the tone for the remainder of the safety analysis sections.

7. Main Body Outline (Continued)

2.0.2 SAR Organization

- Breakdown of chapters with a summary of each chapter's content.

2.0.3 Supporting Information

- Description of types of supporting information to be used in the safety analysis sections
- List of various sources
- Reference Sections 2.3 and 2.4 for use of NRC technical positions and requirements for further technical information respectively.
- [The FCRG requests the project description be done in terms of the systems organizational approach of the draft regulatory guide. Use the Catawba FSAR as a guide for this introductory section.]

8. Conclusion:

This section provides introductory material to generally describe the MGDS in terms of program, license application contents, and documentation used to prepare the license application.

9. Support Authors & Their Assignments:

M.D. Ceraldi (DE & S)

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 2.0 GENERAL INFORMATION FOR THE SAFETY ANALYSIS REPORT

Lead Author & Phone No. T. M. Williamson 702-794-1821
(Marshall Weaver 702-794-1871)
(M.D. Ceraldi 704-382-1655)

A. Figure/Table No.

Caption/Title:

Content:

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title:

Content:

Section No. & Title: 2.0 GENERAL INFORMATION FOR THE SAFETY ANALYSIS REPORT

Lead Author & Phone No. T. M. Williamson 702-794-1821
(Marshall Weaver 702-794-1871)
(M.D. Ceraldi 704-382-1655)

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

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MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number:
2. Section no. & title: **2.0 GENERAL INFORMATION FOR THE SAFETY ANALYSIS REPORT**
3. Lead author & phone no: **T.M. Williamson (702) 794-1821**
   Marshall Weaver (702) 794-1871
   M.D. Ceraldi (704) 382-1655
4. Information request date:
5. Work location:
6. Type of information needed:
7. What is the information needed for?
8. What group is the probable information supplier?
9. When is the information needed?
10. What kind of related information is already available in references, etc.?

---

11. Response by (name):
12. Response date:
13. Response:

MGDS Annotated Outline Information Need Form
Form B: Information Response

Date: 9/30/92

1. Section No. & Title: 2.0 GENERAL INFORMATION FOR THE SAFETY ANALYSIS REPORT

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester): Jim Duguid 703-204-8851

   Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log Number on this form should be identical to the Log Number of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form C: Information Request Tracking Log

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

MGDS Annotated Outline

Section 2.1 Identification of Agents and Contractors

TABLE OF CONTENTS

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2.1 IDENTIFICATION OF AGENTS AND CONTRACTORS

[The prime agents and contractors for the design, construction, and operation of the Mined Geologic Disposal System (MGDS) will be identified in this section. Also to be identified will be the principal consultants and outside service organizations, including quality assurance (QA) auditors (if any). The division of work between agents, contractors, consultants, and outside service organizations will be clearly delineated.]

2.1.1 Design Agents and Contractors

[The design agents and contractors responsible for the MGDS design will be identified in Table 2.1A, Agents and Contractors Responsible for MGDS Design. The MGDS design organization is illustrated in Figure 2.1A, Design Organization.]

2.1.2 Construction Agents and Contractors

[The construction agents and contractors responsible for the MGDS design are identified in Table 2.1B, Agents and Contractors Responsible for MGDS Construction. The MGDS construction organization is illustrated in Figure 2.1B, Construction Organization.]

2.1.3 Operations Agents and Contractors

[The agents and contractors responsible for the MGDS operations are identified in Table 2.1C, Agents and Contractors Responsible for MGDS Operations. The MGDS operations organization is illustrated in Figure 2.1C, Operations Organization.]

2.1.4 Consultants and Outside Service Organizations

[The consultants and outside service organizations are identified in Table 2.1D, Consultants and Outside Service Organizations.]

Table 2.1A. Agents and Contractors Responsible for MGDS Design

Agent/Contractor	Address	Technical Work Area
	TMW-1	

Table 2.1B. Agents and Contractors Responsible for MGDS Construction

Agent/Contractor	Address	Technical Work Area
	TMW-2	

Table 2.1C. Agents and Contractors Responsible for MGDS Operations

Agent/Contractor	Address	Technical Work Area
	TMW-3	

Table 2.1D. Consultants and Outside Service Organizations

Agent/Contractor	Address	Technical Work Area
	TMW-4	

Figure 2.1A. Design Organization

TMW-5

Figure 2.1B. Construction Organization

TMW-6

Figure 2.1C. Operations Organization

TMW-7

1. Section No. & Title: 2.1 IDENTIFICATION OF AGENTS AND CONTRACTORS

2. Lead Author & Phone No. T. M. Williamson (702) 794-1821
   Marshall Weaver (702) 794-1871

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
   (Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   This section identifies the prime agents and contractors for the design, construction, and operation of the HLW repository. The principal consultants and outside service organizations are identified. The division of technical work areas among the agents and contractors is delineated.

6. Opening Statement:

7. Main Body Outline:

   2.1.0 Introduction
   2.1.1 Design Agents and Contractors
   2.1.2 Construction Agents and Contractors
   2.1.3 Operations Agents and Contractors
   2.1.4 Consultants and Outside Service Organizations

8. Conclusion:

9. Support Authors & Their Assignments:

   Note: As appropriate, attach forms specifying figures and tables, references, and information needs. Consult Annotated Outline Management Plan for more detailed instructions.

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: **2.1 IDENTIFICATION OF AGENTS AND CONTRACTORS**

Lead Author & Phone No. T.M. Williamson (702) 794-1821
Marshall Weaver (702) 794-1871

A. Figure No. **2.1A**

Caption: **Design Organization**

Content: Organization chart for design, including principal area of responsibility.

B. Table No. **2.1A**

Title: **Agents and Contractors Responsible for MGDS Design**

Content: This table shows the prime agents and contractors during design. It will delineate the division of technical work areas between each.

C. Table No. **2.1B**

Title: **Agents and Contractors Responsible for MGDS Construction**

Content: This table shows the prime agents and contractors during construction. It will delineate the division of technical work areas between each.

Date: 9/30/92

Section No. & Title: **2.1 IDENTIFICATION OF AGENTS AND CONTRACTORS**

Lead Author & Phone No. T.M. Williamson (702) 794-1821
Marshall Weaver (702) 794-1871

A. Table No. **2.1C**

Title: **Agents and Contractors Responsible for MGDS Operations**

Content: This table shows the prime agents and contractors during construction. It will delineate the division of technical work areas between each.

B. Figure No. **2.1B**

Caption: **Construction Organization**

Content: Organization chart for construction, including principal area of responsibility.

C. Figure No. **2.1C**

Caption: **Operation Organization**

Content: Organization chart for operation, including principal area of responsibility .

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: **2.1 IDENTIFICATION OF AGENTS AND CONTRACTORS**

Lead Author & Phone No. Marshall Weaver (702) 794-1871

A. Table No. **2.1D**

Title: **Consultants and Outside Service Organizations**

Content: This table will show the outside service organizations during design. It will delineate the division of technical work areas between each.

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title::

Content:

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title: 2.1 IDENTIFICATION OF AGENTS AND CONTRACTORS

Lead Author & Phone No.: T.M. Williamson 702- 794-1821
Marshall Weaver 702-794-1871

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

1. [M&O believes that the DOE has done some analysis on this subject. We need to find out where it is documented.]

2.

3.

4.

5.

6.

7.

8.

MGDS Annotated Outline Information Need Form **Date: 9/30/92**
Form A: Information Request

1. Log number: **TMW-1**

2. Section no. & title: **2.1 IDENTIFICATION OF AGENTS AND CONTRACTORS**

3. Lead author & phone no: **T. M. Williamson (702) 794-1821**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Company names, addresses, and technical scope of work for all agents and contractors involved in MGDS design.

7. What is the information needed for?

   SAR Section 2.1.

8. What group is the probable information supplier?

   M&O.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: TMW-2

2. Section no. & title: 2.1 IDENTIFICATION OF AGENTS AND CONTRACTORS

3. Lead author & phone no: T. M. Williamson (702) 794-1821

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Company names, addresses, and technical scope of work for all agents and contractors involved in MGDS construction.

7. What is the information needed for?

   SAR Section 2.1.

8. What group is the probable information supplier?

   M&O.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **TMW-3**

2. Section no. & title: **2.1 IDENTIFICATION OF AGENTS AND CONTRACTORS**

3. Lead author & phone no: **T. M. Williamson (702) 794-1821**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Company names, addresses, and technical scope of work for all agents and contractors involved in MGDS operations.

7. What is the information needed for?

   SAR Section 2.1.

8. What group is the probable information supplier?

   M&O.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **TMW-4**

2. Section no. & title: **2.1 IDENTIFICATION OF AGENTS AND CONTRACTORS**

3. Lead author & phone no: **T. M. Williamson (702) 794-1821**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Company names, addresses, and technical scope of work for all consultants and outside service organizations involved in MGDS design, construction, and operations.

7. What is the information needed for?

   SAR Section 2.1.

8. What group is the probable information supplier?

   M&O.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1.	Log number:	TMW-5
2.	Section no. & title:	2.1 IDENTIFICATION OF AGENTS AND CONTRACTORS
3.	Lead author & phone no:	T. M. Williamson (702) 794-1821
4.	Information request date:	2/21/92
5.	Work location:	M&O - Las Vegas

6. Type of information needed:

   Organization chart for all agents and contractors involved in MGDS design.

7. What is the information needed for?

   SAR Section 2.1.

8. What group is the probable information supplier?

   M&O.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None.

---

11. Response by (name):

12. Response date:

13. Response:

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **TMW-6**

2. Section no. & title: **2.1 IDENTIFICATION OF AGENTS AND CONTRACTORS**

3. Lead author & phone no: **T. M. Williamson (702) 794-1821**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Organization chart for all agents and contractors involved in MGDS construction.

7. What is the information needed for?

   SAR Section 2.1.

8. What group is the probable information supplier?

   M&O.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: TMW-7

2. Section no. & title: 2.1 IDENTIFICATION OF AGENTS AND CONTRACTORS

3. Lead author & phone no: T. M. Williamson (702) 794-1821

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Organization chart for all agents and contractors involved in MGDS operations.

7. What is the information needed for?

   SAR Section 2.1.

8. What group is the probable information supplier?

   M&O.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    None.

---

11. Response by (name):

12. Response date:

13. Response:

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Information Need Form
Form B: Information Response

Date: 9/30/92

1. Section No. & Title: **2.1 IDENTIFICATION OF AGENTS AND CONTRACTORS**

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester): T. M. Williamson (702) 794-1821

   Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date: February 8, 1992

Lead Author: T.M. Williamson 702-794-1821

Log No.	Section	Date Issued	Date Response Received
TMW-1	2.1	TBD	
TMW-2	2.1	TBD	
TMW-3	2.1	TBD	
TMW-4	2.1	TBD	
TMW-5	2.1	TBD	
TMW-6	2.1	TBD	
TMW-7	2.1	TBD	

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Section 2.2 Material Incorporated by Reference

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2.2 MATERIAL INCORPORATED BY REFERENCE

Skeleton Text Has Not Been Developed For This Section

MGDS Annotated Outline Planning Package
Form 1: Text

Date: 9/30/92

1. Section No. & Title: **2.2 MATERIAL INCORPORATED BY REFERENCE**

2. Lead Author & Phone No. T.M. Williamson (702) 794-1821
   Marshall Weaver (702) 794-1871

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
   (Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   This section provides a list of all topical and issue-resolution reports that are incorporated by reference as part of the safety analysis report (SAR). Included in this section are references to non-proprietary summary descriptions of the general content of reports proposed to be withheld from public disclosure pursuant to 10CFR2.790(b) as propriety documents.

6. Opening Statement:

7. Main Body Outline:

   Identify scope of reports.
   Define terms: topical or issue-resolution reports
   proprietary reports
   Explain referencing system
   Explain summarization requirements (summary required for test and analysis reports, and reports submitted in connection with other applications).
   Refer to Table 2.2A

8. Conclusion:

9. Support Authors & Their Assignments:

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: **2.2 MATERIAL INCORPORATED BY REFERENCE**

Lead Author & Phone No. T.M. Williamson (702)-794-1821
Marshall Weaver (702) 794-1871

A. Table No. 2.2A

Title: **Referenced Topical and Issue-Resolution Reports**

Content:

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title:

Content:

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title: 2.2 MATERIAL INCORPORATED BY REFERENCE

Lead Author & Phone No. T. M. Williamson 702-794-1821
(Marshall Weaver 702-794-1871)
(M.D. Ceraldi 704-382-1655)

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

1.

2.

3.

4.

5.

6.

7.

8.

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: TMW-8

2. Section no. & title: **2.2 MATERIAL INCORPORATED BY REFERENCE**

3. Lead author & phone no: **T. M. Williamson (702) 794-1821**
   Marshall Weaver (702) 794-1871

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Table 2.2A entry data for all applicable references.

7. What is the information needed for?

   SAR Section 2.2: Ensure all reports filed separately with NRC in support of the MGDS SAR are identified.

8. What group is the probable information supplier?

   All section lead authors must identify referenced material.

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

    Licensing Support System (LSS) should contain information. (Integrate LSS format and Table 2.2A format.)

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form B: Information Response

Date: 9/30/92

1. Section No. & Title: 2.2 MATERIAL INCORPORATED BY REFERENCE

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester):

   Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log Number on this form should be identical to the Log Number of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

Section 2.3 Use of NRC Technical Positions

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2.3 USE OF NRC TECHNICAL POSITIONS

2.3.1 Definition of Applicable NRC Technical Positions

2.3.2 Justification of Exceptions

2.3.3 DOE Conformance to NRC Technical Positions

2.3.4 NRC Regulatory Guide Compliance Program

Skeleton Text Has Not Been Developed For This Section

1. Section No. & Title: 2.3 USE OF NRC TECHNICAL POSITIONS

2. Lead Author & Phone No. T.M. Williamson (702) 794-1821
Marshall Weaver (702) 794-1871

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   This section indicates the extent to which DOE uses all applicable NRC technical positions. Those positions are identified, as are the applicable safety analysis sections. Exceptions to NRC technical positions are identified.

6. Opening Statement:

   [This section describes and justifies the extent to which DOE uses NRC technical positions.]

7. Main Body Outline:

2.3 USE OF NRC TECHNICAL POSITIONS

2.3.1 Introduction and Definition of what constitutes an applicable NRC technical position (or conversely, what does not)

2.3.2 Explanation of how exceptions are justified. Use of table versus text in the safety analysis sections

2.3.3 Description of Table 2.3-A

2.3.4 Description of Program for ensuring compliance with applicable NRC regulatory guides including those issued or revised during and after license process.

8. Conclusion:

[A statement similar to the following will be required for an LA: DOE conforms to NRC technical positions to the extent required to meet the requirements of 10 CFR 60 and other sections of 10 CFR as they apply to geologic repositories.]

9. Support Authors & Their Assignments:

Mark Ceraldi (DE & S)

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: **2.3 USE OF NRC TECHNICAL POSITIONS**

Lead Author & Phone No. T. M. Williamson (702)-1821
Marshall Weaver (702) 794-1871

A. Table No. 2.3A

Title: **DOE Conformance to NRC Technical Positions**

Content:

Technical Position Number	Title	Revision	Applicable (yes/no)	Applicable SAR Section(s)	Exceptions	Justification
					Identify	Summarize

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title:

Content:

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title: 2.3 USE OF NRC TECHNICAL POSITIONS

Lead Author & Phone No.: T.M. Williamson (702) 794-1821
Marshall Weaver, 702-794-1871

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

1. [M&O believes that the DOE has done some analysis on this subject. We need to find out where it is documented.]

2.

3.

4.

5.

6.

7.

8.

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: TMW-9

2. Section no. & title: 2.3 USE OF NRC TECHNICAL POSITIONS

3. Lead author & phone no: T. M. Williamson (702) 794-1821
   Marshall Weaver (702) 794-1871

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Listing of all NRC technical positions with following: TP number, title, revision; expected applicable Safety Analysis Section number, and that section's lead author.

7. What is the information needed for?

   To ensure that lead authors properly address compliance with NRC technical positions.

8. What group is the probable information supplier?

   Licensing group.

9. When is the information needed?

   9/1/91.

10. What kind of related information is already available in references, etc.?

    LSS.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form B: Information Response

1. Section No. & Title: 2.3 USE OF NRC TECHNICAL POSITIONS

2. Person Supplying Information: T.M. Williamson 702-794-1821
Marshall Weaver (702) 794-1871

3. Phone No.:

4. Lead Author (Requester):

   Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

MGDS Annotated Outline

Section 2.4 Requirements for Further Technical Work

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2.4 REQUIREMENTS FOR FURTHER TECHNICAL INFORMATION

2.4.1 Technical Information Not Supplied

2.4.2 Technical Information Development Programs

Skeleton Text Has Not Been Developed For This Section

REFERENCES

1. Section No. & Title: 2.4 REQUIREMENTS FOR FURTHER TECHNICAL INFORMATION

2. Lead Author & Phone No. T.M. Williamson 702-794-1821
Marshall Weaver 702-794-1871

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   This section identifies, describes, and discusses those safety features or components for which further technical information is required in support of MGDS license issuance, but is not supplied in the Safety Analysis Sections at the time of its submittal. The reason such information was not reasonably available is explained. The section also summarizes special technical information development programs undertaken to establish the final design and/or demonstrate the conservatism of the design. The section further discusses any programs that will be conducted during operation to demonstrate the acceptability of contemplated future changes in design or operation.

6. Opening Statement:

   [A statement similar to the following should be made in a potential license application: This section identifies and explains technical information required to support the issuance of a license for the MGDS, but which has not been submitted with the Safety Analysis Sections.]

7. Main Body Outline:

   2.4.1 Technical Information Not Supplied (see Table 2.4A)

   2.4.2 Technical Information Development Programs (see Table 2.4B)

Table 2.4B identifies the Safety Analysis section reference for TIDP discussion. This discussion includes:

7. Main Body Outline: (Continued)

- Affected safety feature or components
- Program description. Provide sufficient detail to show how the information will be obtained
- Describe specific technical information which must be obtained to demonstrate acceptable resolution of the TIDP
- Discuss (a) design alternatives or (b) operational restrictions if results of the TIDP do not demonstrate acceptable resolution of the TIDP
- If a reference is made to material incorporated by reference (see Safety Analysis Section 2.2), discuss applicability of each technical information development item to the repository.

8. Conclusion:

[The foregoing discussion justifies whether information is not reasonably available to submit with these Safety Analysis sections, but which does not adversely impact the issuance of a license for the MGDS.]

9. Support Authors & Their Assignments:

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 2.4 REQUIREMENTS FOR FURTHER TECHNICAL INFORMATION

Lead Author & Phone No. T.M. Williamson 702-794-1821
Marshall Weaver 702-794-1871

A. Table No. **2.4A**

Title: **Technical Information Not Supplied with the Safety Analysis Sections**

Content:

Item	Technical Information	Explanation
	Identify	Explain why such information is not reasonably available

---

B. Table No. **2.4B**

Title: **Technical Information Development Programs**

Content:

Item	Program Title	Type (Note 1)	Information To Be Obtained (Note 2)	SAR Reference For Program Discussion	Schedule for Completion (Note 3)

Note 1: Program

Type	Description
A	Required to determine adequacy of new design
B	Used to demonstrate margin of conservatism of a proven design
C	Conducted during operations to demonstrate the acceptability of contemplated future changes in design or operation
D	Other

Note 2: This is information to be obtained to demonstrate acceptable resolution of the technical information development program (TDIP).

Note 3: Scheduled date for repository operation startup is TBD

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title: 2.4 REQUIREMENTS FOR FURTHER TECHNICAL INFORMATION

Lead Author & Phone No.: T. M. Williamson 702-794-1821
Marshall Weaver 702-794-1871

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

1.

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MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **TMW-10**

2. Section no. & title: **2.4 REQUIREMENTS FOR FURTHER TECHNICAL INFORMATION**

3. Lead author & phone no: **T. M. Williamson (702) 794-1821**
Marshall Weaver (702) 794-1871

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Identify information for Tables 2.4A and 2.4B.

7. What is the information needed for?

   Safety Analysis Section 2.4. Identification of information needed to support the issuance of a MGDS license.

8. What group is the probable information supplier?

   All lead authors.

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form B: Information Response

1. Section No. & Title: 2.4 REQUIREMENTS FOR FURTHER TECHNICAL INFORMATION

2. Person Supplying Information:

3. Phone No.: 702-794-1821

4. Lead Author (Requester): T.M. Williamson

Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

Section 2.5 Radioactive Materials

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2.5 RADIOACTIVE MATERIALS

Skeleton Text Has Not Been Developed For This Section

REFERENCES

MGDS Annotated Outline Planning Package Date: 9/30/92
Form 1: Text

1. Section No. & Title: **2.5 RADIOACTIVE MATERIALS**

2. Lead Author & Phone No. T.M. Williamson 702-794-1821
Marshall Weaver as placeholder for Bill Cole (JAI)
703-934-2449

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   This section provides a description of the kind, amount, and specifications of the radioactive material proposed to be received and possessed at the geologic repository operations area.

6. Opening Statement:

7. Main Body Outline:

   [Consider description of radioactive material in emplaced configuration if different from received configuration.]

8. Conclusion:

9. Support Authors & Their Assignments:

Section No. & Title: **2.5 RADIOACTIVE MATERIALS**

Lead Author & Phone No. T.M. Willliamson 702-794-1821
Bill Cole (JAI) 703-934-2449

A. Table No. 2.5"X"

Title: **Radioactive Material Specifications - Type "N"**

Content:

Similar to Table 2.5B for each type of material

B. Table No. 2.5A

Title: **Radioactive Material to be Received and Possessed at the Geologic Repository Operations Area**

Content:

Type	Amount	Specification	Other Non-Specification Information
1		Table 2.5B	
2		Table 2.5C	
3		Table 2.5D	
.		.	
.		.	
.		.	

C. Table No. 2.5B

Title: **Radioactive Material Specifications - Type 1**

Content: Itemize specification values. Typical items for spent fuel could be:

Burnup, max
Original enrichment, max
Individual nuclide concentration, max
Heat generation, max
Fuel defects, max.

Section No. & Title: 2.5 RADIOACTIVE MATERIALS

Lead Author & Phone No.: T.M. Williamson 702-794-1821
Bill Cole 703-934-2449

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

1. [Oak Ridge has done considerable work on this subject. They keep a data base and have done some publishing.]

2. [The M&O waste acceptance people may have reference on this.]

3.

4.

5.

6.

7.

8.

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: TMW-11

2. Section no. & title: 2.5 RADIOACTIVE MATERIALS

3. Lead author & phone no: T. M. Williamson (702) 794-1821
   Bill Cole (JAI) (703) 934-2449

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Waste form specifications for material in emplaced configuration.

7. What is the information needed for?

   Safety Analysis Section 2.5 describes radioactive material to be received and possessed at the GROA. This material may not be in the same configuration as received.

8. What group is the probable information supplier?

   M&O Waste Package Design Group - P. C. Childress.

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form B: Information Response

Date: 9/30/92

1. Section No. & Title: **2.5 RADIOACTIVE MATERIALS**

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester):

Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

MGDS Annotated Outline

Section 2.6 License Specifications

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2.6 LICENSE SPECIFICATIONS

Skeleton Text Has Not Been Developed For This Section

REFERENCES

1. Section No. & Title: **2.6 LICENSE SPECIFICATIONS**

2. Lead Author & Phone No. T.M. Williamson 702-794-1821
Marshall Weaver 702-794-1871
(M.D. Ceraldi 704-382-1655)

3. First Phase Planning Package Due: 6/21/91

Second Phase Planning Package Due: 10/18/91

First Phase Skeleton Draft Due: 12/30/91

Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

This section identifies and justifies those variables, conditions, or other items that are probable subjects of license specifications. Justification is provided for the selection of those variables, conditions, or other items.

6. Opening Statement:

[The purpose of this section is to identify and justify those variables, conditions, or other items DOE determines to be probable subjects of license specifications.]

7. Main Body Outline:

2.6 LICENSE SPECIFICATIONS

2.6.1 Scope

2.6.2 Define "Probable Subject of License Specification."

2.6.3 Define "Variable"/"Condition"

Variable - parameter such as temperature, water level, radioactivity level, which is subject to variation
Condition - State of operation of facility or system.

7. Main body Outline (Continued)

2.6.4 Justification System

An operational analysis is performed in order to justify variables and conditions, which will result in determination of operating parameter boundaries. In the case of a repository operations facility, as opposed to an operating nuclear station, protection systems are utilized for containing and maintaining the spent fuel, versus containing high pressure, high temperature radioactive fluids and producing electricity.

As part of this analysis, a series of block diagrams categorizing events and system responses is created to allow determination of hardware and functional requirements of each system. Once the required actions of the systems have been identified, requirements and restrictions are established for system hardware to ensure that the required actions can be achieved within the redundancy goals set for the system or action.

Required action to be taken, should a protection requirement not be met is determined by considering the associated unacceptable results.

The requirements obtained by the above described method are then simplified into license specifications, which encompass the operational requirements, but are specific enough to be readily used by facility operations and management.

8. Conclusion:

[A statement similar to the following should be made in a potential license application: The variables, conditions, and other items identified and justified above can result in an operating envelope which protects the health and safety of the public and DOE workers.]

9. Support Authors & Their Assignments:

See Information Requests

M.D. Ceraldi (DE & S)

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: **2.6 LICENSE SPECIFICATIONS**

Lead Author & Phone No. T.M. Williamson 702-794-1821
Marshall Weaver 702-794-1871

A. Table No. 2.6A

Title: License Specification Variables

Content: Variables which are probable subjects of license specifications

		Value			Justification	
Item	Description	Nominal	Lower Limit	Upper Limit	Summary	Ref SAR Section

---

B. Table No. 2.6B

Title: License Specification Conditions

Content:

Conditions which are probable subjects of license specifications.

- Duplicate of 2.6A -

C. Table No. 2.6C

Title: License Specification Parameters

Content:

Other parameters which are probable subject of license specifications.

- Duplicate of 2.6A -

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title: 2.6 LICENSE SPECIFICATIONS

Lead Author & Phone No.: T.M. Williamson 702-794-1821
Marshall Weaver 702-794-1871

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

1.

2.

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8.

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **TMW-12**

2. Section no. & title: **2.6 LICENSE SPECIFICATIONS**

3. Lead author & phone no: **T. M. Williamson (702) 794-1821**
   Marshall Weaver (702) 794-1871

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Proposed variables, conditions, or other items that are probable subjects of license specifications.

7. What is the information needed for?

   To propose a set of license specifications acceptable to DOE.

8. What group is the probable information supplier?

   All section lead authors.

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Information Need Form
Form B: Information Response

Date: 9/30/92

1. Section No. & Title: 2.6 LICENSE SPECIFICATIONS

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester):

Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

The above Annotated Outline text is guidance that may be used for the future development of a MGDS License Application.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

Chapter 3.0 Natural Systems Of the Geologic Setting

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3.0 NATURAL SYSTEMS OF THE GEOLOGIC SETTING

Skeleton Text Has Not Been Developed For This Section

REFERENCES

1. Section No. & Title: **3.0 NATURAL SYSTEMS OF THE GEOLOGIC SETTING**

2. Lead Author & Phone No. Hank Lang (702) 794-1821

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
   (Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   This section describes the natural systems of the geologic setting of the region in which the repository is to be located. Included are descriptions of the overall purpose and function of the repository site and how the site fulfills the requirements of 10CFR Part 60. Descriptions and assessments focus on the function of the natural systems of the geologic setting in isolating high-level radioactive waste from the accessible environment.

6. Opening Statement:

7. Main Body Outline:

   3.0.0 Introduction

   3.0.1 Natural Systems

   (Reference Table 3.0A). Describe the natural systems of the geologic setting of the region of the site, to include those within the controlled area (CA); additionally, any conditions outside the CA affecting isolation within the CA.

   3.0.2 Geologic Setting of the Geologic Repository Region

   (Reference Diagram 3.0B) and (Reference Photo 3.0C). Describe the geologic setting of the region in which the geologic repository is to be located.

   3.0.3 Overall Purpose and Function of the Repository Site

   (Reference Table 3.0D). Describe the overall purpose and function of the repository site.

7. Main Body Outline (Continued)

3.0.4 Requirements of 10CFR60 for a Nuclear Repository

(Reference Table 3.0E). Describe how the site fulfills the requirements of 10CFR Part 60.

Indicate the major items in 10CFR Part 60 that are fulfilled for the nuclear waste site requirements.

3.0.5 Capability of the Natural Systems in Isolating High-Level Radioactive Waste from the Accessible Environment

(Reference Table 3.0F). Describe and assess the function of the natural systems of the geologic setting in isolating high-level radioactive waste from the accessible environment.

8. Conclusion:

9. Support Authors & Their Assignments:

Bill Distel, [others].

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: **3.0 NATURAL SYSTEMS OF THE GEOLOGIC SETTING**

Lead Author & Phone No. Hank Lang (702) 794-1821

A. Figure No. **3.0A**

Caption: **Natural Systems of the Geologic Setting**

Content: See Paragraph 3.0.1

This will show the primary natural systems found and active in the geologic setting in the region of the geologic repository.

Natural Systems of the Geologic Setting

- Strata	- Zones	- Volcanos
- XTUFF	- UX	- YTUFF
- Z----	- SZ	

B. Figure No. **3.0B**

Caption: **Geologic Setting of the Geologic Repository Region**

Content: See Paragraph 3.0.2

This diagram will provide a dimensional surface view of the geologic setting, in the geologic repository region.

C. Figure No. **3.0C**

Caption: **Geologic Setting of the Geologic Repository Region**

Content: See Paragraph 3.0.2

This photo will be a N-S oriented photo at an oblique angle of between 45 degrees - 60 degrees, to show the physical aspects of the YM and surrounding surface geologic setting.

Section No. & Title: **3.0 NATURAL SYSTEMS OF THE GEOLOGIC SETTING**

Lead Author & Phone No. Hank Lang (702) 794-1821

A. Table No. **3.0D**

Title: **Overall Purpose and Function of the Repository Site**

Content: See Paragraph 3.0.3

Overall purpose is .....

Functions
Function 1
Function 2
Function 3
Function 4
Function 5

B. Table No. **3.0E**

Title: **Major Requirements of 10CFR 60 for a Nuclear Repository Site**

Content: See Paragraph 3.0.4

10CFR 60: Title: Disposal of HL Radioactive Waste in Geologic Repository

1. ----------
a. Cite major title items that pose
b. specific/major requirements
2. ----------

*See Paragraph 3.0.4

C. Table No. **3.0F**

Title: **Capability of the Natural Systems of the Geologic Setting in Isolating High Level Radioactive Waste from the Accessible Environment**

Content: See Paragraph 3.0.5

Part 1: High Level Waste Special Requirement

1. ----
   a.
   b.
   etc.

Part 2: Natural Systems Isolation Capabilities

1. TUFF
   a. SZ
   b. UZ
2. Water Table
   a.

Section No. & Title: 3.0 NATURAL SYSTEMS OF THE GEOLOGIC SETTING

Lead Author & Phone No.: Hank Lang (702) 794-1821

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

1. USGS Mapping and Photo Service.

2. DOE Satellite Imagery.

3. NASA Earth Resources Imagery.

4.

5.

6.

7.

8.

MGDS Annotated Outline Information Need Form Date: 4/17/92
Form A: Information Request

1. Log number: **HL-1**

2. Section no. & title: **3.0 NATURAL SYSTEMS OF THE GEOLOGIC SETTING**

3. Lead author & phone no: **Hank Lang (702) 794-1821**
Placeholder for TBD

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   A definition of "Natural Systems" and a short discussion of their capabilities to act as natural barriers to isolate radioactive HLW.

7. What is the information needed for?

   FCRG, in Section 3.0 requires a "Focus on the <u>function</u> of the natural systems of the geologic setting in isolating high level radioactive waste from the accessible environment".

8. What group is the probable information supplier?

9. When is the information needed?

   ASAP.

10. What kind of related information is already available in references, etc.?

    10 CFR 60.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form B: Information Response

Date 9/30/92

1. Section No. & Title: **3.0 NATURAL SYSTEMS OF THE GEOLOGIC SETTING**

2. Person Supplying Information: Hank Lang (702) 794-1821

3. Phone No.:

4. Lead Author (Requester):

   Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log Number on this form should be identical to the Log Number of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Oultine Information Need Form Date: 9/30/92
Form C: Information Request Tracking Log

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

Section 3.1 Description of Individual Systems and Characteristics of the Site

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LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

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LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE

3.1.0 Introduction

The purpose of this section is to describe the natural systems of the geologic setting in the region of the site, specifically for the "controlled area". [However, if conditions outside the controlled area affect waste isolation within the controlled area, then the relevant and material information on conditions outside the controlled area will be included.] The controlled area is defined in 10 CFR 60 as "a surface location, to be marked by suitable monuments, extending horizontally no more than 10 kilometers in any direction from the outer boundary of the underground facility, and the underlying subsurface, which area has been committed to use as a geologic repository and from which incompatible activities would be restricted following permanent closure".

The natural systems of the geologic setting in the region in the site consists of: geologic system, hydrologic system, geochemical system, and climatological and meteorological system. This section also contains the integrated natural system response to the maximum design thermal loading. [The extent of the geologic setting is to be described and must be determined in the future.]

3.1.1 Geologic System

The purpose of this section is to demonstrate whether the areas studied provide a representative description of the conditions throughout the region around the site and at the site. [Detailed justification for the areal limits placed on regional studies will be provided.

[The pertinent data, analyses, and level of assessment of natural geological analogs will be provided such as those selected for tectonic (faulting, seismic, and volcanic) models, natural resource assessment, and geomorphic evaluation of the site. The basis for selecting the analog and the basis for comparing and contrasting the analog conditions with those at the site will be described. Similarities between the natural analog and the site, the process or features of interest, how the analog is used, the time frame of the comparative study, and any differences in scale or features between the analog and the site will be described and discussed. Maps and cross sections will be provided to illustrate the location and geological characteristics of the analog sites.]

[Sources of information and data collection methods used to obtain measurements and observations will be described and documented. Geological and geophysical descriptions will be accompanied by maps, cross sections, photographs, and fence diagrams. The variability and uncertainty of data and information will be discussed.]

[The representativeness of the data, the effects of varying geologic conditions, the reliability of geological and geophysical interpretations made and uncertainties associated with the extrapolation of data and information to repository conditions will be addressed in the discussions and descriptions. The use of conceptual models will be discussed with respect to uncertainties in the data bases, the applicability and appropriateness of the geologic assumptions, the sensitivity of the model results to the uncertainty of the geologic input data and model validation.]

3.1.1.1 Regional Geology

[The geologic characteristics in the region of the site will be described, accompanied with sufficient data and technical analyses to demonstrate a clear understanding of the regional geology.]

3.1.1.1.1 Geomorphology and Topographic Features in the Region of the Site

[The data, information, investigations, and analyses related to the geomorphology and topographic features in the region of the site will be described (KKB-1 define "the region of the site", its extent and relation to the controlled area). The past, present, and future conditions such as climate and tectonism that influence the geomorphic and topographic features will be described.]

[Identification of the geomorphic units and features within and abutting the controlled area, geomorphic processes that are acting and could be acting within the geologic system, and the paleogeomorphic processes that have occurred, could have occurred, or could re-occur within the geologic system will be addressed here. Erosion rates that occurred within the Quaternary Period and on those rates projected to occur during the next 10,000 years will be emphasized.]

[In order to demonstrate compliance with all applicable regulatory requirements, the data and analyses presented here must demonstrate that the region surrounding Yucca Mountain has been stable during much of the middle and late Quaternary Period and the rate of geomorphic processes are likely to remain low during the next 10,000 years of repository performance period.]

Desert geomorphic processes acting in conjunction with extensional tectonism have molded the present topography of the Yucca Mountain area. Future tectonism, climatic change, or complex threshold-related changes could alter the intensity and distribution of these processes, thereby changing present pattern and rates of erosion and deposition. In turn, such changes could affect the surface drainage, erosion, ground water recharge, and subsurface water flow. These factors are all important to the construction and operation of the repository and waste isolation.

3.1.1.1.1.1 Regional Physiography

The physiographic areas surrounding Yucca Mountain include: 1) the large north-south trending basins and ranges of the central Great Basin; 2) the basins and ranges of the southeast Great Basin; 3) the massive ranges and deep basins of the southwest Great Basin; 4) the small, irregularly shaped ranges and basins of the northeast Mojave Desert and 5) the highly variable terrain of the northwest-trending Walker Lane belt (Figure 3.1.1.1.1.1A, source SCP Figure 1-3). [The general characteristics of these areas will be summarized in Table 3.1.1.1.1.1A, source SCP Tables 1-1a and 1-1b).]

The controlled area and the adjacent area of the Yucca Mountain area are subdivided into eight clearly defined physiographic areas: Bare Mountain, Crater Flat, Yucca Mountain, Fortymile Wash, Jackass Flats, the valley of the Beatty Wash, Pinnacles Ridge, and the northeast margin of the Amargosa Desert. [These areas will be shown in Figure 3.1.1.1.1.1B. Figures 3.1.1.1.1.1C and D will be Landsat images and overlays for the Yucca Mountain area. Figures 3.1.1.1.1.1E and F will show high-altitude photographs and overlays of the Yucca Mountain area respectively. (Source of these figures are SCP Figures 1-6, 1-7a, 1-7b, 1-8a, and 1-8b).]

3.1.1.1.1.2 Geomorphic Process

The long-term geomorphic process that might affect the construction, operation, or long-term waste isolation capability of the repository is discussed below. The types and the rates of geomorphic processes operating in the region surrounding Yucca Mountain is described. The Quaternary erosion rates in the southern Great Basin and adjacent areas, and the more' significant geomorphic processes presently active in the Yucca Mountain area are included in this discussion. Together with predictions of future tectonic activity and climatic change, this information is necessary for estimating the magnitude and the distributions of erosion and deposition on Yucca Mountain and the contiguous piedmonts in the next 10,000 years.

Conditions Relevant to the Geomorphic Processes. The geomorphic processes in the southern Great Basin and the Northern Mojave Desert are largely determined by climate, existing topography, and tectonic activity, as well as the spatial and temporal relationship between these determinants.

Influence of Tectonism on Geomorphic Process. Differential vertical movement induced by regional extensional tectonism has probably been the most single important factor in the development of the landscape of the region surrounding Yucca Mountain. Specifically in the Yucca Mountain area, including Yucca Mountain, the average rate of relative vertical tectonic adjustment during the late Tertiary and Quaternary periods have been estimated by Carr (Reference 3.1.1.1.1.2-A, Carr, 1984) to be less than 3 cm per 1,000 years. Thus, it is unlikely that vertical tectonic movement will significantly affect the types and rates of geomorphic process in the Yucca Mountain in next 10,000 years.

Influence of Climate on Geomorphic Processes. Yucca Mountain is one of the warmest and driest regions in the United States. The present climate is characterized by hot summers, mild winters, and little precipitation. [Studieis will be necessary to conclude that glacial and periglacial processes have not been active (KKB-2, provide the evidence) in the Yucca Mountain area during most or all of middle and late Quaternary time, and that lacustrine processes were, at most, confined to limited basin areas.]

The semiarid to arid climates of the past and present have tended to preserve the landscape of the region of Yucca Mountain. Weathering has been limited. Flow of surface water is intermittent and subjected to flash floods resulting in intermittent sediment transport. The late and middle Pleistocene ages of many of these landforms and radiometric ages attest to the slow and discontinuous nature of sediment transport throughout this region.

3.1.1.1.1.3 Average Erosion Rates in the Region of Yucca Mountain

The average Quaternary erosion rates for local areas of Southern Great Basin and northern Mojave Desert is estimated to range between (___ and ___ cm per 1000 yr). [It will be necessary to support the conclusion that the general degradation of upland areas in the region surrounding Yucca Mountain is proceeding relatively slowly.]

3.1.1.1.1.4 Significant Late Quaternary Geomorphic Process

Tectonic and Volcanic Processes. During the Quaternary period, tectonic and volcanic processes in the Yucca Mountain area have included: 1) less than 3 cm/1000 yr relative vertical tectonic adjustment; 2) local surface faulting along the eastern and western flank of the Bare Mountain, along the eastern and western flanks of the Yucca Mountain, and in Crater Flat; 3) horizontal movement on these fault systems (__ cm), and 4) local Strombolian volcanic activity from seven basaltic centers located 8 to 40 km from the proposed repository. [Studies will be necessary to conclude that: the effects of these past activities have been limited, and comparable tectonic and volcanic activities during the next 10,000 years should induce a comparably limited effect on the late Quaternary landscape of Yucca Mountain (KKB-3 provide study report to support this assertion).]

Surficial Processes. [Investigations of tectonic movement, climatic history, and general geomorphic characteristics of Yucca Mountain area will be necessary to show that only a limited number of geomorphic processes involving the significant movement of surficial materials have been operating in the Yucca Mountain area during the late Quaternary. (KKB-4, provide estimates of these movements of surficial material during the Quaternary).] The processes are: 1) degradation of upper upland slopes by weathering; 2) degradation of lower upland slopes 3) alternating degradation and aggradation of intermittent streamflow in the lower valley and upper piedmont areas 4) net aggradation by intermittent streamflow in lower piedmont and basin areas and, 5) eolian deposition on piedmonts and on lower upland slopes.

3.1.1.1.2 Stratigraphy and Lithology of the Region

The stratigraphic and lithologic framework of the region surrounding the Yucca Mountain is described in this section. The description includes a discussion of the relationship between stratigraphic and lithologic units.

The history of pertinent stratigraphic and lithologic units includes a discussion of processes of formation and alternation. Discussions of formation should consider sedimentation, provenance, environment of genesis, and deposition. Alteration history includes alteration effects resulting from processes such as tectonism, metamorphism, plutonism, volcanism with attendant hydrothermal processes.

[Geologic formations, hydrogeologic units, and the lithologic character of pre-Cenozoic and Cenozoic rocks in the southern part of the Great Basin will be shown in Figure 3.1.1.1.2A (source SCP, Figure 1-10, Generalized regional stratigraphic column showing geologic formations and hydrogeologic units in the southern Great Basin). Studies will be necessary to show that the pre-Cenozoic and Cenozoic parts of the sequence are separated by regionally significant unconformity discernible in the subsurface by geophysical means. Surficial deposits rest on late Tertiary and Quaternary erosional unconformity which is regionally extensive. (KKB-5 provide rationale for stratigraphic boundaries such as mineralogical or geochemical characteristics).]

3.1.1.1.3 Seismology

[A complete list of all historically reported earthquakes in the region surrounding the site will be provided in Table 3.1.1.1.3A (KKB-6, provide the table by updating table 1-10 of SCP).] The seismic record is derived from primarily two sources: 1) the catalog of historical earthquakes occurring prior to the installation of the Southern Great Basin Seismic Network (SGBSN) (Reference 3.1.1.1.3A, Meremonte and Rogers, 1987), and 2) SGBSN earthquake catalog (Reference 3.1.1.1.3B, Rogers, et.al. 1981, 1983, 1987). [The list will encompass all earthquakes that have been reported to have occurred in geologic settings or on geologic structures that lie at least partially within 200 miles (320 km) of the site. Figure 3.1.1.1.3A will show the seismic activity within a circle of 200 miles radius centered on Yucca Mountain during the recorded history (1769 to 199-). (Source of figure, SCP Figure 1-51).]

3.1.1.1.3.1 Relationship of Seismicity to Geologic or Tectonic Characteristics of the Candidate Area

The purpose of this section is to discuss the correlation of earthquakes to recognized geologic structures on seismotectonic zones. In assessing the earthquake potential of the Yucca Mountain area, the spatial and temporal description of the seismicity and the spatial and temporal geologic characteristics of the area are compared in order to identify geologic structures or types of structures that may be capable of producing damaging earthquakes. [Understanding the nature of the seismicity and its relationship to geologic structures will contribute to the development of a tectonic model that will be used to characterize future seismic activity. (KKB-7, The relationship between seismicity and geologic structure and the tectonic model is yet to be developed by WCC or LANL).]

[A number of seismic source models will be used to evaluate if earthquakes are related to specific geologic structures or seismotectonic zones (___ name models) and the results will be described here. (KKB-8, provide the model description and analyses). Table 3.1.1.1.3.1A will show significant earthquakes in or near the southern Great Basin.]

[An analysis of the correlation between epicenters or regions higher intensity of historically reported earthquakes and the geologic setting or geologic structures within the setting will be provided below (KKB-9, provide such analyses). The largest earthquakes associated with the geologic setting or each geologic structure within that setting will be identified. Table 3.1.1.1.3.1B will show the data related to this correlation of earthquakes and geologic structures or setting.]

3.1.1.1.4 Structural Geology and Tectonic Information

[Structural and tectonic features in the site region, including a discussion and analysis of regional tectonic models and their applicability to the site will be provided here.]

3.1.1.1.4.1 Structural Features in the Yucca Mountain Region

[The structures and structural history of the southern Great Basin and the Yucca Mountain and its immediate surroundings will be discussed in the following section. The Tertiary and Quaternary structures including faulting and folding will be described (text available in SCP 1.3.2.2 and will not be repeated here). Figure 3.1.1.1.4.1A will show a schematic geologic cross section at Yucca Mountain region (Source figure 1-32 from SCP). Table 3.1.1.1.4.1A will list Quaternary faulting at and near Yucca Mountain (source SCP Table 1-7).]

Fractures are common in all the volcanic units in the Yucca Mountain region. The fractures were produced by cooling, by basin and range tectonism, and by unloading due to removal of overburden. (KKB-10, the regional fracture, discontinuities, and heterogeneity needs to be further investigated for the Yucca Mountain region).

3.1.1.1.4.2 Volcanic Features in the Yucca Mountain Region

[The igneous history of the southern Great Basin and Yucca Mountain will be discussed below. It will provide the history of volcanism during the Tertiary and Quaternary periods. Figure 3.1.1.1.4.2 A, Figure 3.1.1.1.4.1B, Figure 3.1.1.1.4.2C, and Figure 3.1.1.1.4.1D will show the distribution of the Cenozoic volcanic rocks in the southern Great Basin during the time periods of 0 - 43 million years ago (Source Figures 1-28 a,b,c and d of SCP). Table 3.1.1.1.4.2A will show the characteristics of basaltic volcanism fields in the Yucca Mountain area (source, SCP Table 1-6).]

3.1.1.1.5 Natural Resources

[The natural resources near the site that are economic, marginally economic and sub-economic, and the exploitation of which could result in inadvertent intrusion into the repository, will be described. Resources such as mineral, fuels, hydrocarbon, and geothermal resources will be addressed. Potable, agricultural, and industrial waters including waters in the form of brine will be included in the discussion.]

[The description of these resources will include information on recourse type occurrence, location, extent, net worth, recoverability, and current and projected use. Also provided will be: 1) a comparison of the site and environs with areas of mineral and hydrocarbon deposits with similar origins, host rocks and structural regimes, 2) an assessment of the near-site area based on comparisons with known mineral resources and models, and 3) the location, nature, and extent of any known or suspected mineralization, hydrocarbons, or waters of elevated temperatures.]

3.1.1.1.5.1 Mineral Resources of the Yucca Mountain Region

[Table 3.1.1.1.5.1A will list the non-fuel mineral production in Nevada for the years (199- to 2000).] The mineral industry in Nevada remains highly ranked in comparison to other states and likely to remain so in the far future.

Interpretation of regional geophysical data including gravity and magnetic data provides information regarding the mineralization potential of the area. [These data will be used in ore genesis models (KKB-11, provide the description of the models and result of the analyses).]

Precious and Base Metal Deposits. Precious and base metals deposits in Nevada have historically been the most important economically. Yucca Mountain is located in the southeastern part of the eastern metallogenic province of Nevada.

Much of Nevada, including Nye county and all of Yucca Mountain at the surface, consists primarily of ash flow tuffs. However, 93 percent of all major metal mining in Nevada is in lithology other than silicic tuff. Areas within calderas are typically barren of economically important base and precious metals while strongly altered and metamorphosed rock located on the margins of the calderas are more economically important. [Only (__) of the Nevada's (__) calderas have produced 1 million dollars or more of gold, silver, copper, lead, zinc, mercury, antimony, and iron.]

Gold and Silver Resources.

(No skeleton text developed for this subsection.)

Mercury Resources. Only two of the eight potential mercury host rock characteristics are found in the Yucca Mountain. To date, no warm or hot spring deposits that would be associated with sulfurous mercury ores have been identified at or near Yucca Mountain.

Small amounts of mercury have been produced from highly silicified volcanic rock at the Thompson Mine at the northwest end of the Yucca Mountain. The production figures are less than (___) flasks. [Further study will be necessary to conclude that no indications of highly silicified, opalized, and mercury-bearing mineral have been recognized from north central or southern Yucca Mountain during surface mapping (KKB-12, confirm this finding during further mapping).]

[Data gathered from site characterization will be necessary to support the conclusion that there is very little potential for an economic deposit of mercury at Yucca Mountain. Mercury is considered to be a speculative, undiscovered resource of sub-economic grade. Geochemical sampling for mercury in surface outcrop and drill cores will be needed to confirm these findings (KKB-12, provide the geochemical test data to support this conclusion).

Industrial Minerals and Rocks. This category includes a variety of minerals and rocks that are commonly equated with non-metallic and industrial minerals and rocks. [Only the ones that have been found to occur or have a potential for occurring in the Yucca Mountain region will be discussed here.]

[From the results of investigation (define type of investigation) it will be concluded whether the geologic setting at Yucca Mountain is favorable for the occurrence of barite deposits.] Only ______ occurrence of barite is found in veins at depths of (__ m or more). These deposits have _______ economic potential because of their depths of (__m or more), and due to ________ of their occurrence elsewhere in Nevada at surface level.

Yucca Mountain has a low potential for future economic deposits or future exploration for the industrial mineral fluorite because: 1) its known occurrences are rare and of low grade (__ indicate grade), 2) deposits in ash flow tuffs are typically low grade, 3) numerous deposits occur elsewhere in Nevada, 4) world-wide reserves are vast, and 5) known occurrence at Yucca Mountain are minor replacements of limited extent and size.

Zeolite at Yucca Mountain is not classified as a resource or a reserve because of widely distributed availability over the region, and low grade and tonnage available (__ tons reserve at __ grade) at Yucca Mountain. Zeolite at Yucca Mountain occurs at a depth of 500 meters in solid rock, whereas vast reserves are available at surface in sedimentary form.

In addition to the industrial minerals, a variety of construction material occurs locally including clays, volcanic cinder, perlite, pumice, silica, sand, and gravel. No economically known currently or historically significant construction material deposits exist at Yucca Mountain. The construction material resources in the vicinity of Yucca Mountain are of local economic importance and only a few are being exploited. [Table 3.1.1.1.5.1B will show a summary of all construction material in the vicinity of Yucca Mountain.]

These construction materials do not occur in the bedrock of Yucca Mountain with the exception of silica resources that have been historically mined at the Silicon mine. More readily extractable and abundant silica is available elsewhere in the region and in the United States. There is no foreseeable potential for future exploration or exploitation of these resources that would result in drilling or other surface activities in close proximity to the Yucca Mountain site.

3.1.1.1.5.2 Energy Resources of Yucca Mountain Region

Energy resources consist of uranium, hydrocarbons, and geothermal sources. [The potential for these sources will be discussed below.]

Uranium Resources. [In an LA, it will be necessary to make a statement such as: Based on historical data, examination of core samples, and geochemical analyses of surface and subsurface samples, it is concluded that uranium is a speculative, undiscovered resource of subeconomic grade (KKB-13, provide the result of yet to be performed geochemical analyses to support these conclusions).]

Geothermal Resources. The area surrounding Yucca Mountain has a low potential for intermediate and high-temperature geothermal fields, but is underlain by a deep seated (greater than 3 km) regional geothermal source whose surface characteristics are greatly affected by the overlying hydrologic system and thermal conductance of the rock. It is concluded from the data that the waters from Yucca Mountain are a potential resource for space heating and agricultural uses. [In an LA, it will be necessary to make a statement such as: However, Yucca Mountain is not currently considered a geothermal resource area because: 1) The use of low temperature water is only technologically feasible only in a few parts of the world and is cost prohibitive if transported rather than used at the site (__ provide substantiation of these statements at the end of the decade); 2) Topographic lows with shallow depths to the water table would be the most likely areas of use whereas Yucca Mountain is a topographic high with great depths to the water table, and 3) These low temperature and shallow resources are widely available elsewhere in Nevada at shallower depths.]

Hydrocarbon Resources. The potential for conventional hydrocarbon resources (i.e., petroleum or crude oil and natural gas) and unconventional hydrocarbon resources including tar sands and oil shale, and coal (not strictly a hydrocarbon) will be discussed here.

Coal, Tar Sands, and Oil Shales. [The purpose of this section is to discuss whether coal, tar sands, and oil shales have extremely low potential for occurrence in the Yucca Mountain area. This will be supported by historical data, regional geology, geologic mapping, drilling, geophysical logging and other data. (KKB-13, provide data on future drilling, geophysical logging and other data to support these conclusions).]

Oil and Natural Gas. Table 3.1.1.1.5.1C will show the location, date of discovery, producing formation, depth of production and cumulative production for Nevada oil and gas fields. [In an LA, it will be necessary to provide statements such as: There are no oil or gas fields within the Death Valley Region or in southern Nye county. Extensive drilling, mapping, and geophysical logging and other investigations (___ name these investigations) have shown no potential source rock for oil and natural gas occurrences. In addition, the calculated thermal maturation of any potential source rocks in the area of Yucca Mountain are not favorable for hydrocarbon resources.]

Potable, Agricultural, and Industrial Water Resources.

3.1.1.1.6 Geophysics

[The results of geophysical investigations for issue resolution and a basic description of the region of the site will be described here. Surface based geophysical investigations will be performed for site characterization and included seismic reflection and refraction, gravity, magnetic, remote sensing, aeromagnetic, electrical and low-sun-angle mapping. These investigations will provide information regarding natural resources, faulting, fractures and voids, potential magma chambers, magma sources, and other tectonic features of importance to the design and analyses of the repository. These investigations will also be used to identify the major tectonics and natural resource features in the vicinity of the site.]

3.1.1.1.6.1 Regional Geophysical Characteristics of the Site

[Generally, the region around the Yucca Mountain is a gravity low corresponding to the thick Cenozoic volcanic cover and presence of several caldera complexes. However, local magnetic and gravity highs have been interpreted to include the existence of a deep pluton that extends from (KKB-14, provide further results of magnetic and gravity surveys).]

3.1.1.2 Site Geology

3.1.1.2.1 Geomorphology and Topographic Features of the Site Area

The purpose of this section is to describe the geomorphology and topographic features of the site. [The data, information, investigations, and analyses will address the following: 1) whether extreme erosion is represented at the site or an adjacent area such that isolation of waste within the site may or may not be affected, 2) projections of the maximum erosion rates in the vicinity of facilities important to safety (critical structures) and engineered features (i.e., exploratory shafts, waste handling facilities, etc.), and 3) projections of the maximum erosion rates in areas (such as washes) overlying underground facilities having minimum thickness of overburden or vulnerability to denudation. In considering projection of the maximum erosion rates, the effects of subsidence and faulting are incorporated in the analysis.]

[Appropriate geomorphic and topographic maps and cross sections will be provided to illustrate and clarify the characteristics of the site and the potential for erosion. Additional Figures and Tables will be required]

3.1.1.2.1.1 Erosion at the Site

The Yucca Mountain site has been generally geomorphologically stable. However, episodes of rapid erosion have occurred locally in areas of concentrated alluvial activity (e.g. the ravines, valleys, and washes of the mountain and adjacent piedmonts). In these areas, the rates of stream incision, averaged over the past .15 to 0.3 million years range from (_ cm/year to _ cm/year). (KKB-15, provide site specific erosion rates in the areas of critical surface facilities once Title II designs of ESF and the repository is developed).

[Note: Information and data regarding the extreme erosion issue will be presented in this section. The information and data provided will demonstrate whether erosion potential is an adverse condition. Further discussion of this issue will be provided in Section 3.2.]

3.1.1.2.2 Stratigraphy and Lithology of the Site

[The stratigraphy and lithologic framework of the site will be described here including: 1) accepted rock-stratigraphic unit names, 2) relative or isotopic age of units, 3) genetic relationships of delineated units, 4) rationale (i.e., mineralogical, geochemical, paleontological, etc.) for stratigraphic boundaries (contacts), and 5) alteration affecting the units. In discussing the formation of the units, sedimentation, provenance, genetic environment, and deposition will be considered. Processes resulting from tectonism, plutonism, volcanism, and metamorphism with attendant hydrothermal processes will be considered in the alteration history of the units.]

[The stratigraphic and lithologic units surrounding or hosting (repository horizon) the waste including identification of mineralogical and paleontological constituents and physical characteristics will be described in detail. The description will include texture, bedding, grain size, percent and size of cavities, degree of cementation, and schistocity. Zones of alteration, vertical or lateral variation of composition and/or physical characteristics within units including affects of faulting, folding, uplift, and subsidence should be discussed.]

[The information sources and methods used to obtain site specific data will be documented. Geologic maps, isopach maps, and cross sections illustrating the stratigraphic and lithologic units at the site will be provided. Additional Figures/Tables will be needed].

The rocks at Yucca Mountain (Figure 3.1.1.2.2A, source SCP Figure 1-17) comprise a gently dipping of sequence of Miocene ash-flow tuffs, lavas, and volcanic breccia more than (_ meters) thick, interlaced with relatively thick units of volcaniclastic rock and flanked by younger alluvial deposits. [The data from deep drillholes (up to ___meters) will provide the stratigraphic information on the sequence of rocks in Yucca Mountain (KKB-16, provide the stratigraphy to the depth necessary when deep geological holes are drilled and data analyzed. The data should include the rationale for stratigraphic units based on mineralogical, paleontological, and geochemical characteristics of the units). Figure 3.1.1.2.2B will show the location of the geological drill holes used to determine the stratigraphy of the site and the location of the geological cross-sections to be shown on Figure 3.1.1.2.2C and Figure 3.1.1.2.2D. These two latter figures will show the north/south and east/west stratigraphic correlation between the selected drillhole data. Table 3.1.1.2.2A will show the stratigraphy, thickness, and age of the rock units at Yucca Mountain site.]

3.1.1.2.2.1 Description of Lithology of the Units Surrounding the Repository Horizon

The following is a description of the lithologic units surrounding and hosting the waste. The mineralogical and paleontological constituents and physical characteristics such as texture, bedding, grain size, percent and size of cavities, degree of cementation, and schistosity are described.

The Paintbrush Tuff, more than 460 meters thick, constitutes nearly all of the exposed rocks at Yucca Mountain. In ascending order, the four members of the Paintbrush Tuff are:

- Tiva Canyon
- Yucca Mountain
- Pah Canyon
- Topopah Spring.

The repository horizon lies within the Topopah Spring Member of the Paintbrush Tuff. This member is a multiple flow compound cooling unit. [Figure 3.1.1.2.2.1 will show the sequence and thickness of the various cooling units within the Topopah Spring Member.]

The tuffaceous beds of the Calico Hills unit underlies the Topopah Spring Member in the Yucca Mountain site. The tuffaceous beds of Calico Hills unit are considered as a major barrier to the downward migration of radionuclide from the repository horizon. This unit consists of massive, homogeneous, non-welded ash flow tuffs totaling (__ meters to ___ meters) in thickness which are separated in places by ash fall and reworked tuff as much as (___ meters) thick. The non welded tuff is mostly crystal poor (less than ____ percent), but locally it is rich in lithic fragments, some as much as (___ cm) long. Underlying most of the northern part of the Yucca Mountain, the entire unit is zeolitized but it the remains vitric in the southern area. Zeolites constitute (__ to __) percent of the rock volume.

[The zones of alteration with the stratigraphic units will be described below (KKB-17, describe the zones of alteration from drilling data). The vertical and lateral variation of compositional and physical characteristics within each stratigraphic unit will also be described here (WCC to provide such description).]

3.1.1.2.3 Seismology

[The ground motion at the site will be determined assuming seismic energy transmission effects are constant, and that the largest earthquake associated with each geologic structure or geologic setting occurs at the point of closest approach to the site. Ground motion determinations are related to [based on?] the site-specific material properties of each stratum. These properties include seismic compressional and shear velocities, bulk densities, soil properties and classification, shear modulus and its variation with strain level, and water table elevation and its variation.]

[Design response spectra corresponding to the design basis earthquake will be defined and their conservation assessed by comparisons to ground motion expected from each potential maximum earthquake. (Table 3.1BC, Table 3.1BD, Tables 3.1BE and 3.1BF) Additional Figures/Tables will be needed to illustrate probabilistic modeling and hazard assessment.]

[Note: This section will present information and data used in the resolution of the seismic design issue. This information and design will be used in the designs presented in Section 4.0, Geologic Repository Operational Area.]

3.1.1.2.3.1 Ground Motion at the Site from Earthquakes in the Area

[(KKB-18, Provide ground motion calculations using deterministic or probabilistic or both approaches [this point needs to be clarified] when appropriate data are generated).]

3.1.1.2.3.2 Material Properties of Rocks at the Site

[(KKB-19, Provide seismic compressional and shear velocities, bulk densities, soil properties, and classification, shear modulus and its variation with strain level, and water table elevation and its variation. For static properties of soil and rock, refer to Section 3.1.1.2.7, Geoengineering. It is not clear whether laboratory determined dynamic and static properties or in situ properties are required for soil and rock units located under the site.).]

3.1.1.2.3.3 Seismic Wave Type Effects of Wave Transmission

[The types of seismic waves that produce the maximum ground motion for each set of conditions describing the occurrence of maximum potential earthquake will be determined and the results will be provided herein. Also, the results of analyses to determine the effects of transmission in the site material for the identified seismic wave types in the significant frequency bands will be included. The acceleration, effective frequency range, and duration corresponding to each maximum potential earthquake are provided both at ground surface, and at depth of the underground repository (KKB-20 will provide these calculations and results when the necessary data are available).]

3.1.1.2.3.4 Design Responses to Ground Motion from Potential Earthquake

[Design response spectra corresponding to design basis earthquakes will be described. The conservatism of the design will be evaluated by comparing the design response spectra with the ground motion expected from potential earthquakes as presented in Section 3.1.1.2.3.3 (KKB-20 provide these calculation when Title II design of the repository is complete).]

3.1.1.2.4 Structural Geology and Tectonics

[The structural and tectonic features in the site area will be described here including a discussion and analysis of local structural and tectonic models and their applicability to the site. The volcanic history, faulting history, folding history, jointing history, and the stress field at the site will be discussed. Methods (i.e., remote sensing techniques, geophysical studies, age dating, mapping, trenching, etc.) used in arriving at faulting and volcanic histories (location, ages, and recurrence intervals of fault movements and volcanic episodes) will be described and documented. The purpose of this Section is to determine whether features and conditions are representative of structural and tectonic features at the site and whether the range of tectonic conditions has been established. Individual tectonic features that may directly or indirectly affect waste isolation will be described and discussed in detail. Possible relationships among tectonic processes, including coupled processes, will be discussed. (Figures 3.1BH and 3.1BI) Additional tables and figures will be needed].

3.1.1.2.4.1 Faulting at Yucca Mountain

Yucca Mountain is the erosional remnant of a volcanic plateau. It consists of a series of north trending structural blocks that have been tilted eastward along major west dipping, high angle normal faults. These blocks are [provide a description such as: imbricate fault slices overlying one or more detachment faults.] The major normal faults bounding the structural blocks at Yucca Mountain are typically only (_ to _) km apart. The component of strike slip faults at Yucca Mountain is [(__ provide offset amount).]

The major normal faults that bound the structural blocks generally strike north and dip steeply west. The faults generally have offsets of (___ meters). They decrease in both offset and abundance northward throughout Yucca Mountain (provide offset amount). [Figure 3.1.1.2.4.1A will show the location of faults at Yucca Mountain and the location of cross sections throughout the site. Figure 3.1.1.2.4.1B and C will be cross sections showing the faults and their characteristics in the site.] Additionally, Quaternary deposits are offset or fractured by (__) faults in the (__ km^2) area of Yucca Mountain [and will be shown in Figure 3.1.1.2.4.1A.]

Seismic reflection, low altitude aeromagnetic surveys, electrical resistivity data, remote sensing, and geologic mapping [(add other methods when site characterization is complete)] were used to delineate and identify faults in the Yucca Mountain site and determine their characteristics. [Figures 3.1.1.2.4.1D, E, F, and G will show the faults interpreted from these methods. Table 3.1.1.2.4.1A will show the estimate of age of faults using radiometric dating and stratigraphic correlation (add any other methods used for fault dating) in the site.]

3.1.1.2.4.2 Folding at Yucca Mountain

[No folding information is available in the SCP from a quick scan. If true, folding information including history, occurrence, age, and characteristics have to developed from site characterization.]

3.1.1.2.4.3 Fractures at Yucca Mountain

Fractures are common in all volcanic units at Yucca Mountain. The fractures were produced by cooling, basin and range tectonism, and unloading due to the removal of overburden. The fractures are commonly strata-bound (i.e. their vertical extent is limited to the individual stratigraphic unit or group of unit).

[Detailed studies of fractures from surface mapping, drill core observation, down hole surveys (___ name the surveys, e.g. seisviewer, video tape etc.) and underground mapping will be performed for all the units from ground surface down to Calico Hills.] The (____ types of fractures) are found in the units. [Table 3.1.1.2.4.3A will show the lithological unit, type of fracture, dip and strike, frequency and infilling. Figures 3.1.1.2.4.3A and B will show rose diagrams for fracture measurements from surface and underground mapping at Yucca Mountain repository site (KKB-21 provide these diagrams after completion of surface and underground mapping in the ESF).]

3.1.1.2.4.4 Volcanism at Yucca Mountain

The youngest volcanic centers near Yucca Mountain are in southern and northern Death Valley; near Crater Flat; immediately west of Yucca Mountain; and north of Beatty, Nevada. Depending on the age dating techniques used the Lathrop Wells cinder cone, at the southern edge of Crater Flat, is the youngest volcanic feature in the Yucca Mountain area. The age of the volcanic feature is estimated to be between (___ years and _____ years). [Figure 3.1.1.2.4.4A will show the volcanic centers in the Yucca Mountain site.]

[Note: Information and data regarding the volcanism issue will be presented in this section. The information and data provided will demonstrate whether volcanism is an adverse condition. Further discussion of this issue will be provided in Section 3.2].

3.1.1.2.5 Natural Resources

[Natural resources at the site that are economic, marginally economic, or sub-economic, and the exploitation of which could result in inadvertent intrusion into the controlled area, will be described. Natural resources considered include minerals (both metallic and non-metallic ore), fuels including hydrocarbons (gas, oil, tar sands, asphalt), geothermal resources, and water (potable, agricultural, industrial, and in the form of brine). The economic assessment will include sources such as literature, mapping, geochemical sampling, and comparison with models of known mines, prospects, and exploratory drill holes. The descriptions of the resource will include resource type, occurrence, location, extent, net worth, recoverability, and current and projected use.]

[In addition the following information will be provided:

- A comparison of the site with areas of mineral and hydrocarbon deposits with similar origins, host rocks, and structural regions
- An assessment of the site area based on comparisons with known mineral sources and models
- The location, nature, and extent of any known or suspected mineralization, hydrocarbons (included are the potential for hydrocarbons within the Paleozoic stratigraphic units and trap rocks underlying the site), or waters of elevated temperatures.]

[Possible presence of mineral deposits at the site and their association with stratigraphy or lithologic units of volcanic origin, veining, fault zones, alteration zones, and subsurface plutons will be discussed.] (Table 3.1-BJ) [Additional Figures and Tables will be needed to address various portions of regulations].

3.1.1.2.5.1 Mineral Resources at the Site

Gold, Silver, Base Metal Occurrence. The alteration of the type associated with gold, silver, and base-metals in the volcanic-hosted hydrothermal deposits is generally lacking at the Yucca Mountain site. No significant hydrothermal alterations have occurred since (_ million years) ago. Deposit of calcite and opaline silica are found locally along fault zones near Yucca Mountain. [Investigation will show whether these deposits near Yucca Mountain (are/ are not) of commercial value.]

Gold analyses from (____ samples) from drill core and surface and underground have been analyzed and found to have (__ parts per million to ____ parts per million) of gold and silver. [Table 3.1.1.2.5.1A will summarize the results of assays of gold and silver from rocks at the site. Provide future chemical analyses in parts per billion range for further evaluation of gold and silver potential in Yucca Mountain.]

[The data base will demonstrate whether Yucca Mountain is an unfavorable site for gold, silver and other base metals (provide conclusive evidence for this conclusion).]

Mercury Occurrence. [Site characterization will be needed to determine whether there is potential for mercury deposits at or near Yucca Mountain. Indication of highly silicified, opalized, and mercury-bearing mineral will have to assessed during the site characterization of Yucca Mountain. Determine whether the tuffs shallower than 1,000 meters ever reached sufficient temperature for mercury mineralization, having undergone alteration temperature of no greater than (______ degree C). (Temperatures of 100 to 200 °C are necessary for mercury mineralization.) Mercury mineralization in drill holes or underground rock samples will be assessed. Provide analyses to support conclusions reached .]

3.1.1.2.5.2 Energy Resources at the Site

[Energy resources, consisting of uranium, hydrocarbons (i.e. oil, gas, oil shale, tar, and asphalt deposits, and coal), at the Yucca Mountain site will be discussed below. The data supporting the description of energy resource of the site will be collected from literature search, surface and underground mapping, drill hole sampling, geochemical analyses, and comparison with working models of known mines, and exploratory drill holes.]

Uranium. Data on the variation of uranium content found in the Topopah Spring Member and other tuff units present at the site show uranium content in the range of (___ ppm to ___ ppm). [Analyses of data will determine whether little remobilization of uranium has occurred at the site and that the processes responsible for vein or disseminated deposits have not been active. The presense of silicified bleached rock, extensive fluorite veins, carbonized wood, or other associations indicative of uranium will be assessed during site characterization.]

Hydrocarbon Resources at the Site. [Provide evidence of occurrence of any coal or tar sand deposit during the site characterization activity at the site. Document whether surface exposure or underground evidence of oil shale occurrence has been found during drilling, mapping, and underground exploration at the Yucca Mountain site.]

[Provide evidence of known oil or gas fields within the Death Valley region or in southern Nye County. The thermal history of potential source rocks under the site will provide the necessary evidence (for/against) preservation of any hydrocarbons (KKB-22 provide evidence of oil and gas occurrence below the mountain).]

Geothermal Resources. The vicinity of site has potential for low temperature geothermal energy. [Figure 3.1.1.2.5.2A will show the occurrence of hot springs and geothermal wells and low temperature resources in the vicinity of the site.] The spring and down hole temperatures range from (__ to___ ^{0}C). The average thermal gradient under Yucca Mountain is (__ degree Celsius) per km of depth. The measured heat flow from drill holes in the site ranges from (__ to __ cal/cm2s.

[Water chemistries and the isotopic character of waters from springs and drillholes will be evaluated and used to estimate the temperature at depth with which the thermal water equilibrated.] The water temperature of equilibration is less than (____ ^{0}C) and average approximately (___^{0}C).

[Isotopic data will be used to assess whether waters have equilibrated with meteoric water, hot thermal waters, or result from a mixture of the two.] The results show that the source (provide results when available).

3.1.1.2.6 Geophysics

[The results of geophysical investigations conducted for issue resolution and basic understanding of the site will be described. Data will consist of surface-based geophysical investigation such as: seismic reflection, seismic refraction, gravity, magnetic, aeromagnetics, resistivity, and electromagnetic and borehole geophysical investigations such as:

- Downhole and crosshole seismic surveys
- Nuclear logs
- Acoustic logs
- Borehole gravity, magnetic, and radar.]

[The limitations of the data collected will be discussed with regard to level of detail, resolution quality, and other sources of uncertainty. Detailed characterization of tectonic features, physical properties of the formations, and fracture characteristics will be provided from the investigation (Table 3.1BK).]

[(Note: This subsection will be difficult to prepare because most of the geophysical investigation is in support of determination of lithology, stratigraphy, structural geology, tectonics, natural resources, and other subsystem of the geological system of the site. These other subsections under site should be referred to in this section).]

3.1.1.2.7 Geoengineering

[The geoengineering properties of the rock units present at the site will be described and discussed in detail below.]

[For each rock unit or rock discontinuity, the geoengineering properties should include a set of mechanical properties, a set of thermal and thermomechanical properties, and the existing stress field. These properties include, but are not limited to confined and unconfined compressive strength, Young's modulus, Poisson's ratio, tensile strength, thermal conductivity, and thermal expansion. The properties determined by testing, the testing procedure, the logic for selection of rock samples, the stratigraphic framework for testing (include the strategy for testing intact rock units as well as discontinuities within or between rock units), sample size, the number of joints or fractures, and the conceptual rock mechanics models that used the collected data will be described. The effects of anisotropy lithophysae, porosity, density, and water saturation on the resultant geoengineering properties of the rock units should be included in the description of the testing. The stress field discussions should include geologic and tectonic evidence, results of field testing, and estimates on the variability of the stress field around the site and within the GROA.]

[Excavation characteristics of the rock mass, the methods chosen for excavation of the shafts, ramps, and underground facility, changes in geoengineering properties resulting from excavation and the application of thermal load, estimated in flow of ground water, and estimated ground support requirements under both ambient and elevated temperature conditions will be discussed.]

3.1.1.2.7.1 Geoengineering Properties of Rock Units at the Site

Tests Performed and Methodology. [Table 3.1.1.2.7.1A will show the geoengineering properties that have been determined by testing of rock samples from the site. The tests will be performed to meet regulatory requirements and design issues related to configuration of underground facilities, waste retrievability, non-radiological health and safety, and pre-closure design and technical feasibility. The testing procedures for each type of test will be described. Where available and appropriate, ASTM or ISRM methodology will be used as basis for test development.]

Logic for Sample Selection. [The logic for selection of rock samples (both intact and containing discontinuities) will include attaining a confidence level in the representativeness of data from the rock units present at the site. Sampling strategy will require collection of samples from each unit to represent the spatial and vertical variability of the rock properties.]

Stratigraphic Framework for Testing. [The formal stratigraphic units at the site will be subdivided into further functional stratigraphy depending on the thermo-mechanical properties of the rock units. The functional stratigraphy is better suited for the presentation of the geoengineering properties than the formal stratigraphic units which encompass a wide variation in mineralogic composition, porosity, and fracturing. Figure 3.1.1.2.7.1A will show the thermal/mechanical stratigraphy at Yucca Mountain.]

Thermal and Mechanical Properties. [Table 3.1.1.2.7.1B will show the thermal and mechanical properties for rock (compressive strengths, Young's Modulus, Poisson's ratio, tensile strength, thermal conductivity, and thermal expansion, creep function (?) and others) from each thermo-mechanical equivalent unit. Both intact and discontinuous (joint) properties will be shown.]

[Figures 3.1.1.2.7.1B, C, D, E, G will show the variation of compressive strengths, Young's Modulus, tensile strength, thermal conductivity, thermal expansion and other properties with changes in moisture content, lithophysae, anisotropy, density of the rock units.]

Stress Field. [Measurements of in situ stresses at the site will be made to determine the stress field. The results of individual stress measurements in drill holes at various location within the site will be shown in Figure 3.1.1.2.7.1H. The stress measurement data from underground measurements will be shown in Figure 3.1.1.2.7.1I.] The maximum principal stress at the site is ________. The secondary principal stresses are oriented at the axis (____ provide directions). [Figure 3.1.1.2.7.1J will show the least (horizontal) and maximum (vertical) principal stress values plotted against depth at Yucca Mountain.]

Excavation Characteristics of Rock Mass. [The excavation characteristics of the rock mass will be evaluated from tests on core samples, shaft and ramps construction, and underground drifting using a variety of equipment. Both mechanical and drill and blast mining methods will be used at the site. Table 3.1.1.2.7.1C will provide the rate of advance, assessed damage to the rock, and support requirements for excavation of the rock units present at the site by various mechanical excavators and by drill and blast.]

Methods Chosen for Excavation of the Repository. The repository shafts are to be excavated by (____ method). Ramps are to be excavated by (___ method). The underground facilities are to be excavated by (____ method). The rationale for the selection of excavation methods are provided (_____ provide a discussion for each method selected).

Changes in Geoengineering Properties. [The changes in the geoengineering properties due to excavation by various methods and application of thermal loads will be evaluated using underground measurements, laboratory testing, and numerical analyses (describe the measured and estimated changes in mechanical and thermal properties when data are available).]

Estimated in Flow of Ground Water. The repository is located in the unsaturated zone. The ramps and shafts (encounter/do not encounter) some perched water zones during construction. It is estimated that (__ gpm) of ground water inflow may be expected from the shafts and ramps. In the underground facility, it is estimated that (____ gpm) of water may inflow over the life of the repository. [Table 3.1.1.2.7.1D will show the estimated inflow of groundwater from the underground facility over the operational life of the facility.]

Estimated Ground Support System. [The ground support system will be devised from stress field data, in situ and laboratory measurements of intact and discontinuous rock properties, and using numerical thermo-mechanical analyses and empirical rock mass classification type of analyses. Figures 3.1.1.2.7.1K-O will show the rock mass classification and support requirement for the thermal-mechanical units encountered at the repository and shaft and ramps.] The rock at the repository horizon is classified as (__ to __) and requiring (__describe type of support) in the emplacement and non-emplacement areas of the facility. [Details of the ground support system will be described in Section 4.1.3.1, Excavation and Ground Support System.]

3.1.1.3 Future Variation in Geologic Process

[Assessment of future changes that might be expected to occur in the geologic system will be discussed in this section. This assessment includes the potential for earthquake on any faults in the geologic system the potential for new and any extended faulting and fracturing currently unfaulted and unfractured areas, including location and nature of rupture, and the potential for volcanism including location, extent, and proximity to the site. Also described will be features of interest, how the analog is used; the time frame of the comparative study, and any differences in scale or features between the analog and the site.]

Potential for Earthquake on any Faults. [Describe the potential for earthquake on the faults identified within 10 km of the repository.]

Potential for New and Extended Faulting. [The movement potential of faults within the vicinity of Yucca Mountain is being studied and provide the results when available.]

Potential for Volcanism. [Studies are to be performed for the potential for volcanic eruption within the vicinity of the Yucca Mountain site and will be described here when completed.]

3.1.2 Hydrologic System

[This section will describe the hydrologic conditions of the geologic setting of the region and the site. A description of the hydrology of the site and the surrounding area is presented. The surface water, groundwater (both saturated and unsaturated flow), the interrelationship between the surface and groundwater flow, flooding potential, site drainage, and other hydrologic phenomena will be described. The purpose of this section is to discuss whether the areas studied provide a representative description of the conditions throughout the region, around the site, and at the site. Detailed justification for the areal limits of regional studied will be presented.

3.1.2.1 Surface Water Hydrology

[This section will describe the surface water hydrology characteristics of the hydrologic system. The areas covered by this study include the site, the area surrounding the site, and all areas downstream of the site which could be impacted by the site.]

3.1.2.1.1 Description of Surface Water Bodies and Physical Characteristics of Drainage Areas

[The general hydrographic area studied for the Yucca Mountain site and region will be shown in Figure 3.1.2.1.1A. The peak streamflow data for selected crest-stage sites in the hydrographic study area will be shown in Table 3.1.2.1.1A.]

There are no perennial streams in or near the Yucca Mountain area. However, the many ephemeral stream channels, including the large drainage system of Fortymile Wash and the Amargosa River, flow following significant storms. The Yucca Mountain region has high average annual potential evaporation (___ mm/ year to___ mm/year), low average precipitation (_____ mm/year), and infrequent storms (average frequency ____/year).

Throughout the hydrographic study area, perennial surface water comes only from springs, and restricted to some short reaches of the Amargosa River, to source pools at some large springs, and to some marshes around the edge of the salt pan in Death Valley. One small lake, locally known as Crystal Reservoir, with a storage capacity of 2.27×10^6 m^3 occurs in the Ash Meadows part of the upper Amargosa hydrographic area (Figure 3.1.2.1.1A). There are ______ playas in the site area.

3.1.2.1.2 Surface-Water Monitoring Network

[This subsection will provide information on the surface water monitoring network. The network will be described as to location (see Figure 3.1.2.1.2B), type and number of stations, and measurement frequencies. Data will be collected using a network of crest-stage gages and (_ name other types of gages). These gages will be monitored (__ cite frequency of monitoring). The data collected will be summarized in Table 3.1.2.1.2A. (KKB-23, Provide the surface water monitoring data when available).]

3.1.2.1.3 Water Control Structures and Diversions

[Surface water structures that may influence or be influenced by the site will be described. These structures include existing and planned manmade structures that may influence the potential for flooding. Figure 3.1.2.1.3A will show the location of reservoirs, mining, lumbering and other structures (KKB-24 no data appears to be available at this time and needs to be developed during site characterization.]

3.1.2.1.4 Flood History

Flooding in the Yucca Mountain region can occur over an extensive area, however, intense floods are generally restricted to relatively small areas and occur as flash floods of short duration. [Table 3.1.2.1.4A will show maximum unit peak flood discharges ranging from (__m^3/s to __ m^3/s) for drainage areas greater than 100 km^2 to more than (___ m^3/s) for areas of 10 km^2.

Table 3.1.2.1.5A will show the major flood occurrences in some of the washes. The date, level, peak discharge, and related information for these major floods will be shown in this table. (Flooding induced by landslides and other causes should be included in this table).] Because the Yucca Mountain area is located inland and has no significant water bodies or water control structures located near the site, there is no potential for such features as surges, seiches, tsunamis, dam failures, ice jams that could affect the site, nor is there any potential for future dam development.

[Geologic evidence of Quaternary flooding in the region of Yucca Mountain with emphasis on the Holocene will be presented here (KKB-25, this information needs to be developed from further studies).]

3.1.2.1.5 Flood Potential

[Studies will be performed for flood prediction in the region and site using regional stream flow, precipitation, channel morphology data and modeling. These studies will be supplemented by investigation of paleoflood sediments which provide history of major floods in the area.]

[Estimates of the magnitudes of the 100 and 500 year flood peaks and the regional maximum peaks will be shown in Figure 3.1.2.1.5A. The design basis water level at the location of the surface facilities and underground accesses will be shown in Figure 3.1.2.1.5B. Table 3.1.2.1.5B will provide the elevation of all structures and systems related to the surface facilities and underground openings.]

The method for calculating the probable maximum flood is based on a determination of maximum probable precipitation over the drainage or drainage being considered. [Detailed information of the drainage basin including stream flow data, precipitation and storm data, infiltration runoff characteristics and other information will be used in flood prediction calculation.]

[Protection of potential flooding at the site will be considered in choosing the proposed locations for the surface facilities and underground accesses. Topographic maps, direct observation, PMF flows and level will be considered in the design of the repository.]

3.1.2.1.6 Chemical Composition of Identified Bodies of Surface Water

[The chemical composition of bodies of water that could be affected by releases from the facility will be described. The seasonal cycles of physical and chemical limnological parameters, bottom and shoreline configuration, sedimentation rates (suspended and bed load), and sorption rates (as asked for in the Reg Guide DG-3003) are not applicable in the discussion of the chemical composition of surface water in the Yucca Mountain region because of the arid to semiarid climate.]

[Surface water samples will be collected from the Yucca Mountain hydrographic area. The location of the samples will be shown in Figure 3.1.2.1.6A. The chemical composition of the watercourses in the vicinity of Yucca Mountain will be shown in Table 3.1.2.1.6A .]

3.1.2.1.7 Location, Quantity, and Quality of Surface Water Extracted

Very little surface water exists in the vicinity of Yucca Mountain because of the arid to semiarid climate. No perennial stream exists except short reaches of the Amargosa River which is fed by springs. Other sources of perennial surface water are small spring fed ponds in Oasis Valley, the Amargosa Desert, and Death Valley. [The locations of perennial sources of surface water will be shown in Figure 3.1.2.1.7A. Table 3.1.2.1.7A will show the water source location, owner, type of intake, population served, maximum daily and average quantities of water pumped. Table 3.1.2.1.7B will provide the water quality of these sources.]

3.1.2.1.8 Projected Surface Water Use

[A projection into the foreseeable future of the quantities and potential areas of surface water use for the region will be provided here.] Arid conditions of the region and the absence of perennial streams and lakes make surface water an unlikely source of use for the Yucca Mountain region.

Surface water use by man would probably increase (___ provide justification of statement) only in the event of climate change to a wetter one.

3.1.2.2 Regional Hydrogeology

[This section will provide general information on the regional hydrogeology. This will describe the regional groundwater conditions that may be affected by the MGDS. In addition, the existing and projected users and uses of groundwater will be described.]

3.1.2.2.1 Regional Flow System Boundaries and Hydrogeologic Units

[This section will describe the physical boundaries and hydrogeologic units of the regional hydrogeological system.] A hydrogeologic unit is a geologic unit with consistent hydraulic properties such that the unit may be classified as an aquifer, confining layer, or a combination of both. [The hydrogeologic units at the Yucca Mountain region will be defined on the basis of stratigraphy, lithology, and structural considerations. Figure 3.1.2.2.1A will show the distribution of the hydrogeologic units in the saturated zone Yucca Mountain region. Table 3.1.2.2.1A will show the relation between stratigraphic and geohydrologic units in the Yucca Mountain region.]

3.1.2.2.2 Potentiometric Levels and Hydraulic Gradients

[The time history and areal distribution of measured potentiometric levels of each hydrogeological unit will be described. The observed hydraulic gradients within and between units will also be discussed. Figure 3.1.2.2.2A will show the location of the wells and the potentiometric surface of the regional geohydrologic area. Potentiometric data will be collected from regional potentiometric levels, monitoring well network, and local water-level monitoring.]

3.1.2.2.3 Characteristics of the Hydrological Units

[The hydraulic characteristics of each hydrogeologic unit will be described below, and geostatistical analysis of the hydraulic characteristics of each unit will be presented. Table 3.1.2.2.3A will show the hydraulic characteristics of each major unit in the Yucca Mountain region. Table 3.1.2.2.3B will show the geostatistical analyses of the hydraulic characteristics for each unit.]

3.1.2.2.4 Recharge and Discharge

[The recharge and discharge areas in the ground water basin will be shown in Figure 3.1.2.2.4A.] Recharge occurs from surface water runoff along major channels (__ provide name of channels). Ground-water discharges from the basin by spring flow, evapotranspiration, and, evaporation from bare soil area. The principal areas of discharge are in the southern Amargosa Desert. [Smaller, less significant areas are near Beatty, Indian Springs and in Death Valley and will be shown in Figure 3.1.2.2.4A. Table 3.1.2.2.4A will show major ground water discharge in the hydrogeologic region of Yucca Mountain.]

3.1.2.2.5 Age of Regional Ground Water

[An estimate of the regional ground waters based on hydrochemical information will be provided. Table 3.1.2.2.5A will show the estimated age of the major regional ground water ages.]

3.1.2.2.6 Ground-Water Flow Paths

Ground water movement is mostly from recharge areas in the (___ parts of the area) to the discharge areas in the (___ parts of the area) basin. Groundwater generally flows (___ in the direction) through most of the area with local variation (___ provide local direction). [Figure 3.1.2.2.6A will show the regional ground-water flow paths. Figure 3.1.2.2.6B will show a cross section providing the flow net through the region.]

[The flow paths will be developed from hydraulic characteristics, gradients, hydrochemistry, recharge, discharge, temperature profiles in wells (___ add any other studies for flow path determination). Numerical modeling will be performed using the codes (__ name the codes and methodology, and provide documentation, verification, calibration and other associated information for the numerical models).]

3.1.2.2.7 Paleohydrology

[The geologic evidence of hydrogeologic conditions throughout the region that have occurred during the Quaternary Period with emphasis on the Holocene Age will be described here. Figure 3.1.2.2.7A will show the south central Great Basin location of uranium-series dated veins which is evidence of former high levels of water in this basin. This indicates that higher levels of water occurred during the Pleistocene time, (__ yr to __ ago).] The Quaternary water table may have been (____ meters to _____ meters) above the current water table.

[Figure 3.1.2.2.7B will show the probable ground water flow paths during the Quaternary Period.] During the late Wisconsin, 21,000 to 10,000 years ago, average annual precipitation may have been (___ percent) greater, and temperature may have been (____ degree C) cooler. (Provide discussion of groundwater during the late Wisconsin.)

3.1.2.2.8 Regional Ground Water Use

The regional aquifers in the hydrogeologic study area that are used for human activities are the valley fill aquifer and the lower carbonate aquifer. The welded tuff aquifer is locally important; it is developed only in the southwestern areas of the NTS in support of the former Nevada research and development area. [Figure 3.1.2.2.8A will show areas of heavy withdrawal and injection of ground-water in the regional hydrologic area. Table 3.1.2.2.8A will show a list of wells in the region with location, rates of withdrawal, typical well construction, and specific hydrologic unit source. Ground water usage for irrigation, municipal, domestic, livestock, and energy resources (mining ?, geothermal) will be included.]

[Table 3.1.2.2.8B will show a list of wells in the region where water is injected, the location of the wells, method of construction, rate of injection, and the hydrologic unit where water is injected. Figure 3.1.2.2.8B will show the location of these injection wells in the regional geohydrologic area.]

3.1.2.2.9 Regional Ground Water Management Plan

Water use in Nevada is governed by the Office of the State Engineer, and the Division of Water Resources. Chapter 534 (Title 48-Water) of the Nevada Water Laws outline and delineate the allowable uses of ground water. The State of Nevada uses a recharge-use philosophy in its management of ground water resources. At the first indication of an aquifer overdraft, measures are taken to carefully regulate ground water withdrawals. The State Engineer has the authority to designate ground water basin boundaries where he considers the ground water resources are being depleted. [Such designation has been issued in the regional areas of (___ name any such designated area at the time of License Application. (Also provide an assessment of the regional ground-water projection at that time depending the policy of the State of Nevada).]

3.1.2.3 Site Hydrogeology

[This section will describe the site hydrogeologic system and supporting data and technical analyses.]

3.1.2.3.1 Baseline Monitoring Network

[Monitoring wells will be established in the saturated and unsaturated zone at the site.]

Unsaturated Zone. The monitoring program is designed to quantify the energy status of the variably saturated rock system at Yucca Mountain. Fluid potentials that govern variably saturated rock are the two-phase (liquid-gas) flow and are measured by a monitoring network. These potentials are: 1) matric potential for the liquid phase, 2) gas-phase or pneumatic phase, 3) osmotic potential, and 4) thermal potential. Gravitational potential is given directly by the height of the monitoring point above an arbitrary datum.

[Figure 3.1.2.3.1A will show the locations of the bore holes that are being used to monitor the unsaturated zone at Yucca Mountain site. Figures 3.1.2.3.1(B-R ?) will show the construction, wellhead elevation, total depth, casing type and depth, seals, screened intervals, monitoring intervals, instrumentation, and time since instrument installation in the monitoring bore holes. The selection process for choosing the locations and depth of the data collection system will be described below (KKB-26 provide this information when monitoring wells are selected).]

Saturated Zone. In the saturated zone, water table levels are measured in order to determine the potentiometric surface at Yucca Mountain. [The location of the saturated zone monitoring wells will be shown in Figure 3.1.2.3.1S. Figure 3.1.2.3.1T will show the typical construction of these monitoring wells. Table 3.1.2.3.1A will show a list of all monitoring wells in the saturated zone at the site, and includes the location, wellhead elevation, total depth, diameter of well, depth of completion, construction of each well, monitoring interval, seals etc.]

[Reasons for the selection of these wells will be detailed below (KKB-26 provide the rationale when monitoring wells are completed).]

3.1.2.3.2 Site Flow System Boundaries and Hydrogeologic Units

[The site hydrogeologic units and their correlation with rock stratigraphic units for the unsaturated (vadose) zone and saturated zone will be shown in Figure 3.1.2.3.2A. A discussion of the basis for selection of these hydrogeologic units will be described below (KKB-27 provide this discussion once hydrogeologic units are confirmed).]

3.1.2.3.3 Potentiometric Levels, Matric Potentials, and Gradients

Unsaturated Zone. [In situ measurements of matric potential within the unsaturated zone at Yucca Mountain will be measured in instrumented boreholes. See Figure 3.1.2.3.3A (to be developed) for the location of these instrumented boreholes. Figure 3.1.2.3.3A will show a representative profile of matric-potential measured in the boreholes by various instrumentation (___ name instrumentation e.g. heat-dissipation probes, thermocouple psychrometers).]

[The time history and areal distribution of the measured matric potentials and moisture contents (including osmotic potential) will be discussed for each hydrogeologic unit at the site. (KKB-28, provide this discussion when data are available).]

[The temporal and spatial extent of the perched water system encountered at the site will be described below. (KKB-28 provide perched water system information if found during site characterization).]

Saturated Zone. [Potentiometric data will be obtained in the saturated form measuring water levels and observing their variation with time. Water levels in the monitoring well from the site at selected dates will be shown in Table 3.1.2.3.3A and Figure 3.1.2.3.3A.] The water levels range in elevation (___ meters to ___ meters) above sea level and generally represent water-table or unconfined conditions. [Figure 3.1.2.3.3B will display a cross section through the Yucca Mountain site showing the potentiometric surface and its relationship with the stratigraphic units.]

The gradient of the saturated zone is (KKB-28 provide discussion of water surface gradient within and between individual geohydrological units at the site).

[Hydrographs of water level data will not be provided (KKB-29 verify this when data are available).] In Yucca Mountain ground water levels do not show short term or seasonal fluctuations that can be correlated with precipitation. This is because of extremely low rate of net infiltration (__ provide number) and recharge attributable to local precipitation, the great depths to water table (___ meters to ____ meters), and very long ground water travel time (ranging from ___ mm/year to ___ mm/year). [Characteristic fluctuations resulting from various factors such as seasonal pumping variations, seasonal response to surface water bodies, barometric data will be presented. Figure 3.1.2.3.3C will show potentiometric fluctuation due to pumping at the site. Figure 3.1.2.3.3D will show a typical response to barometric variation and water table at the site.]

3.1.2.3.4 Characteristics of Hydrogeologic Units

[The characteristics of each hydrogeologic unit at the site will be described in detail below.]

3.1.2.3.4.1 Saturated Media

General Physical Characteristics. [Table 3.1.2.3.4.1A will show the total and effective porosity including the nature of porosity (interstitial, fracture, or solution). Figure 3.1.2.3.4.1A will show the fracture geometry, orientation, filling and fracture matrix sealing along the surface for each hydrogeologic unit in the saturated zone.]

General Hydraulic Characteristics. [Table 3.1.2.3.4.1B will present the summary of hydrologic characteristics of the major hydrogeologic units at Yucca Mountain.] Characteristics include intrinsic permeability transmissivity, hydraulic conductivity (with saturated thickness), leakage coefficients for aquitards, and the storage coefficient.

General Transport Characteristics. [The longitudinal and transverse dispersivity and tortuosity of each hydrogeological unit at Yucca Mountain will be described here. Table 3.1.2.3.4.1C will provide the data for these transport characteristics.]

3.1.2.3.4.2 Unsaturated Zone

General Physical Characteristics. [Table 3.1.2.3.4.2A will show the mean values of total and effective porosity, bulk and skeletal density of the unsaturated units at the site. Figure 3.1.2.3.4.2A will show the fracture geometry and orientation. Figure 3.1.2.3.4.2B will show the pore geometry and pore size distribution for the hydrogeological units.]

Additional Fracture Surface Characteristics. [A description of the characteristics of fractured media including fracture-matrix sealing along surfaces, fracture surface profiles, roughness, fracture permeability, drainage suction (capillary aperture), and fracture conductance (conductivity normal to fracture plane) will be provided here. See Figure 3.1.2.3.4.2C and Table 3.1.2.3.4.2B.]

General Hydraulic Characteristics. [Table 3.1.2.3.4.2C will show the mean values of hydraulic characteristics of unsaturated zone including air or water intrinsic permeability and Klinkenberg coefficient. Figures 3.1.2.3.4.2D, and E will show unsaturated hydraulic conductivity as a function of water content and matric potential. Figure 3.1.2.3.4.2E will show the moisture characteristic curves (both wetting and drying) for the hydrogeologic units of the unsaturated zone. Figure 3.1.2.3.4.2F will present moisture diffusivity as function of water content and matric potential, and Figure 3.1.2.3.4.2G will show specific water capacity as a funciton of both water content and matric potential.]

General Transport Characteristics. [Table 3.1.2.3.4.2D will show the longitudinal and transverse dispersivity for the unsaturated zone units at the site.]

General Pneumatic and Vapor Transport Characteristics. [Table 3.1.2.3.4.2E will present the unsaturated pneumatic permeability and the relevant diffusion characteristics. The variation of existing gaseous components as well as existing gaseous flow and transport conditions will be described.]

Parameters for Hydrologic Models

3.1.2.3.5 Site Ground Water Recharge

The ultimate source of moisture in the unsaturated zone in Yucca Mountain site is by net infiltration from precipitation on the mountain. The average annual precipitation in Yucca Mountain site is (___ mm/year). [The spatial and temporal variation of net infiltration will be evaluated at the Yucca Mountain site; however, because of the great depth of the saturated zone, the temporal variation and spatial distribution beneath Yucca Mountain is not expected to be equal to the temporal distribution and surficial distribution of net infiltration. Slow temporal variation of the moisture flux at any horizon is expected to occur generally only in response to long term climatic changes (provide results of analyses to support this assertion).]

[Note: This section will present information and dates used in determining the groundwater travel time used in resolving the pre-emplacement issue. The pre-emplacement groundwater travel times will be fully discussed in Section 3.3.2.]

The present rate of net infiltration over the surface of Yucca Mountain is not a reliable indicator of either the net recharge beneath Yucca Mountain or the net moisture flux at or below the repository horizon.

[A recharge rate will be estimated using regional relationship among recharge, altitude zones, precipitation, runoff during intense storms, local rainfall distribution, temperature, vegetation cover (KKB-30, provide the results of this study when completed). Ground water modeling analyses will be performed in support of recharge estimates. Figure 3.1.2.3.4.2H will show the ground water recharge at the site.]

3.1.2.3.6 Site Ground Water Discharge

[Figure 3.1.2.3.6A will show the springs, seeps, stream base flow and other local ground water discharge in the Yucca Mountain area.]

3.1.2.3.7 Age of Ground Water

[An estimate of the age variation of the site ground waters and velocity of movement at the site based on hydrochemical information will be provided. Table 3.1.2.3.7A will summarize this information. The method of ground water age and velocity determination as well as error analyses of all results will be described and documented in this subsection.]

3.1.2.3.8 Site Pathway Analysis

[This section will describe the fluid pathways (e.g. liquid or gas) to the accessible environment. The methodology to be used to develop the description of fluid pathways will consider the distribution of flux and use information on hydraulic characteristics, gradients, hydrochemistry, recharge, discharge and other data developed through site characterization activities. The variability and uncertainty of data will be accounted for in the analyses and justification for neglecting any contradictory information will be provided. The transience of baseline conditions and the sensitivity of baseline conditions to the perturbation in the context of existing or near term time frame (not thousands of years) will be assessed.]

[Numerical modeling using (____ name computer codes) will be used to develop fluid pathways at the site. The numerical analyses type (____ finite difference, finite element, closed form solution etc.) documentation of code and verification, calibration, and other associated information will be provided. (KKB-31, provide fluid flow numerical code information when analyses is complete). Figures 3.1.2.3.8A and B will show the generalized east-west and north-south fluid flow system under natural conditions. Figure 3.1.2.3.8C will show the generalized ground water flow in the Yucca Mountain site.]

3.1.2.3.9 Local Ground Water Use

[All the local ground water users and their locations, rates, typical well construction, and hydrogeologic unit source will be identified. Figure 3.1.2.3.9A will show the location of the local ground-water users. Table 3.1.2.3.9A will show the information regarding the local water users.]

3.1.2.3.10 Paleohydrology

[The hydrological conditions during the Quaternary Period, with emphasis on Holocene, that differ significantly from present conditions at the site will be described.]

[The paleohydrology of the site will be assessed from field studies (____ name these studies) and computer modeling (____ name codes, and provide documentation).] On the basis of mineralogy, ground water level in the Quaternary was estimated to be (between ___ meters and ____ meters) above the current level at the site.

[The pluvial related water table levels beneath the Yucca Mountain will be analyzed using numerical (____ provide type of model) modeling of ground water at the site. In an LA, a statment such as the following will be needed: The results conclude that in the past, water levels at the site in the past have been (____ meters) above the current level.]

[Deposits along the fault zones will be investigated for evidence of change in hydrologic conditions. The origin of deposits prove that minerals have been deposited as a result of (KKB-34, provide results of trench 14 and other future tests).]

3.1.3 Geochemical System

[This section will describe the geochemical characteristics of the geologic setting and the site, including information on anomalies, properties, and conditions affecting the stability of geochemical characteristics. This section will discuss whether the areas studied provide a representative description of the conditions throughout the region around and at the site. Detailed justification for the areal limits placed on regional studies will be provided. The difference between unsaturated zone and saturated zone geochemical characteristics, properties, and conditions will also be included.

3.1.3.1 Regional Geochemistry

[The saturated and unsaturated zone geochemical characteristics, conditions, and properties of the region will be described in this section. Specifically, the conditions and processes that exist and have existed during the Quaternary Period, with emphasis on those differing from the present conditions, will be described below. An assessment of changes that might be expected in the future will be presented. Sufficient details will be provided to allow independent analysis of the results. The use of natural analogs for describing geochemical systems of the region and site will be addressed, and the role of expert judgment in the various analyses will be documented.]

3.1.3.1.1 Information and Investigations on the Geochemistry of the Regional Rock

[The regional saturated and unsaturated zone mineralogy, petrology, and chemistry will be described in this section including:

- Bulk rock chemistry (Figure 3.1.3.1.1A, Table 3.1.3.1.1A)
- Mineral distributions in bulk rock (Figure 3.1.3.1.1B, Table 3.1.3.1.1B)
- Mineral chemistry (Table 3.1.3.1.1C)
- Mineral distributions in fractures (Figure 3.1.3.1.1C, Table 3.1.3.1.1D)
- Chemistry of fracture deposits (Figure 3.1.3.1.1D, Table 3.1.3.1.1E)
- Information on rock, mineral and glass origins, mineral and glass stability, and general thermal characteristics. Differences between the geochemistry of the regional saturated and unsaturated zones (Table 3.1.3.1.1F) will also be discussed.]

[The codes used to model saturated and unsaturated zone rock/fracture geochemistry will be described including the uncertainties related to the thermodynamic data bases, the applicability of specific models, the appropriateness of the assumptions used in models, the sensitivity of model results to variability and uncertainty of input data, the propagation of errors, and the input/output data, and interpretations of data used in models.]

3.1.3.1.2 Information and Investigations on the Regional Geochemistry of the Ground Water and Gas

[The regional properties and chemistry of the saturated and unsaturated zone ground water will be described in this section. Including:

- Ground water chemistry (Table 3.1.3.1.2A)
- Dissolved gas content (Table 3.1.3.1.2B)
- Major and minor inorganic and organic content (Table 3.1.3.1.2C and Table 3.1.3.1.2D)
- Trace element content (Table 3.1.3.1.2E)
- Stable and radioactive isotopes (Table 3.1.3.1.2F), particulate, colloids, and mineral controls on water composition.
- Discussion and rationale for the selection of ground water used in conducting experiments.
- Differences between the regional saturated and unsaturated zone ground water geochemistry (Table 3.1.3.1.2G).]

[The regional properties and chemistry of the saturated and unsaturated zone gas will be described herein including an analyses of inorganic context and discussions on stable and radioactive isotopes, aerosols, and temperature and pressure.]

[The location of samples and data collection methods will be presented in this section and include an evaluation of data representativeness, the effects of scale differences between laboratory and field data sources, the effects of varying hydrologic conditions, and uncertainties associated with the extrapolation of data and information.]

[The codes to be used to model saturated and unsaturated zone ground water geochemistry will include uncertainties related to the thermodynamic data bases, the applicability of specific models, the appropriateness of the assumptions used in models, the sensitivity of model results to variability and uncertainty of input data, propagation of errors, and the input/output data and interpretations of data used in models.]

3.1.3.1.3 Information and Investigations on the Regional Geochemistry Governing Radionuclide Mobility

[The regional saturated and unsaturated zone geochemical properties and conditions that affect radionuclide mobility will be discussed herein and include: 1) solubility and precipitation as a function of radionuclide speciation (Table 3.1.3.1.3A); water chemistry (Table 3.1.3.1.2B); radiation field; 2) sorption and desorption as a function of ground water composition (Table 3.1.3.1.3C); mineralogy and surface structure (Table 3.1.3.1.3D); speciation; waste element concentration; gas composition; temperature; colloidal material; organic complexity; 3) sorption kinetics; 4) biological sorption and desorption; 5) dispersive, diffusive, and adjective process; and

6) transport of gaseous radionuclides. Differences between regional saturated and supersaturated zone radionuclide transport characteristics will be presented.

[Sources of information, location of samples, and data collection methods will be described and documented in this section. Included will be:

- Evaluation of data representativeness
- Effects of scale difference between laboratory and field data sources
- Effects of varying conditions
- Uncertainties associated with the extrapolation.]

3.1.3.2 Site Geochemistry

[Sufficient data and technical analyses will be provided to describe the saturated and unsaturated zone geochemical characteristics, conditions, and properties of the site. Specifically, the geochemical conditions and processes that exist and have existed during the Quaternary (with emphasis on those that differ significantly from present conditions), will be presented. Assessments of changes that might reasonably be expected to occur in the future will be included. The use of natural analogs will be addressed. The role of expert judgment will be documented.]

3.1.3.2.1 Information and Investigations on the Geochemistry of the Site Rock

[The site saturated and unsaturated zone mineralogy, petrology, and chemistry will be described here. This information will include: bulk rock chemistry, mineral distributions in bulk rock, mineral chemistry, mineral distributions in fractures, chemistry of fracture deposits, information on rock, mineral, and glass origins; alteration history of bulk rock and fracture mineralization; mineral and glass stability, and general thermochemical characteristics. The differences between the geochemistry of the site saturated and unsaturated zones will also be discussed.

[The sources of information, location of samples, and data collection methods will be discussed and documented. The discussion will include:

- Evaluation of data representativeness
- Effects of scale difference between laboratory and field data sources
- Effects of varying conditions
- Uncertainties associated with the extrapolation of data and information

[The codes to be used to model saturated and unsaturated zone rock/fracture geochemistry will be discussed including the uncertainties related to the thermodynamic data bases; applicability of specific models; appropriateness of the assumptions used in models; sensitivity of model results to variability and uncertainty of input data; propagation of errors; and input/output data, and interpretations of data used in models.]

3.1.3.2.2 Information and Investigations on the Geochemistry of the Site Ground Water and Gas

[The properties, character, and chemistry of the saturated and unsaturated zone ground water and gas at the site will be described herein and the discussion will include:

- Ground water chemistry
- Major and minor inorganic and organic content
- Trace element content
- Stable and radioactive isotopes
- Dissolved gas content
- Particulates
- Colloids
- Mineral controls on water composition.]

[Discussion and the rationale for the selection of ground water used in conducting experiment and the differences between the site saturated and unsaturated zone ground water geochemistry will also be described.]

[The site properties and chemistry of the saturated and unsaturated zone gas will be described, and included in the description will be the analyses of inorganic context; stable and radioactive isotopes; aerosols; and temperature and pressure.]

[The sources of information and data collection methods used to obtain measurements and observations will be presented. The discussionwill include an evaluation of data representativeness; effects of scale difference between laboratory and field data sources; effects of varying hydrologic conditions; and uncertainties associated with the extrapolation of data and information.]

[The codes to be used to model saturated and unsaturated zone ground water geochemistry will also be discussed and include the uncertainties related to the thermodynamic data bases; applicability of specific models; appropriateness of the assumptions used in models; sensitivity of model results to variability and uncertainty of input data; propagation of errors; input/output data, and interpretations of data used in models.]

3.1.3.2.3 Information and Investigations on the Site Geochemistry Governing Radionuclide Mobility

[The site saturated and unsaturated zone geochemical properties and conditions that affect radionuclide mobility will be described including: 1) solubility and precipitation as a function of radionuclide speciation, water chemistry, and radiation field, 2) sorption and desorption as a function of ground water composition, mineralogy and surface structure; speciation; waste element concentration; gas composition; temperature; colloidal material; and organic complexity, 3) sorption kinetics, 4) biological sorption and desorption, 5) dispersive, diffusive and adjective processes, and 6) the transport of gaseous radionuclides.]

[The sources of information, locations of sampling, and data collection methods used to obtain measurements and observations will be described and documentation will be provided. The discussion will include the evaluation of data representativeness, the effects of difference of scale between laboratory and field data sources, the effects of varying conditions, and uncertainties associated with the exploration data and information.]

[The conceptualizations and the documentation and validation of codes used to model saturated and unsaturated zone radionuclide mobility will be discussed with respect to uncertainties related to thermodynamic data bases, the applicability of specific models, the appropriateness of assumptions used to model site radionuclide mobility in the saturated and unsaturated zone, and the sensitivity of model results to the uncertainty of the geochemical input date will be discussed. The variability and uncertainty of data and information, as well as the propagation of errors will also be presented. Input/output data and interpretations will also be provided.]

3.1.4 Climatological and Meteorological Systems

[Past and present climatological and meteorological conditions of the geologic setting and the site will be described herein. An assessment of future climatic variation of the site will also be provided. This section should demonstrate whether the areas studied provided representative descriptions of the conditions throughout the region around the site and at the site.]

3.1.4.1 Present Climate and Meteorology

[The baseline climatological and meteorological conditions of the site will be described in this sub-section.]

3.1.4.1.1 Climate

[The general climate of the region and site will be described with respect to types of air masses, synoptic features, frontal systems, airflow patterns, and relationships between synoptic-scale atmospheric processes and site meteorological conditions. Climactic characteristics attributable to the terrain will also be identified.]

[Site and regional climatological data for Yucca Mountain will be collected from (____ number of) monitoring stations at the site, and weather stations operated by National Weather Service (NWS). These data will be supplemented by information obtained from the National Oceanic and Atmospheric Administration (NOAA), and the National Climatic Center (NCC), government facilities (NTS ?), and universities (____ name any). Figure 3.1.4.1.1AG will show the locations of the climatological data stations in the Yucca Mountain region.]

The Yucca Mountain site is situated in an area bordering two NWS climatological zones of Nevada, south central and extreme southern. Lower elevations in the vicinity of Yucca Mountain experience conditions typical of southwestern desert zones within the United States that are characterized by hot summers, mild winters, and limited amounts of precipitation. Higher elevations have less severe summer temperatures and greater, but still limited amounts, of precipitation.

The major air masses affecting the weather at Yucca Mountain originate either over the Pacific Ocean or over polar-continental regions. A thermally induced area of low pressure is created during the summer months over most desert regions (Reference 3.1.4.1.1A, Wallace and Hobbs, 1977), and prevails over the southwestern United States during the summer. Although this thermal low is generally associated with weak cyclonic motion (Reference 3.1.4.1.1B, Huschke, 1959), it brings south to southwesterly wind to the Yucca Mountain area. Another less frequent summer circulation pattern that brings moisture to the area is a semipermanent subtropical high-pressure system called a Bermuda High (Reference 3.1.4.1.1B, Huschke, 1959).

In addition to these synoptic-scale climatic influences, the rugged terrain of the Yucca Mountain area can create micrometeorological variations of a given parameter within relatively short distances. Drainage winds are an example of this phenomenon. These winds can locally affect wind speed, wind direction, and temperature (Reference 3.1.4.1.1C, Eglinton and Dreicer, 1984).

Another example of micrometeorological variations induced by the terrain is the variability in precipitation amounts between stations at different elevations, and between those with differing exposure to prevailing storm tracks or occurrences. [Table 3.1.4.1.1A will provide a general outline of the climatic conditions experienced at Yucca Mountain.]

[The relationship between synoptic-scale processes and their effect on site-specific meteorology will be established using the multi-tower monitoring program implemented at Yucca Mountain (KKB-35, provide the data when this program is established and data become available).]

The climatological conditions at the site impact the design and operation of the repository. [The surface facilities will be designed to withstand temperature, wind, and precipitation conditions. The potential for flooding at the surface facilities and underground accesses will be considered in the design. The ventilation system for the surface and underground facilities will be impacted by the climatological conditions.]

3.1.4.1.2 Site Meteorological Monitoring Network

[The network of meteorological monitoring instruments used to develop baseline information for the site will beescribed.] The key meteorological data that indicate local climate are temperature, precipitation, relative humidity, insolation, ground surface infrared radiation, soil temperature, barometric pressure, wind speed, and wind direction. [The site monitoring program will also be collecting both synoptic-scale meteorological influences and specific terrain-induced perturbations. Meteorological data at the site will be collected from monitoring stations. The locations of these stations will be shown in Figure 3.1.4.1.2A. Table 3.1.4.1.2A will provide specific information as to elevation, type and period of measurements for each of these stations. The instrumentation of these stations will be described in Table 3.1.4.1.2B including the frequency of measurements.

Regulatory Guide 1.23, "Onsite Meteorological Programs" will be used for guidance in setting up the onsite meteorological measurement and data format.]

3.1.4.1.3 Site Meteorology

[The site meteorological conditions, including temperature, humidity, average and extreme durations and intensity of precipitation, and average and extreme wind vectors will be described herein. Table 3.1.4.1.3A will show the temperature data at the site including: average daily maximum, highest daily, average daily minimum, lowest daily, and monthly average for the period of record (19xx to 20xx). Table 3.1.4.1.3B will show the relative humidity and wet-bulb data for the site.]

[Table 3.1.4.1.3C will show the average and extreme duration and intensity of precipitation at the site. Figure 3.1.4.1.3A will show the monthly average precipitation for stations located at the Yucca Mountain. Table 3.1.4.1.3D will show the maximum 1 and 24 hour precipitation levels at the site. The seasonal variation of wind direction and speed will be shown in Figures 3.1.4.1.3B and C for elevations of (____ meters and ____ meters). The same data will be presented in Table 3.1.4.1.3E and Table 3.1.4.1.3F. Annual extreme wind speed at (____ meters) above ground at the site will be provided in Table 3.1.4.1.3G.]

3.1.4.2 Paleoclimatology

[An analysis of the Quaternary climatology of the site will be presented here including the atmospheric, hydrospheric, and cryospheric aspects of the successive climatic regimes in the context of determining the magnitude of the climatic changes and the rates at which the changes occurred. Changes in precipitation regimes, glaciated areas, and windflow patterns will be identified.]

[Historical and prehistorical climatic, limnologic, hydrologic, and vegetational date obtained from near Yucca Mountain and the surrounding region will be used to increase and supplement the paleoclimatic data base use for characterization of the Yucca Mountain site. These data will be used in the calibration of vegetation-climate and lake-climate models, as well as in the development of a regional climate model. Pollen and pack rat midden macrofossil assemblages from the (____ name area) will be collected and correlated with climatological data. Table 3.1.4.2A will provide a summary of palynological and pack rat midden data from the Yucca Mountain site.]

[Sediment cores will be obtained from playas, paleomarshes, and lakes near Yucca Mountain and the site which will provide a dated time series of:

- Changes in size, chemistry, and productivity of lakes.
- Wet phases in now dry playas and marshes.

- A generalized model of the site was developed for the Quaternary climatic variation at the site and surrounding region (KKB-36, provide the results of modeling when complete).]

[The size (areal extent and thickness) of glaciers and their accumulation and ablation rates, and the impact of glaciers on precipitation regimes and windflow patterns will be presented (KKB-36, provide glacier information at the site if appropriate). The relationship between air temperature and regional precipitation, in relationship to the water balance of the area will also be discussed. (KKB-36, provide such discussion).]

3.1.4.3 Future Climatic Variation

[An assessment will be made of the magnitude and rate of climatic changes that might reasonably be expected to occur in the future. The assessment will be based on the reconstruction of the paleoclimate and the recent climate, and will consider human activities for both the present and near-term future. Long-term estimates of climatic variations will also be included.]

The paleoenvironmental record for the Quaternary shows that significant variations have occurred in the past, and similar variations can be expected in the future. The repeated fluctuations between glacial and interglacial climates during the Quaternary have occurred in response to changes in the seasonal and latitudinal receipt of solar radiations as determined by the earth's orbital elements (Reference 3.1.4.2A, Hays et. al., 1976).

[For the near-term future (the next 10 to 1000 years), predictions of climate, the effects of large inputs of anthropogenic aerosols, carbon dioxide, and other trace gases in the climate system will be taken into account. In addition, climatic, stream flow, and vegetational data for the region and site during the past (____ years) will be used for modeling purposes. Vegetational, geologic, and hydrologic time-series data will also be used in developing the future climate modeling effort. (KKB-37, describe the results of near-term future climatic modeling effort).]

Over the long-term (1000 to 100,000 years), climatic variation estimates include: 1) potential maximum and minimum changes and rates of change in precipitation and air temperature from the present, 2) potential regional windflow and precipitation patterns that may evolve in the future as a result of climatic and geologic changes, 3) the potential for glaciation, including estimates of times of onset of glaciation and lengths and severity of glacial regimes in the site area, and 4) future fluctuations in sea levels and the cryosphere caused by climatic changes. [Models for the Yucca Mountain site will be formulated using (____ name of code, documentation) and methodology (____ describe methodology) will be used to perform the estimate. (KKB-37, provide the results of the modeling and other analyses for the long-term estimate).]

3.1.5 Integrated Natural System Response to the Maximum Design Thermal Loading

[The anticipated response of the geomechanical, hydrologic, and geochemical subsystems to the maximum design level thermal loading, considering the discontinuities and the heat transfer properties of the rock mass and ground water will be described here.] The maximum design thermal load of the repository is (____ W/m ^{2}).

3.1.5.1 Response of Geomechanical Subsystem

The design level thermal load, due to the emplacement of waste in the repository, will affect the geomechanical subsystem in the near and far field.

Emplacement of hot nuclear waste in relatively cold (____ ^{0} C), partially saturated tuff will produce a geomechanical response in the rock mass. Both the temperature and temperature gradient will change with development of thermal stresses and strains. A number of phenomena, including mineral phase changes, dehydration, and mineral and water expansion, will contribute to the response of the rock mass to the application of thermal load.

The thermal load will induce stresses in the rock mass that can produce new fractures, and opening or closing of existing discontinuities. The existing stress regime can change in a transitory manner due to the heat flux and affect the stability of the repository during its development and operation.

The intact mechanical properties of the rock at the site are affected by the thermal load imposed on them. [These effects on intact rock properties will be discussed in Section 3.1.1.2.7.]

[Thermomechanical analyses will be conducted using (____ type of code, name and documentation) to assess the response of near and far field rock mass to thermal loading. Figures 3.1.5.1A-D will show the resultant temperature and stress distribution in the repository scale.]

[Figures 3.1.5.1E-H will show the region of joint aperture changes in the repository scale (____ years, years, ____ years, and ____ years) after emplacement. Figures 3.1.5.1-I and J will show the region of slip along joints (____ years and ____ years) after emplacement. (KKB-38 discuss the results of the response of the geomechanical subsystem here.)]

3.1.5.2 Hydrologic Response to Thermal Loading

The hydrologic response to thermal loading includes dehydration, expansion of water, changes in fluid permeability due to creation of new fractures, and opening or closure of existing ones. The predominant flow may change from matrix to fracture flow or vice versa.

[Numerous analyses will be performed to evaluate the response of the hydrological subsystem using numerical analyses (____ name computer codes and provide documentation). The results will be discussed here. (KKB-39 provide the results of analyses).]

3.1.5.3 Response of Geochemical System to Thermal Loading

(No skeleton text has been developed for this subsection.)

Table 3.1.1.1.1.1A. Morphometric Characteristics of Physiographic Areas in the Southern Great Basin

Table 3.1.1.1.3.1A. Significant Earthquakes in or Near the Southern Great Basin

Table 3.1.1.1.3.1B. Data Related to the Correlation of Earthquakes and Geologic Structures or Setting

Table 3.1.1.1.4.1A. List of Quaternary Faulting at and Near Yucca Mountain

Table 3.1.1.1.4.2A. Characteristics of Basaltic Volcanism Fields in the Yucca Mountain Area

Table 3.1.1.1.5.1A. List of Non-Fuel Mineral Production in Nevada for the Years (199- to 2000)

Table 3.1.1.1.5.1B. Summary of All Construction Material in the Vicinity of Yucca Mountain

Table 3.1.1.1.5.1C. Location, Date of Discovery, Producing Formation, Depth of Production and Cummulative Production for Nevada Oil and Gas Fields

Table 3.1.1.2.2A. Stratigraphy, Thickness, and Age of the Rock Units at the Yucca Mountain Site

Table 3.1.1.2.4.1A. Estimate of Age of Faults Using Radiometric Dating and Stratigraphic Correlation

Table 3.1.1.2.4.3A. Lithological Units, Type of Fracture, Dip and Strike, Frequency and Infilling

Table 3.1.1.2.5.1A. Summary of the Results of Assays of Gold and Silver from Rocks at the Site

Table 3.1.1.2.7.1A. Geoengineering Properties Determined by Testing of Rock Samples From the Stie

Table 3.1.1.2.7.1B. Thermal and Mechanical Properties for Rock (Compressive strengths Young's Modulus, Poisson's ratio, tensile strength, thermal conductivity, and thermal expansion, creep funciton (?) and others)

Table 3.1.1.2.7.1C. Rate of Advance, Assessed Damage to the Rock, and Support Requirement for Excavation of the Rock Units Present at the Site by Various Mechanical Excavators and by Drill and Blast

Table 3.1.1.2.7.1D. Estimated Inflow of Ground Water From the Underground Facility Over the Operational Life of the Facility

Table 3.1.2.1.1A Peak Streamflow Data for Selected Crest-Stage Sites in the Hydrographic Study Area

Table 3.1.2.1.2A. Summary of Surface Water Monitoring Data

Table 3.1.2.1.4A. Maximum Unit Peak Flood Discharges

Table 3.1.2.1.5A. Date, Level, and Peak Discharge for Major Flood Occurrences Washes in the Region

Table 3.1.2.1.5B. Elevation of all Structures and Systems related to the Surface Facilities and Underground Openings

Table 3.1.2.1.6A. Chemical Composition of the Watercourses in the Vicinity of Yucca Mountain

Table 3.1.2.1.7A. Water Source Location, Owner, Type of Intake, Population Served, Maximum Daily and Average Quantities of Water Pumped From the Vicinity of Yucca Mountain

Table 3.1.2.1.7B. Water Quality of Perennial Surface Water Sources

Table 3.1.2.2.1A. Relation Between Stratigraphic and Geohydrologic Units in the Yucca Mountain Region

Table 3.1.2.2.3A. Hydraulic Characteristics of Each Major Hydrogeologic Unit in the Yucca Mountian Region

Table 3.1.2.2.3B. Geostatistical Analyses of the Hydraulic Characteristics for Each Hydrogeologic Unit

Table 3.1.2.2.4A. Major Ground Water Discharge in the Hydrogeologic Region of Yucca Mountain

Table 3.1.2.2.5A. Estimated Age of the Major Regional Ground Waters

Table 3.1.2.2.8A. List of Wells in the Region with Location, Rates of Withdrawal, Typical Well Construction, and Specific Hydrologic Unit Source

Table 3.1.2.2.8B. List of Wells in the Yucca Mountain Region Where Water is Injected (The Location of the Wells, Method of Construction, Rate of Injection, and the Hydrologic Unit Where Water is Injected)

Table 3.1.2.3.1A. List of All Monitoring Wells in the Saturated Zone at the Site Including: Location, Wellhead Elevation, Total Depth, Diameter, Depth of Completion, Construction of Each Well, Monitoring Interval, Seals Etc.

Table 3.1.2.3.3A. Water levels in the Monitoring Well From the Site at Selected Dates

Table 3.1.2.4.3.1A. Total and Effective Porosity of Hydrogeologic Units in the Saturated Zone Including the Nature of Porosity (Interstitial, Fracture, or Solution)

Table 3.1.2.3.4.1B. Summary of Hydrologic Characteristics of the Major Hydrogeologic Units at Yucca Mountain

Table 3.1.2.3.4.1C. Data for the Longitudinal and Transverse Dispersivity and Tortuosity of Hydrogeoligcal Unit in the Saturated Zone

Table 3.1.2.3.4.2A. Mean Values of Total and Effective Porosity, Bulk and Skeletal Density of the Unsaturated Units at the Site

Table 3.1.2.3.4.2B. Characteristics of Fractured media in the unsaturated Units at the Site

Table 3.1.2.3.4.2C. Mean Values of Hydraulic Characteristics of Unsaturated Zone Including Air or Water Intrinsic permeability and klinkenberg Coefficient

Table 3.1.2.3.4.2D. Longitudinal and Transverse Dispersivity for the Unsaturated zone Units at the Site

Table 3.1.2.3.4.2E. Unsturated Pneumatic Permeability and the Relevant Diffusion Characteristics

Table 3.1.2.3.7A. Summary of the Age Variation of the Site Ground Waters and Velocity of Movement

Table 3.1.2.3.9A. Locations, Rates, Typical Well Construction, and Hydrologic Source of Local Ground Water Users

Table 3.1.3.1.1A. Regional Bulk Rock Chemistry

Table 3.1.3.1.1B. Mineral Distributions in Regional Bulk Rock

Table 3.1.3.1.1C. Regional Bulk Rock Mineral Chemistry

Table 3.1.3.1.1D. Mineral Distributions in Fractures in Regional Bulk Rock

Table 3.1.3.1.1E. Chemistry of Fracture Deposits

Table 3.1.3.1.1F. Differences Between the Geochemistry of the Regional Saturated and Unsaturated Zones

Table 3.1.3.1.2A. Ground Water Chemistry

Table 3.1.3.1.2B. Dissolved Gas Content of Regional Saturated and Unsaturated Zone Ground Water

Table 3.1.3.1.2C. Major and Minor Inorganic Content of Saturated and Unsaturated Zone Ground Water

Table 3.1.3.1.2D. Major and Minor Organic Content of Saturated and Unsaturated Zone Ground Water

Table 3.1.3.1.2E. Trace Element Content of Saturated and Unsaturated Zone Ground Water

Table 3.1.3.1.2F. Stable and Radioactive Isotopes of Saturated and Unsaturated Zone Ground Water

Table 3.1.3.1.2G. Differences Between Regional Saturated and Unsaturated Zone Ground Water Geochemistry

Table 3.1.3.1.3A. Solubility and Precipitation as a Function of Radionuclide Speciation

Table 3.1.3.1.3B. Water Chemistry

Table 3.1.3.1.3C. Sorption and Desorption as a Function of Ground Water Composition

Table 3.1.3.1.3D. Mineralogy and Surface Structure

Table 3.1.4.1.1A. General Outline of the Climatic Conditions Experienced at Yucca Mountain

Table 3.1.4.1.2A. Elevation, Type of Measurements, and Period of Measurements for Each Stations in the Meteorological Monitoring Network

Table 3.1.4.1.2B. Instrumentation of Stations In Meteorological Network, Including the Frequency of Measurements

Table 3.1.4.1.3A. Temperature Data at the Site Including: Average Daily Maximum, Highest Daily, Average Daily Minimum, Lowest Daily, and Monthly Average for the Period of Record (19xx to 20xx)

Table 3.1.4.1.3B. Relative Humidity and Wet-Bulb Data for the Site

Table 3.1.4.1.3C. Average and Extreme Duration and Intensity of Precipitation at the Site

Table 3.1.4.1.3D. Maximum 1 and 24 Hour Precipitation at the Site

Table 3.1.4.1.3E. Seasonal Variation of Wind Direction

Table 3.1.4.1.3F. Seasonal Variation of Wind Speed

Table 3.1.4.1.3G. Annual Extreme Wind Speed at (___m) Above Ground at the Site

Table 3.1.4.2A. Summary of Palynological and Pack Rat Midden Data from the Yucca Mountain Site

Figure 3.1.1.1.1.1.A. Generalized Map showing Approximate Locations of the Physiographic Subdivisions of West Central andCouthern Great Basin

Figure 3.1.1.1.1.1B. Topography and Physiographic Subdivisions of the Yucca Mountain Area

Figure 3.1.1.1.1.1C Landsat Image of the Yucca Mountain Area

Figure 3.1.1.1.1.1C. Overlay for the Landsat Image in Figure 3.1.1.1.1.1C (Continued)

Figure 3.1.1.1.1.1D. High-Altitude Oblique Aerial Photograph of the Yucca Mountain Area

Figure 3.1.1.1.1.1E. TBD

Figure 3.1.1.1.1.1F. TBD

Figure 3.1.1.1.2A. Generalized Regional Stratigraphic Column showing Geologic Formations and Hydrogeologic Units in the Southern Great Basin

Figure 3.1.1.1.3A. Semismicity Within a Circle of 200 Miles Radius Centered on Yucca Mountain During the Recorded History (1769 to 199-)

Figure 3.1.1.1.4.1A. Schematic Geologic Cross Section at Yucca Mountain Region

Figure 3.1.1.1.4.2A. Distribution of the Cenozoic Volcanic Rocks in the Southern Great Basin During the Time Periods of 43-34 Million Years Ago

Figure 3.1.1.1.4.2B. Distribution of the Cenozoic Volcanic Rocks in the Southern Great Basin During the Time Periods of 34-17 Million Years Ago

Figure 3.1.1.1.4.2C. Distribution of the Cenozoic Volcanic Rocks in the Southern Great Basin Druing the Time Periods of 17-6 Million Years Ago

Figure 3.1.1.1.4.2D. Distribution of the Cenozoic Volcanic Rocks in the Southern Great Basin During the Time Periods of 6-0 Million Years Ago

Figure 3.1.1.2.2A. Generalized Map of Yucca Mountain Showing Major Faults and Stratigraphic Units

Figure 3.1.1.2.2B. Location of the Geological Drill Holes Used to Determine the Stratigraphy of the Site

Figure 3.1.1.2.2C. North-South Cross Section of Stratigraphic Correlation Between Selected Drill Holes

Figure 3.1.1.2.2D. East-West Cross Section of Stratigraphic Correlation Between Selected Drill Holes

Figure 3.1.1.2.2.1. Sequence and Thicknesses of the Various Cooling Units Within the Topopah Spring Member

Figure 3.1.1.2.4.1A. Location of Faults at Yucca Mountain and the Location of Cross Sections Through the Site

Figure 3.1.1.2.4.1B. East/West Cross Section Showing the Faults and Their Characteristics

Figure 3.1.1.2.4.1C. North/South Cross Section Showing the Faults and Their Characteristics

Figure 3.1.1.2.4.1D. TBD

Figure 3.1.1.2.4.1E. TBD

Figure 3.1.1.2.4.1F. TBD

Figure 3.1.1.2.4.1G. TBD

Figure 3.1.1.2.4.4A. Volcanic Centers at the Yucca Mountain Site

Figure 3.1.1.2.5.2A. Occurrence of Hot Springs and Geothermal Wells and Low Temperature Resources in the Vicinity of the Site

Figure 3.1.1.2.7.1A. Thermal/Mechanical Stratigraphy at Yucca Mountain

Figure 3.1.1.2.7.1B. Variation of Compressive Strengths

Figure 3.1.1.2.7.1C. Variation of Young's Modulus

Figure 3.1.1.2.7.1D. Variation of Tensile Strengths

Figure 3.1.1.2.7.1E. Variation of Thermal Conductivities

Figure 3.1.1.2.7.1F. Variation of Thermal Expansions

Figure 3.1.1.2.7.1G. Variation of Other Properties

Figure 3.1.1.2.7.1.H. Stress Measurements in Drill Holes

Figure 3.1.1.2.7.1I. Stress Measurements From Underground Locations

Figure 3.1.1.2.7.1J. Least (Horizontal) and Maximum (Vertical) Principal Stress Values Plotted Against Depth at Yucca Mountain.

Figure 3.1.1.2.7.1K. Rock Mass Classification and Support Requirements at Tiva Canyon Unit

Figure 3.1.1.2.7.1L. Rock Mass Classification and Support Requirements at Paint Brush Unit

Figure 3.1.1.2.7.1M. Rock Mass Classification and Support Requirements at Topopah Spring (TSw1) Unit

Figure 3.1.1.2.7.1N. Rock Mass Classification and Support Requirements at Topopah Spring (TSw2) Unit

Figure 3.1.1.2.7.10. Rock Mass Classification and Support Requirements at Topopah Spring (TSw3) Unit

Figure 3.1.2.1.1A. General Hydrographic Study Area for Yucca Mountain Site and Region

Figure 3.1.2.1.2B. Surface Water Monitoring Network at the Yucca Mountain Region

Figure 3.1.2.1.3A. Locations of Reservoirs, Mining, Lumbering and Other Structures

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Figure 3.1.2.3.1T. Typical Construction of Monitoring Wells

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Figure 3.1.5.1E. Regions of Joint Aperture Changes In The Repository Scale At ___ Years

Figure 3.1.5.1F. Regions of Joint Aperture Changes In The Repository Scale At ____ Years

Figure 3.1.5.1G. Regions of Joint Aperture Changes In The Repository Scale At _____ Years

Figure 3.1.5.1H. Regions of Joint Aperture Changes In The Repository Scale At ____ Years

Figure 3.1.5.1I. Region Of Slip Along Joints At ____ Years

Figure 3.1.5.1J. Region Of Slip Along Joints At ____ Years

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MGDS Annotated Outline Planning Package Date: 9/30/92
Form 1: Text

1. Section No. & Title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE**

2. Lead Author & Phone No. Kal Bhattacharyya (702) 794-1872

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
   (Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   This section describes the natural systems of the geologic setting of the region of the site, specifically for the "controlled" area. However, if conditions outside the controlled area may affect isolation within the controlled are, that "outside" information or conditions will be included provided such information is relevant.

6. Opening Statement:

7. Main Body Outline:

   3.1 Introduction

8. Conclusion:

9. Support Authors & Their Assignments

   Bill Distrel
   John Blair

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title:

Lead Author & Phone No.

A. Figure/Table No.

Caption/Title:

Content:

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title:

Content:

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEM AND CHARACTERISTICS OF THE SITE

Lead Author & Phone No. Kal Bhattacharyya (702) 794-1872

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer' Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

1.

2.

3.

4.

5.

6.

7.

8.

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **KKB-1**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE** (Subsection 3.1.1.1.1)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Define "the region of the Site", its extent, and relation to the controlled area. This phrase is in the Regulatory Guide DG 3003, but is not defined in 10 CFR 60.

7. What is the information needed for?

   The definition is necessary for determining the extent of the area around Yucca Mountain for which the geologic setting has to be described for SAR Section 3.1.

8. What group is the probable information supplier?

   Regulatory and Licensing Group.

9. When is the information needed?

   This definition is fundamental to the writing of Chapter 3. Therefore, it is needed ASAP.

10. What kind of related information is already available in references, etc.?

    Don't know.

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: KKB-2

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.1.1.2 Geomorphic Process)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Provide evidence that glacial and periglacial processes have not been active in the Yucca Mountain area during most or all late Quaternary time.

7. What is the information needed for?

   For response to FCRG, Section 3.1.1.1.1 - Geomorphology and Topographic Features in the Region of the Site Area.

8. What group is the probable information supplier?

   The information will probably be generated by USGS and WCC will be able to get this information from USGS.

9. When is the information needed?

   Whenever available (mid-1990s).

10. What kind of related information is already available in references, etc.?

    SCP Chapter 1.1, Vol I.

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: KKB-3

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.1.1.1.4 - Significant Late Quaternary Geomorphic Process in the Yucca Mountian Area.)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   The effect of tectonic and volcanic processes in the late Quaternary Period have been limited and comparable tectonic and volcanic activities during the next 10,000 years should induce a limited effect on the landscape of Yucca Mountain. This statement needs to be substantiated by study of volcanism and tectonics at Yucca Mountain.

7. What is the information needed for?

   Response to FCRG Section 3.1.1.1.1. - Geomorphology and Topographic Features in the Region of Yucca Mountain Site Area.

8. What group is the probable information supplier?

   Crowe of LANL will probably be the PI who will perform the study. WCC may collect the specific information from the study.

9. When is the information needed?

   Mid 1990s.

10. What kind of related information is already available in references, etc.?

   SCP, Chapter 1.1.3.3.1, Vol I.

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **KKB-4**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE** (Subsection 3.1.1.1.1.4, Significant Late Quaternary Geomorphic Process in the Yucca Mountain Area)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Provide an estimate of the movement of surficial material during the Quaternary in the Yucca Mountain Site area.

7. What is the information needed for?

   The information is requested in FCRG Section 3.1.1.1.1.

8. What group is the probable information supplier?

   USGS may generate this information. WCC should be able to collect this from future work by others.

9. When is the information needed?

   Long-term need.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 1.1.3.3.2.

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: KKB-5

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.1.1.2 - Stratigraphy and Lithology of the Region)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Provide rationale for stratigraphic boundaries of the Yucca Mountian region such as mineralogical and geochemical characteristics.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.1.1.2 - Stratigraphy and Lithology of the Region.

8. What group is the probable information supplier?

   USGS and WCC.

9. When is the information needed?

   At the end of surface-based testing (1993-94).

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 1.2.1.

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB-6

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.1.1.3 - Seismology)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   A complete list of all historically reported earthquakes in the region surrounding the site is needed.

7. What is the information needed for?

   Asked for in FCRG Subsection 3.1.1.1.3 - Seismology.

8. What group is the probable information supplier?

   LANL, WCC.

9. When is the information needed?

   Mid 1990s.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 1.4.1.1.1, Table 1-10.

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB-7

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.1.3.1 - Relationship of seismicity of geologic or tectonic characteristics of the candidate area)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Relationship between seismicity and geologic structure and a tectonic model of the region is needed.

7. What is the information needed for?

   For FCRG Section 3.1.1.1.3 - Seismology.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   Mid 1990s.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 1.4.1.2.

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **KKB-8**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE** (Subsection 3.1.1.1.2.1 - Relationship of seismicity to geologic or tectonic characteristics of the candidate area).

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Causative mechanism of earthquakes in the southern Great Basin.

7. What is the information needed for?

   Response to FCRG Section 3.1.1.1.3 - Seismology.

8. What group is the probable information supplier?

   LANL, WCC.

9. When is the information needed?

   Mid 1990s.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 1.4.1.2.

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB-9

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.1.1.3.1 - Relationship of seismicity to geologic or tectonic characteristics of the candidate area)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Correlation between epicenters or regions of higher intensity of historically reported earthquakes and the geologic setting of geologic structures within the setting is to be provided.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.1.1.3 - Seismology.

8. What group is the probable information supplier?

   LANL, WCC.

9. When is the information needed?

   Mid-1990s.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 1.4.1.2.

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form **Date: 9/30/92**
Form A: Information Request

1. Log number: **KKB-10**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE** (Subsection 3.1.1.1.4.1 - Structural features in the Yucca Mountain)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   The regional fracture, discontinuities, and heterogeneity in the Yucca Mountain region.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.1.1.4 - Structural Geology and Tectonic Information FCRG.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   Before 1994 (will need it for subsurface design).

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 1.3.2.2.2.

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB-11

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.1.1.5.1 - Mineral Resources of Yucca Mountain)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Provide ore genesis models and results of analyses regarding mineralization potential of the Yucca Mountain area.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.1.1.5 - Mineral Resources.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   This information is a site suitability condition and needs to be answered as soon as possible, probably within the next 2-3 years (1993-94).

10. What kind of related information is already available in references, etc.?

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **KKB-12**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE**
   (Subsection 3.1.1.5.1 - Mineral Resources of the Yucca Mountain Region)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Occurrences of precious - and base - metal deposits such as opalized and mercury bearing mineral in the Yucca Mountain region. Geochemical sampling for mercury in surface outcrop and drill core to confirm absence of mercury bearing rocks in the region.

7. What is the information needed for?

   In response to FCRG Section 3.1.1.1.5 - Natural Resources.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   Mid-1990s.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 1.7.1.2 and 1.7.1.3.

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: KKB-13

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.1.1.5.2 - Energy Resources of Yucca Mountain Region)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Confirmatory information that uranium is a sub-economic grade occurrence in the Yucca Mountain region. Similarly coal, tar sands, and oil shale have low potential for occurrence in the region.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.1.1.5 - Natural Resources.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   1994-95.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 1.7.1.5.

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **KKB-14**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE** (Subsection 3.1.1.6.1 - Regional Geophysical Characteristics of the Site)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Provide results of magnetic and gravity surveys to identify geophysical characteristics of the region.

7. What is the information needed for?

   Response to FCRG Section 3.1.1.1.6 - Geophysics.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   Mid-1990s.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter xxxxx.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: KKB-15

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.1.2.1 - Erosion at the site)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Site specific erosion rate in the areas of critical surface facilities.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.1.2.1 - Geomorphology and Topographic Features of the Site Area.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   Needed for Title II design of the ESF (by 1994-95).

10. What kind of related information is already available in references, etc.?

    SCP Chapter 1.1.2.3 and 1.1.2.4.

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **KKB-16**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE** (Subsection 3.1.1.2.2 - Stratigraphy and Lithology of the Site)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Stratigraphy at depth under the Yucca Mountain site.

7. What is the information needed for?

   Response to FCRG Section 3.1.1.2.2 - Stratigraphy and Lithology of the Site.

8. What group is the probable information supplier?

9. When is the information needed?

   After drilling is complete, mid-1990s.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 1.2.2.

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB-17

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.1.2.2.1 - Description of Lithology of the Units Surrounding the Repository Horizon).

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872.

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Description of the zone of alteration with the stratigraphic units surrounding the repository horizon and the vertical and lateral variation of compositional and physical characteristics within each stratigraphic unit.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.1.2.2 - Stratigraphy and Lithology of the Site.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   Late 1990s.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 1.2.2.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **KKB-18**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE** (Subsection 3.1.1.2.3.1 Ground Motion at the Site from Earthquakes in the Area)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Ground motion calculations using deterministic and/or probabilistic methods (this also needs to be clarified) at the site from earthquakes in the area.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.1.2.3 - Seismology.

8. What group is the probable information supplier?

   LANL, WCC.

9. When is the information needed?

   During Title II design of ESF, mid-1990s.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 1.4.2.1.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB-19

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.1.2.3.2 - Material Properties of Rocks at the Site)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Static and dynamic properties of soil and rock at the site, water table elevation, and variations.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.1.2.7 - Geoengineering.

8. What group is the probable information supplier?

   SNL, WCC, MK.

9. When is the information needed?

   During Title II design of ESF, by 1994.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 2, RIB, SNL reports SAND81-1664; SAND82-1315; SAND80-1453; SAND84-0221; SAND81-0212; SAND82-1723; SAND86-0177.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **KKB-20**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE**
(Subsection 3.1.1.2.3.4 - Design response to Ground Motion from Potential Earthquake)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Acceleration, effective frequency range, and duration corresponding to each maximum potential earthquake are to be provided both at the ground surface and at depth of the underground repository. Also compare the design response spectra with the ground motion expected from potential earthquakes to assess conservatism of design.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.1.2.3 - Seismology.

8. What group is the probable information supplier?

   SNL (for ESF), Fluor-Daniel, MKE (for repository).

9. When is the information needed?

   During ESF Title II design, 1994.

10. What kind of related information is already available in references, etc.?

    TBD.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **KKB-21**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE** (Subsection 3.1.1.2.4.3 - Fractures at Yucca Mountain)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Fracture mapping from surface and underground mapping at the Yucca Mountain repository site.

7. What is the information needed for?

   Section 3.1.1.2.4 of the FCRG asks for this information.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   At the completion of underground mapping at the ESF (late 1990s).

10. What kind of related information is already available in references, etc.?

    None readily available.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **KKB-22**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE** (Subsection 3.1.1.2.5.2 - Energy Resources at the Site)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Evidence for (or against) occurrence of hydrocarbon (specifically oil and gas) beneath the Yucca Mountain site.

7. What is the information needed for?

   This information is asked for in Section 3.1.1.2.5 of the FCRG.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   At the conclusion of SBT (mid-1990s).

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 1.7.2.2.1.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB-23

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.2.1.2 - Surface Water Monitoring Network)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Surface water monitoring data from the Yucca Mountain site.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.2.1.2 - Surface Water Monitoring Network.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   Mid-1990s.

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **KKB-24**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE** (Subsection 3.1.2.1.3 - Water Control Structures and Diversions)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Description of surface water structures, existing or planned, that may influence the potential for flooding at the site.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.2.1.3 - Water Control Structures and Diversions.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   Before completion of Title II design of ESF (1995?).

10. What kind of related information is already available in references, etc.?

    Not readily available to my knowledge.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: KKB-25

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.2.1.4 - Flood History)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Geologic evidence of flooding in the Yucca Mountain region with emphasis on the Holocene.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.2.1.4 - Flood History.

8. What group is the probable information supplier?

   USGS, FCC.

9. When is the information needed?

   Before completion of the ESF Title II design (1995).

10. What kind of related information is already available in references, etc.?

    No specific information is available to my knowledge.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **KKB-26**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE** (Subsection 3.1.2.3.1 - Baseline Monitoring Network)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Description of the selection process for the location and depth of the data collection system for baseline hydrologic monitoring network for the site.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.2.3.1 - Baseline Monitoring Network.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   Late 1990s.

10. What kind of related information is already available in references, etc.?

    None available yet.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB-27

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.2.3.2 - Site Flow System Boundaries and Hydrogeologic Units)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Provide basis for selection of hydrogeologic units at the site for the unsaturated and saturated zones.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.2.3.2 - Site Flow System Boundaries and Hydrologic Units.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   Mid-1990s, this selection is the basis for most of the hydrogeologic analyses.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 3.6.1 describes the regional hydrogeologic units.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **KKB-28**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE** (Subsection 3.1.2.3.3 - Potentiometric Levels, Matric Potential, and Gradients)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   The time history and areal distribution of the measured matric potentials and moisture contents (including osmotic potential) for each hydrogeologic unit as the site. Also the spatial and temporal extent of the perched water system at the site. Description of hydraulic gradient between the hydrologic units at the site.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.2.3.3 - Potentiometric Levels, Matric Potentials, and Gradients.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   At the conclusion of field activities (late 1990s).

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 3.6.3 provides regional information.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB-29

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.2.3.3 Potentiometric Levels, Matric Potentials, and Gradients)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Verify that hydrographs are not necessary as a part of the information to be provided for monitoring points.

7. What is the information needed for?

   Section 3.1.2.3.3 of the FCRG calls for hydrographs.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   Late 1990s.

10. What kind of related information is already available in references, etc.?

    SCP.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **KKB-30**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE**
(Subsection 3.1.2.3.5 Site Ground-Water Recharge)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   The mode and the spatial and temporal distribution of moisture infiltration at the site.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.2.3.5.

8. What group is the probable information supplier?

   USGS, LLL, and WCC.

9. When is the information needed?

   Mid-1990s.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 3.9.3.3.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **KKB-31**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE** (Subsection 3.1.2.3.8 Site Pathway Analysis)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Fluid flow path analysis at the site.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.2.3.8 - Site Pathway Analysis.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   Late 1990s.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 3.9.3.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **KKB-34**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE** (Subsection 3.1.2.3.10 Paleohydrology)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Results of field investigation for evidence of change in hydrologic conditions during the Quaternary Period, including origin of deposits of minerals along fault zones.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.2.3.10 - Paleohydrology.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   This information is part of the site suitability question and results are required at the earliest availability.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 3.7.4.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB-35

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.4.1.1 - Climate)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872
4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Synoptic scale processes and their effects on site specific meteorological conditions.

7. What is the information needed for?

   Asked for in FCRG Section 3.1.4.1.1 - Climate.

8. What group is the probable information supplier?

   EG&G, WCC.

9. When is the information needed?

   Late 1990s.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 5.1.1.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **KKB-36**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE** (Subsection 3.1.4.2 - Paleoclimatology)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Results of a generalized model of the Quaternary climatological model of the site and surrounding area to predict climatic changes. The impact of glaciers on precipitation regimes and windflow patterns at the site (if appropriate). Relationship between air temperature and regional precipitation, in relationship to the water balance of the area is also discussed.

7. What is the information needed for?

   To respond to FCRG Section 3.1.4.2 - Paleoclimatology.

8. What group is the probable information supplier?

9. When is the information needed?

   Late 1990s.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 5.2.1.2.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB-37

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.4.3 - Future Climatic Variation)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Description of the results of near-term (0 to 1,000 years) and long-term (1,000 to 10,000 year) future climatic modeling effort.

7. What is the information needed for?

   In response to FCRG Section 3.1.4.3 - Future Climatic Variation.

8. What group is the probable information supplier?

   EG&G, WCC.

9. When is the information needed?

   In late 1990s.

10. What kind of related information is already available in references, etc.?

    SCP, Chapter 5.2.2.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **KKB-38**

2. Section no. & title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE** (Subsection 3.1.5.1 Geomechanical System Response)

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Results of thermo-mechanical analyses to assess the response of near and far field rock mass to the maximum design thermal loading.

7. What is the information needed for?

   To respond to FCRG Section 3.1.5 - Integrated Natural System Response to the Maximum Design Thermal Loading.

8. What group is the probable information supplier?

   SNL, MKE.

9. When is the information needed?

   During the Title II repository design (1994).

10. What kind of related information is already available in references, etc.?

    SAND86-7011, NUREG/CR-5427, NUREG/CR-5390, NUREG/CR-5426, NUREG/CR-5335, STP On Geologic Repository Operations Area Underground Facility Design--Thermal Loads, etc.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB-39

2. Section no. & title: 3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE (Subsection 3.1.5.2 - Hydrologic Subsystem Response)

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Results of thermo-hydrological studies to determine the near and far field response to maximum design thermal load of the repository.

7. What is the information needed for?

   To respond to FCRG Section 3.1.5 - Integrated Natural System Response to the Maximum Design Thermal Load.

8. What group is the probable information supplier?

   SNL, LLL, MKE.

9. When is the information needed?

   During the Title II repository design (by 1994).

10. What kind of related information is already available in references, etc.?

    SAND, LLL reports (to be filled in).

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form B: Information Response

1. Section No. & Title: **3.1 DESCRIPTION OF INDIVIDUAL SYSTEMS AND CHARACTERISTICS OF THE SITE**

2. Person Supplying Information: Kal Bhattacharyya (702) 794-1872

3. Phone No.:

4. Lead Author (Requester):

   Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form C: Information Request Tracking Log

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

Section 3.2 Description of the Anticipated Processes and Events and Unanticipated Processes and Events

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LIST OF FIGURES

3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

3.2.0 Introduction

This section describes the characteristics of anticipated and unanticipated processes (KKB3.2A, need to know what are the anticipated events and processes and what are the unanticipated events and processes) and events together with a rationale for the selection of each specific process and event described (KKB3.2A, need to know the rationale for each selected process and events). Background information on each process and event is summarized in this section.

[It must be demonstrated that the data base is sufficient to determine which events are anticipated and which are unanticipated.]

[It must be further demonstrated in this section that the models used to make the projections of processes and events are applicable and the interaction between the various natural, repository-induced, and human-induced processes, and events that may affect waste isolation are well understood and considered in the analyses.]

3.2.1 Description of Data Base

The data base related to the natural process and events that occurred during the pre-Quaternary and Quaternary periods and that may be significant to waste isolation is described in this section.

The characteristics of emplaced waste and the area of waste emplacement are briefly described here. References to other sections are provided where detailed descriptions can be found. Human activities that have occurred in the past that may have an effect on waste isolation are also discussed.

3.2.1.1 Natural Processes and Events

The nature, rate, and effects of natural processes and events that have occurred within the geologic setting during the pre-Quaternary and Quaternary periods are described in this section. The interrelationship of the events to the underlying processes have been considered. [Only the pre-Quaternary processes and events that are assessed to have a probability of 1 in 10,000 during the intended period of performance of the repository will be discussed here (KKB3.2B need to know which processes and events have probability of at least 1 in 10,000 of occurrence during the performance period of the repository).]

3.2.1.1.1 Natural Events During the Pre-Quaternary and Quaternary Periods

Natural events that are significant to waste isolation and which occurred during the pre-Quaternary and Quaternary periods are described below. [This description will also include the time of occurrence, recurrence rate, duration and their effects of the repository waste isolation.]

3.2.1.1.1.1 Volcanism

A discussion of the Tertiary and Quaternary volcanism is related to the stratigraphy, lithology, mechanical and thermal properties, jointing and faulting, hydraulic and geochemical characteristics of the host rock and the surrounding rock. Therefore, volcanism is an event important to the discussion of the waste isolation capability of the repository. A discussion of the pre-Quaternary volcanism provides the basis for assessing the likelihood of future igneous activity that could affect the repository.

This section summarizes the history of middle Tertiary volcanism in the Great Basin and Sonoran Desert of Arizona. Most of the volcanic rocks at Yucca Mountain were formed during this time. [(Figure 3.2A).]

The youngest volcanic rocks in the southern Great Basin are mostly basalt flows of late Miocene to Holocene epoch and are 6 to 8 million years old. The Death Valley-Pancake Range zone, extends from southern Death Valley north-northeast through Yucca Mountain into the central

Nevada volcanic field which occurred approximately 8 million years ago. [(Figure 3.2B).] Some basalt fields in the Death Valley-Pancake-range zone contain a large volume of rock, were relatively long-lived (active for several million years), bimodal and consisted of scoria cones or clusters of cones and associated basaltic lavas [Table 3.2A.] The basalts younger than 6.5 million years occurred near Yucca Mountain and in the Southern Death Valley.

The rate of volcanic activity during the last 8 million years in the Yucca Mountain area is consistently low. The Lathrop Wells cinder cone, at the southern edge of Crater Flat, is the youngest volcanism feature in the Yucca Mountain area. Crowe and Carr (Reference 3.2A) give the age of this cone as between 200,000 and 300,000 years.

[Statements similar to the following may be made in a potential license application: The most likely effect of renewed silicic volcanism is deposits of fine-grained volcanic ash at Yucca Mountain ranging from a few millimeters to tens of centimeters thick. Such deposition would pose no recognized hazard to the repository after closure. There is little potential that a silicic eruption near the margins of the Great Basin would affect the geohydrology, geochemistry, and rock properties at the Yucca Mountain because of the great distance separating Yucca Mountain from the potential volcanic centers.]

3.2.1.1.1.2 Faulting

The following is a summary of the Tertiary and Quaternary faults in the region of the repository. A detailed description is provided in Sections 3.1.1.1.4 and 3.1.1.2.4, including the features that may affect the construction and operation of a repository and its post-closure isolation capability. [The discussion will also include the potential for the repository being disrupted by a fault.] Some faults show evidence of Quaternary movement in the area surrounding Yucca Mountain. A zone of faults having demonstrable Pleistocene displacement extends southward from the Sand Springs Valley, 120 kilometers northeast of Yucca Mountain, through Yucca Flat and continues toward the Amargosa Desert.

At Yucca Mountain, major normal faults bound by the structural blocks generally strike north and dip steeply west [Figure 3.2C.] The faults are typically 1 to 2 kilometers apart and generally have vertical offset of more than 100 meters. Most offset in the normal faults occurred between 12.9 and 11.6 million years ago.

The repository will be constructed mainly in the relatively unfaulted western part of one typical structural block. The repository will be bounded on the west side by the Solitario Canyon fault, on the northeast by the Drill Hole Wash fault, and the east and southeast by the western edge of an imbricate normal fault zone. Within the repository boundary, offset on faults is (__ meters) or less, except for the Ghost Dance fault, which has (_____ meters) of vertical offset at the (location). Quaternary deposits are offset or fractured by (__) faults in the (__km^2) area around Yucca Mountain site. [Radiometric dating and correlation of stratigraphy will be used to demonstrate that (_) of them moved (__) million years ago.]

[Quaternary offset will be analyzed for five of the major normal faults at and near Yucca Mountain: the Bare Mountain, Windy Wash, Solitario Canyon, Bow Ridge, and Paintbrush Canyon. These faults will be shown in Figure 3.2E and their characteristics will be summarized in Table 3.2B. (KKB3.2C, Provide description of movements on these faults in the pre-Quaternary and Quaternary periods. Provide the direction of fault movements in the area).]

3.2.1.1.1.3 Seismicity

The rate of occurrence, the nature of seismic events and the effects of seismicity on waste isolation are discussed below. A detailed description of seismicity in the region and vicinity of Yucca Mountain is provided in Section 3.1.1.3. The north-south-trending California-Nevada seismic belt is a part of the regional seismicity with epicenters within 400 km of Yucca Mountain. Six major historical earthquakes of M> 6.5, have occurred in the Nevada-California seismic belt. The nearest recorded major earthquake was in Owens Valley, about 150 km west of Yucca Mountain and occurred in 1872. [Add discussion on the June 29, 1992 earthquake.]

The pattern of local seismicity (Figure 3.2F), as defined by hypocenters within 150 km of Yucca Mountain, is a widespread but diffuse background corresponding principally to the east-west seismic belt, punctuated by clusters of intense activity, and by large nearly aseismic areas. Yucca

Mountain is in a locally quiescent area characterized by few hypocenters and low energy density. Focal depths of hypocenters range from 1 km above to 17 km below sea level. The maximum such earthquake has a magnitude (M=___) and occurred within (____km) of Yucca Mountain. [Provide results of June 29, 1992 earthquake.]

[The correlation of earthquakes to recognized geological structures in the seismotectonic zones will be presented below. A number of models (KKB3.2E provide names of computer models and results of analysis) will be used to determine this correlation.]

3.2.1.2 Characteristics of Emplaced Waste

[The characteristics of emplaced waste and the emplacement area will be described herein. Characteristics of the waste that can modify the natural system and affect waste isolation will be emphasized. The hydrological, geochemical, thermal, and mechanical effects of waste emplacement on the geologic system will be discussed.]

[The waste form will be presented in detail in Section 5.1.2. The characteristics of waste such as thermal output, chemical characteristics of the waste package and engineered barrier that can modify the natural system will also be discussed.]

[Packages for high-level waste will be designed so that interactions between the chemical, thermal, and nuclear properties of the waste package do not compromise the waste isolation capability of the natural system.]

3.2.1.2.1 Expected Thermal Output

[Spent fuel waste packages will be designed to generate a thermal output of between (__kw and _kw) per container. Processed high-level waste packages will be designed to generate an output of (__kw) per container. The outer wall temperature of the waste packages will be calculated to be (____°C) for the spent fuel packages and (____°C) for the high-level waste packages (KKB3.2F).]

3.2.1.2.2 Chemical Characteristics of the Waste Package and Engineered Barrier

[To Be Developed.]

3.2.1.2.3 Location and Size of the Emplacement Panels

[A detailed discussion of the waste emplacement system will be provided in Section 4.1.3.4, Waste Emplacement System.] The waste is emplacement in the (___ mode of emplacement) in the Topopah Spring unit (provide exact geologic/ thermomechanical unit). Waste is emplaced in (___ numbers of panels of covering an area of (___km^2). The areal thermal density is (-w/m^2). Calculated peak rock temperatures in the near field (around the waste packages), room scale (around drifts) and far field (in the repository horizon) are (___ ^{0} C) (KKB3.2G, provide the above data from repository design report).

3.2.1.2.4 Effects from Excavation on the Natural System

The natural system will undergo changes due to excavation of the shafts, ramps, and repository facilities. [The effects of excavation on the surrounding rock mass will be discussed in Section 3.1.1.2.7, Geoengineering. (Further text to be developed).]

3.2.1.2.5 Expected Effects on the Natural System

[Skeleton text has not been developed for this subsection.]

3.2.1.3 Past Human Activities

Human activities that have occurred within the geologic setting or that have affected the geologic setting of Yucca Mountain are described below. Such activities as drilling and excavation within or near the controlled area, effects to the atmosphere from pollution, effects from ground water withdrawal or injection are also described. [This description will include the location and severity of such activities and the interrelations of such activities with natural processes and events.]

3.2.1.3.1 Drilling

All known drilling within 10 km of the GROA has been under the control of either the Nevada Test Site Office or the Nuclear Rocket Development Station (NRDS) currently within the NTS.

[All available drilling and mining records including those of NTS, USGS and others will be examined.] Two drill holes have been found that were drilled prior to the NNWSI Project. [An additional (___) vertical and angle drill holes will be drilled within the controlled area during the site characterization activities including exploration and construction. Figure 3.2G will show a map with all the drill holes within controlled area of the repository. Table 3.2C will list the location, elevation, sampling and drilling method, casing and hole diameter and depths, spud date and completion date.]

3.2.1.3.2 Mining Activities

[Documents regarding the status of active and inactive mines at and within 10 km of the Yucca Mountain repository site will be examined and the results will be discussed below. Documents included the Nevada Bureau of Mines reports and maps, air photos; Nye County, Nevada records of mining claims; BLM records, and USGS geologic reports and topographic maps and reports.]

At present there are (__) mill sites and (__) lode claims on file for the area within 10 km of the GROA. (KKB3.2H, provide description of mill site, lode claims). The past records of mining in southern Nevada show mining activities with the controlled area of the Yucca Mountain site. The closest mining activities were in Bare Mountain district, 15 km west of the site. The only reference to Yucca Mountain concerned the Thompson and Silicon Mines. Both are located at the northwest end of the Yucca Mountain, located approximately 10 km west from the repository.

No evidence of any surface mining activities have been found within 10 km of the Yucca Mountain site.

3.2.1.3.3 Ground Water Injection and Withdrawal

There are (___) injection wells located within the controlled area of the repository. [The injection of wells will occur during the site characterization activities and will be shown in Figure 3.2H. (Provide a map showing the location of wells within the controlled area where injection of wells have occurred). Table 3.2D will show the location, size, casing, drilling method, water level, and rate and amount of water withdrawal and injection. (Provide such a table).]

3.2.1.3.4 Underground Nuclear Tests

The size of current nuclear testing is limited to 150 kilotons by the Threshold Test Ban Treaty and the Treaty on Underground Nuclear Explosions for Peaceful Purpose. The option for larger yield is being retained by the Nuclear Test Site (NTS) and estimated to be (__) kilotons in the Yucca Flats, (__) kilotons in Rainier Mesa, and (__) kilotons at Palhute Mesa (Figure 3.2D). The shortest distance between the repository and an area of Underground Nuclear Event (UNE) is 23 km. [Calculations will be made to show that the repository is stable at a distance of (__) km from a UNE of (__) kiloton yield as designed for a (__)g ground acceleration. Ground motion from aftershocks that follow a large UNE will be considered in the design, and stability problems will be assessed. (KKB3.2D, provide such stability calculations in repository design).]

Aftershocks fall off to the background level within a period of several weeks and are at least 2 magnitude units (on a logarithmic scale) less than the UNE.

[The predicted mean peak vector ground acceleration at Yucca Mountain from UNE at a maximum allowable yield of (___) kiloton will be calculated to be (___)g. Using a very conservative design criterion of three standard deviations, or 99 percent of all probable values, the mean peak vector ground acceleration for Yucca Mountain will be calculated to be (___)g (these values to be supplied).]

[The repository design will consider the effects of UNE at the NTS, and it will be determined whether the design is safe for the effects of UNE.

3.2.2 Anticipated Processes and Events and Unanticipated Processes and Events

3.2.2.1 Natural Processes and Events

[The projected rate of each process, including the "best estimate" and "extremes" will be provided using statistical parameters to describe the uncertainties of this projection. The model or models used to provide these projections will be described, and justification for using the specific models will be provided. Other known and generally recognized models that were rejected for making these predictions are described along with the basis for their rejection.]

Events that could be projected to occur as a result of each process are described below. This description includes intensity, duration, effect, and location of the events. [In general, events that have a probability of occurrence of less than 1 chance in 10,000 during the period of intended performance will not be considered. Quantification of the probabilities will be achieved by using the best scientific techniques available.]

3.2.2.1.1 Volcanism

The potential for renewed silicic volcanism is suggested by the youngest (7 to 8 million years old) silicic volcanic center in the vicinity of Yucca Mountain, at the Black Mountain center, which is located 50 kilometers north of Yucca Mountain. However, the occurrence of silicic volcanism is considered unlikely during the next 10,000 years (Volcanist Crowe,et.al.) because:

A. No silicic volcanism has occurred in the south central Great Basin during at least the past 6 million year period.

B. Silicic volcanism has decreased throughout the central and southern parts of the Great Basin during the past 10 million years and, in most areas silicic volcanism appears to have ceased.

C. Silicic volcanism has been restricted entirely to the margins of the Great Basin during the Quaternary period (the past 2 million years).

Future silicic eruptions from Crater Flat were considered unlikely from review of data related to future bimodal volcanism. No rhyolite has been found associated with basaltic eruptions during the past 8 to 9 million years.

[Additional studies will be conducted to estimate the potential for silicic volcanism, and the results will be used to indicate whether this type of volcanism has significant potential for initiating a disruptive event after the closure repository (KKB3.2I, provide studies to estimate volcanic potential).]

The likelihood of future basaltic volcanism at Yucca Mountain was evaluated by Crowe, et. al. (1982, 1983, 1986). Crowe, et. al. (1982) estimated the probability that the repository would be penetrated by magma during basaltic volcanism during the next 10,000 years as 3.3×10^{-6} to 4.7×10^{-4} (KKB3.2J, studies to be performed to update this probability calculation).

Consequence Analyses of Volcanism on Waste Isolation. In the event of a basaltic eruption (_____ per cent) of the waste will remain in the flow material and (_____ per cent) would be dispersed in the scoria sheet. A lesser amount (____ per cent) would be dispersed in fine-grained (<65 microns) in the wind-borne particles and in the scoria cone (KKB3.2K, provide estimates of effects of a basaltic volcanic eruption on the emplaced nuclear waste).

The consequence analyses of radiological release during a basaltic eruption includes a scenario of early stage hydrovolcanic activity followed by isolated small-volume and short-duration (Strombolian) eruptions that form scoria and lava flows.

3.2.2.1.2 Faulting

The potential for faulting at Yucca Mountain is indicated by the history of Quaternary faulting in the vicinity. [Evidence will be presented here to document the recurrent nature of faults (provide text from SCP). The effect of faulting on the pre-closure and post-closure period of the repository will also be presented here.]

[Studies must determine the estimate of fault reoccurrence at an interval of (____ years) (KKB3.2L, need this estimate).] Displacements along the principal and secondary faults at Yucca Mountain can affect the facilities placed across these faults, particularly during the preclosure period. [Studies must demonstrate that the faulting is not expected to adversely impact the safe operation of the repository, or compromise the waste isolation characteristics of the repository. (Present the results of these studies when they are completed).]

Probability of Faulting. [Studies will be performed to determine the rates and magnitude of faulting in the vicinity of Yucca Mountain. An analysis of data will show that the rates of faulting events range from (__) per year per 1000 km^2. Average rates of vertical displacement during the Quaternary period will be estimated to be (____ mm to ____ mm) per year.

Reoccurrence intervals of faults having such displacement rates are on the order of (___ to ___) years for earthquakes of M equaling approximately (___).]

[The amount of strike-slip fault movement during the Quaternary Period will be estimated to range from (___ mm to ___ mm) per year. The probabilities of occurrence of both vertical and strike-slip faults will be estimated to be (___) (KKB3.2M, need estimates regarding all of the above numbers).]

3.2.2.1.3 Seismicity

Effects of Earthquake on Waste Isolation. Earthquake induced phenomena such as liquefaction, landslides, and lurching of soil masses are expected to be minimal during the operational phase or post-closure period of the repository. The very deep water table, arid climate, scarcity of thixotropic materials make liquefaction highly unlikely. Similarly, landslides and lurching of soil at the site are not expected because of highly competent rock types and favorable topography. [Add pertinent material from June 29, 1992 earthquake.]

[The seismic hazards in the southern Great Basin will be assessed, and recurrence rates will be determined for a magnitude (M = ___) within a 10,000 km^2 area to be (___ per year). This rate is equivalent to a return rate of (___ yrs).]

[The potential vibratory ground motion at Yucca Mountain will be calculated using deterministic and probabilistic approaches. Table 3.2E will depict the deterministic estimates of ground motion (KKB3.2N, provide mean peak accelerations at Yucca Mountain for earthquakes on potentially susceptible faults in or near southern Great Basin). This table will show that the mean peak acceleration at Yucca Mountain is less than (___ g) and that the repository design will account for such magnitude of vibratory motion.]

[Table 3.2F will depict the probabilistic estimates of ground motion for Yucca Mountain.] The probability of exceeding (__ g) is in the range of (__ to ___) per year. It is concluded that the vibratory ground motion values of (___ g to ___ g) has probability range of 10^{-3} to 10^{-4}. These probabilities are implicitly equated with the safe shutdown earthquake of nuclear reactors and should not cause any problems with the repository operation.

[Ground motion resulting from both earthquakes and weapons testing will be assessed at the underground repository facilities. The results of the experimental and model testing will be discussed below (provide results of underground motion calculations). It must be concluded from the results that the ground motion is less at underground and estimated to be within the range of (_ g to ___ g).]

3.2.2.2 Repository Effects

The expected effect on each natural process or event from the emplacement of waste is described below. [The description will include changes to the local stress field, thermal drying, convection cell, and geochemical modifications. This description will include a discussion of those expected effects that could significantly change the nature of the natural process and discussion of those expected effects that could "trigger" an event. The expected changes over time, and the models used to determine the expected changes will be described. Information included in other sections will be noted by reference.

3.2.2.2.1 Expected Effects of Waste Emplacement on the Natural System

Emplacement of waste is expected to effect the hydrology, geochemistry, thermal, and mechanical state of the rock mass surrounding the repository. The effects that can be expected from the emplacement of the waste packages are:

A. Physical changes in the rock unit due to mining activities

B. Changes in the physical and chemical properties of the rock and water of the unsaturated zone due to the waste-related radiation field

C. Heat induced mechanical effects

D. Modification of the in situ groundwater system due to the thermal load generated by the waste package.

The neutron and gamma radiation from the waste form will penetrate through the waste package and interact with the environment it immediately surrounds. Neutrons can cause damage to material by displacing atoms as a result of atomic collision. The damage to the rock from atomic displacement is very limited due to the low level of flux present in the waste form, and would not significantly alter the properties of rock. The neutron radiation would not significantly affect the water chemistry due to the low flux present in the waste form. (Wilcox and Van Konynenburg, 1981).

Less than three percent of the total thermal energy released by the waste package will be deposited in the host rock by gamma radiation. Over 99 percent of the gamma radiation energy will be deposited within 1 meter of the rock surrounding the waste package. Effects of gamma radiation on the tuff will be transient and are not expected to cause significant changes in the rock mineral properties (Durham et al, 1985). Gamma radiation will cause some significant changes in the water and vapor chemistry due to the production of radiolytic species.

Radiolysis products will be those restricted to those resulting from interaction of gamma radiation with moist air. At temperatures below 120 ^{0}C the most abundant products with relatively long lifetimes are HNO_3, N_2O, and small amounts of O_3. (KKB3.2O, provide interaction of gamma radiation with rock).

The resulting rise in temperature from waste package thermal loads will alter the local hydrologic system and would cause initial dehydration in the (KKB3.2P, hydrological analyses to provide the event of near and far field effects of thermal load on the water transportation within the rock by vapor transport, matrix flow, and fracture flow) rock and eventual rehydration as the rock temperature drops with time. The emplacement of waste packages will alter the hydrologic regime within the vicinity of the repository.

The elevated temperature due to the placement of waste package will also encourage rock and water interaction, and will change the chemistry of the water in the geohydrologic system. (KKB3.2Q, provide the results of modeling and theoretical studies of rock-water interaction).

[Effects of waste emplacement on intact and jointed rock properties will be are discussed below.] The primary effect of temperature changes on the near-field rock is a change in the rock volume due to isobaric thermal expansion. The isobaric thermal expansion of the tuff is (___ /K). The maximum temperature in the near field rock is calculated by modeling to be (___^{0}C) and results in total volume change of about (___ percent) based on the numerical calculation.

Cristobalite, which is present in the near-field rock, undergoes a structural transition from tetragonal to cube symmetry. This phase transition results in a volume increase of five percent. The temperature at which this transition occurs is found to be (___ ^{0}C). [The effect of the associated volume change in the rock in the near field of waste package will be discussed here (KKB3.2R, need a study result describing the volume change in rock containing cristobalite at waste package environment).]

Other effects of thermal output from waste package emplacement on the surrounding rock are increases in the stress field due to heating, cooling and creep in the rock. (KKB3.2S, provide results of analyses of changes in rock stress and creep and any stability consideration in the very near-field and near-field).

3.2.2.3 Human Activities

The human activities that are projected to occur during the intended period of performance and that could affect waste isolation are described below. [The models used to make these projections, the direct expected effects of these projected activities, and the human activities that can have an effect on the natural process, will also be described below.

[Controls that will be designed to be in place will be presented together with the expected effects that such controls will have to prevent or mitigate such human activities.]

3.2.2.3.1 Effects of Human Interference from Exploitation of Natural Resources at the Site

The natural resources potential of the site are described in Section 3.1.1.1.5, Natural Resources. [Studies will be performed to identify, analyze, and evaluate the potential human activities that could adversely affect the waste isolation capabilities of the repository or could lead to inadvertent intrusion to the repository. All credible anthropogenic disruption scenarios will be identified and their potential consequences will be assessed. This information will be used as input to models (Intera to provide the name of the models, justification of their use, and the results obtained) to determine the total system release to the accessible environment caused by inadvertent human activities.]

[Investigations will be performed to identify all resources at the site with current markets, or those that could potentially be marketable in the future. These resources will be identified as to their estimated grades and tonnage, and the impact of the potential usage of these resources will be evaluated using computer models (____ name model, provide results of the potential use of natural resources at the site).]

At present ground water is the only known commodity classified as a resource in the immediate vicinity of the site. Exploitation of this resource is expected to become economically feasible in the near future. [The quantity and quality of the ground water resource will be evaluated, and the current and future value of the resource, and the probable rates and locations of ground water exploitation in the near future will be calculated. These factors will be used in the calculation of the probability for human interference and in assessing the potential effects of ground water exploitation on the isolation capabilities of the site during the 10,000 year post-closure period.]

3.2.2.3.2 Underground Nuclear Test

(Text To Be Developed).

3.2.2.3.3 Controlling Mechanism to Prevent or Mitigate Human Activities

[Studies will be performed and assessed to determine the type of human activity controlling methods such as surface markers, and their long-term survivability during the 10,000 year post-closure period. Investigations will be performed to determine all events, both natural and anthropogenic, that could destroy or degrade the surface markers and monuments to control human activities. The primary data utilized in the assessment of marker and monument design will be: the magnitude and location of the fault ruptures and seismically induced ground motion, the rate, magnitude, and locations of potential igneous activities, and the potential effects of tectonic activity and future climatic conditions on the locations, and rates of erosion and deposition of the geologic medium.]

Table 3.2A. Characteristics of Volcanic Rocks in the Yucca Mountain Region

Table 3.2B. Summary of Fault Characteristics in the Yucca Mountain Area

Table 3.2C. Location, Elevation, Sampling and Drilling Method, Casing and Hole Diameter and Depths, Spud Date and Completion Date

Table 3.2D. Location, Size, Casing, Drilling Method, Water Level, and Rate and Amount of Water Withdrawal and Injection

Table 3.2E. Deterministic Estimates of Ground Motion for Yucca Mountain During Repository Operation

Table 3.2F. Probalistic Estimates of Ground Motion for Yucca Mountain During Repository Operation

Figure 3.2A. Volcanic Rocks at the Yucca Mountain Region During Middle-Tertiary Period

Figure 3.2B. Volcanic Rocks at the Yucca Mountain Region During Late Miocene to Holocene Epoch

Figure 3.2C. Major Faults Bounding the Structural Blocks at the Yucca Mountain Site

Figure 3.2D. Locations of Underground Nuclear Testing in the Yucca Mountain Area

Figure 3.2E. Major Normal Faults At and Near Yucca Mountain

Figure 3.2F. Patterns of Local Seismicity

Figure 3.2G. Locations of All Drill Holes Within the Controlled Area of the Repository

Figure 3.2H Map Showing the Location of Wells Within the Controlled Area Where Injection of Wells Have Occurred

REFERENCES

3.2A Crowe, B. M. and Carr. W. J, 1980. Preliminary Assessment of the Risk of Volcanism at a Proposed Nuclear Waste Repository in the Southern Great Basin, USGS-OFR-80-357, Open-File Report, U.S. Geological Survey, Denver, Colorado.

3.2B Wilcox, T. P., and R.A. Van Konynenburg, 1981. Radiation Dose Calculations for Geologic Media Around Spent Fuel Emplacement Holes in the Climax Granite, Nevada Test Site, UCRL-53159, Lawrence Livermore National Laboratory, Livermore California.

3.2C Durham, N. B., J. M. Beiriger, M. Axelrod, and S. Tretle, 1985. The Effect of Gamma Irradiation on the Strength and Elasticity of Climax Stock and Westerly Granites, UCRL-92526, Reprint, Lawrence Livermore National Laboratory, Livermore, California.

1. Section No. & Title: 3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

2. Lead Author & Phone No. Kal Bhattacharyya (702) 794-1872

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
   (Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   This section describes the characteristics of anticipated and unanticipated processes and events along with a rational for the selection of each specific process and event described. This section also summarizes the background on these processes and events, describes in detail the methods of projecting these events in the future, and describes the bases for these projections. Sufficient data are given to determine which events are anticipated and which are unanticipated and to demonstrate models used to make the projections are applicable. Interactions between the various natural, repository-induced, and human-induced processes and events that may affect waste isolation are evaluated and factored into the analysis.

6. Opening Statement:

   [A statement similar to the following should be made in a potential license application: This section describes the characteristics of anticipated and unanticipated processes and events along with a rationale for the selection of each specific process and event described.]

7. Main Body Outline:

3.2 DESCRIPTION OF ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

3.2.1 Description of Data Base

3.2.1.0 Introduction

3.2.1.1 Natural Processes and Events

3.2.1.2 Characteristics of the Emplaced Waste

3.2.2 Anticipated Processes and Events and Unanticipated Processes and Events

3.2.2.1 Natural Processes and Events

3.2.2.2 Repository Effects

3.2.2.3 Human Activities

8. Conclusion:

[A statement similar to the following should be made in a potential license application: Anticipated processes and events and unanticipated processes and events have been evaluated to determine their effects on repository performance and design. Based on these analyses it appears that virtually all anticipated processes and events and unanticipated processes and events either will not adversely impact performance of the repository either during pre- or postclosure or can be effectively mitigated by appropriate design. Those anticipated process and events and unanticipated processes and events that cannot be properly mitigated by appropriate design have been mitigated by resiting of critical facilities.]

9. Support Authors & Their Assignments:

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

Lead Author & Phone No. Kal Bhattacharyya (702) 794-1872

A. Table No. 3.2A

Title: Characteristics of Volcanic Rocks in the Yucca Mountain Region

Content:

B. Table No. 3.2B

Title: Summary of Fault Characteristics in the Yucca Mountain Area

Content:

C. Table No. 3.2C

Title: Location, Elevation, Sampling and Drilling Method, Casing and Hole Diameter and Depths, Spud Date and Completion Date

Content:

D. Table No. 3.2D

Title: **Location, Size, Casing, Drilling Method, Water Level, and Rate and Amount of Water Withdrawal and Injection**

Content:

E. Table No. 3.2E

Title: **Deterministic Estimates of Ground Motion for Yucca Mountain During Repository Operation**

Content:

F. Table No. 3.2F

Title: **Probabilistic Estimates of Ground Motion for Yucca Mountain During Repository Operation**

Content:

G. Figure No. 3.2A

Caption: Volcanic Rocks at the Yucca Mount Region During Middle-Tertiary Period

Content:

H. Figure No. 3.2B

Caption: Volcanic Rocks at the Yucca Mountain Region During Late Miocene to Holocene Epoch

Content:

I. Figure No. 3.2C

Caption: Major Faults Bounding the Structural Blocks at the Yucca Mountain Area Site

Content:

J. Figure No. 3.2D

Caption: **Locations of Underground Nuclear Testing in the Yucca Mountain Area**

Content:

K. Figure No. 3.2E

Caption: **Major Normal Faults At and Near Yucca Mountain**

Content:

L. Figure No. 3.2F

Caption: **Patterns of Local Seismicity**

Content:

M. Figure No. 3.2G

Caption: Locations of all Drill Holes Within the Controlled Area of the Repository

Content:

N. Figure No. 3.2H

Caption: Map showing the Location of Wells within the Controlled Area where Injection of Wells have occurred

Content:

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title: **3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS**

Lead Author & Phone No. Kal Bhattacharyya (702) 794-1872

Instructions: List all books, articles, or other references which are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

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5.

6.

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MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB3.2A

2. Section no. & title: 3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Need to know what are the anticipated events and processes and what are the unanticipated events and processes along with a rationale for the selection of each specific process and event described.

7. What is the information needed for?

   Asked for in the introduction of Section 3.2 - Description of the Anticipated Processes and events and Unanticipated Processes and Events of the FCRG.

8. What group is the probable information supplier?

   INTERA (Performance assessment group).

9. When is the information needed?

   ASAP.

10. What kind of related information is already available in references, etc.?

    TO BE DETERMINED.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB3.2B

2. Section no. & title: 3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Need to know which processes and events have probability of at least 1 in 10,000 of occurrence during the performance period of the repository.

7. What is the information needed for?

   Asked for in Section 3.2.1.1 - Natural Processes and Events of the FCRG.

8. What group is the probable information supplier?

   INTERA.

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB3.2C

2. Section no. & title: 3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Description of movements on major faults at and near Yucca Mountain including: Bare Mountain, Windy Wash, Solitario Canyon, Bow Ridge, and Paintbrush Canyon during, the Pre-Quaternary and Quaternary Periods. Provide the direction of fault movements in the area.

7. What is the information needed for?

   In response to Section 3.2.1.1 - Natural Processes and Events of the FCRG.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   Late 1990s, after the surface mapping, trenching, geological drilling is completed.

10. What kind of related information is already available in references, etc.?

    SCP Section 1.3.2.2.2 - Structure and structural history of Yucca Mountain.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **KKB3.2D**

2. Section no. & title: **3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS**

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Provide stability calculations in repository design showing that the ground motion form aftershocks that follow large Under Ground Nuclear Events (UKE) has been considered in the design and are shown to cause no stability problem.

7. What is the information needed for?

   In response to Section 3.2.1.1 - Natural Processes and Events of the FCRG.

8. What group is the probable information supplier?

   MKE for repository, RSN for ESF.

9. When is the information needed?

   Before completion of ESF and repository Title II design (1995-96).

10. What kind of related information is already available in references, etc.?

    SCP 1.4.2.2.10 The evaluation of ground motion at depth.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: KKB3.2E

2. Section no. & title: 3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Provide names of computer models and results of analysis used to determine the correlation of earthquakes to recognized geological structures in the seismotectonic zones in the Yucca Mountain area.

7. What is the information needed for?

   Section 3.2.1.1 - Natural Processes and Events.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   Late 1990s.

10. What kind of related information is already available in references, etc.?

    SCP Section 1.4.1.3 - Determination of earthquake - generating potential of geologic structures and seismotectonic zones within the Great Basin.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **KKB3.2F**

2. Section no. & title: **3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS**

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Provide waste package thermal output levels and temperature profiles for spent fuel and high level waste.

7. What is the information needed for?

   Response to Section 3.2.1.2 - Characteristics of the Emplaced Waste of the FCRG.

8. What group is the probable information supplier?

   B & W.

9. When is the information needed?

   Early stages of Title II design of repository (1994?).

10. What kind of related information is already available in references, etc.?

    As waste package design is anticipated to be different from the baseline design, this information will have to be developed.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **KKB3.2G**

2. Section no. & title: **3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS**

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Provide number of panels and area where waste is emplaced. Include, areal thermal density, peak rock temperatures in the very near-field (around the waste packages), near-field (emplacement room), and far-field (repository scale).

7. What is the information needed for?

   This information is asked for in Section 3.2.1.2 - Characteristics of the Emplaced Waste, of the FCRG.

8. What group is the probable information supplier?

   B & W, MKE.

9. When is the information needed?

   This information will be developed during the Title II repository and waste package design (by 1996?).

10. What kind of related information is already available in references, etc.?

    This information is not available now as new concepts of repository design and waste package is being developed and the available information will probably be inapplicable.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB3.2H

2. Section no. & title: 3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Provide information regarding the mill sites and lode claims for an area within 10 km of the GROA.

7. What is the information needed for?

   In response to Section 3.2.1.3 - Past Human Activities.

8. What group is the probable information supplier?

   WCC.

9. When is the information needed?

   Late 1990s.

10. What kind of related information is already available in references, etc.?

    SCP Section 1.6.4 - Underground Mining Activities.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB3.2I

2. Section no. & title: 3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Provide evidence that silicic volcanism has no significant potential for initiating a disruptive event after the closure of the repository during the performance period.

7. What is the information needed for?

   To respond to Section 3.2.2.1 - Natural Processes and Events.

8. What group is the probable information supplier?

   LANL, WCC.

9. When is the information needed?

   Late 1990s.

10. What kind of related information is already available in references, etc.?

    SCP Section 1.5.1.1.2 - Likelihood of Silicic Volcanism.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **KKB3.2J**

2. Section no. & title: **3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS**

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Provide an estimate of the probability that the repository would be penetrated by magma during basaltic volcanism during the next 10,000 yrs.

7. What is the information needed for?

   To respond to Section 3.2.1.1 - Natural Processes and Events of the FCRG.

8. What group is the probable information supplier?

   LANL, WCC, AND INTERA.

9. When is the information needed?

   Late 1990s.

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB3.2K

2. Section no. & title: 3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Provide an estimate of the effects of a basaltic volcanic eruption on the emplaced nuclear waste.

7. What is the information needed for?

   Section 3.2.2.1 - Natural Processes and Events of the FCRG.

8. What group is the probable information supplier?

   LANL, WCC, INTERA.

9. When is the information needed?

   Late 1990s.

10. What kind of related information is already available in references, etc.?

    SCP, Section 1.5.1.2.3 Likelihood of basaltic volcanism.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB3.2L

2. Section no. & title: **3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS**

3. Lead author & phone no: **Kal Bhattacharyya (702) 794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Provide an estimate of fault recurrence interval of faults in the Yucca Mountain area.

7. What is the information needed for?

   Section 3.2.2.1 of the FCRG.

8. What group is the probable information supplier?

   USGS, WCC.

9. When is the information needed?

   Late 1990s.

10. What kind of related information is already available in references, etc.?

    SCP Section 1.5.2.2 - Likelihood of faulting.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB3.2M

2. Section no. & title: 3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Estimate of the amount of strike-slip fault movement during the Quaternary Period and the probabilities of occurrence of both vertical and strike-slip faults.

7. What is the information needed for?

8. What group is the probable information supplier?

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB3.2N

2. Section no. & title: 3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

3. Lead author & phone no: Kal Bhattacharyya (702) 794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Provide mean peak acceleration at Yucca Mountain for earthquakes on potentially susceptible faults.

7. What is the information needed for?

   For response to Section 3.2.2.1 - Natural Processes and Events of the FCRG.

8. What group is the probable information supplier?

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB3.2O

2. Section no. & title: 3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

3. Lead author & phone no: Kal Bhattacharyya 702-794-1872

4. Information request date 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Provide interaction of gamma radiation with rock

7. What is the information needed for?

   Section 3.2.2.2 - Repository Effects of the FCRG.

8. What group is the probable information supplier?

   LANL, WCC, INTERA

9. When is the information needed?

   By late 1990s.

10. What kind of related information is already available in references, etc.?

    SCP Section 4.2 Geochemical effects of waste emplacement.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **KKB3.2P**

2. Section no. & title: **DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS**

3. Lead author & phone no: **Kal Bhattacharyya 702-794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Hydrological analyses to provide the event of near and far field effects of thermal load on the water transportation within the rock by vapor transport, matrix flow, and fracture flow.

7. What is the information needed for?

   Response to Section 3.2.2.2 - Repository Effectsof the FCRG.

8. What group is the probable information supplier?

   LLL, WCC, MKE

9. When is the information needed?

   Before completion of Title II design of repository, (1996?)

10. What kind of related information is already available in references, etc.?

    This information has to be developed in concert with the repository design. SCP Section 2.7.2 - Thermally Induced Water Migration is a source.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB3.2Q

2. Section no. & title: 3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

3. Lead author & phone no: Kal Bhattacharyya 702-794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   The elevated temperature due to the placement of waste package will encourage rock-water interaction and will change the chemistry of the water in the geohydrologic system. Provide the results of modeling and theoretical studies of rock-water interaction.

7. What is the information needed for?

   To respond to Section 3.2.2.1 - Repository Effects of the FCRG.

8. What group is the probable information supplier?

   LANL, WCC

9. When is the information needed?

   By late 1990s.

10. What kind of related information is already available in references, etc.?

    To Be Determined.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **KKB3.2R**

2. Section no. & title: **3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS**

3. Lead author & phone no: **Kal Bhattacharyya 702-794-1872**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Need a study result describing the volume change in rock containing cristobalite at waste package environment.

7. What is the information needed for?

   To respond Section 3.2.2.2 - Repository Effects of the FCRG.

8. What group is the probable information supplier?

   LANL, WCC

9. When is the information needed?

   By late 1990s.

10. What kind of related information is already available in references, etc.?

    To Be Determined.

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: KKB3.2S

2. Section no. & title: 3.2 DESCRIPTION OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

3. Lead author & phone no: Kal Bhattacharyya 702-794-1872

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Provide results of analyses of changes in rock stress and creep and any stability consideration in the very near-field and near-field.

7. What is the information needed for?

   To respond to Section 3.2.2.2 - Repository Effects of the FCRG.

8. What group is the probable information supplier?

   MKE, SNL

9. When is the information needed?

   During Title II design of repository (1996)

10. What kind of related information is already available in references, etc.?

    (Sandia National Lab (SAND) Reports - to be named.)

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form B: Information Response

1. Section No. & Title: 3.2 DESCRIPTIONS OF THE ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

2. Person Supplying Information: Kal Bhattacharyya (702) 794-1872

3. Phone No.:

4. Lead Author (Requester):

   Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

MGDS Annotated Outline

Section 3.3 Assessment of Compliance with 10 CFR 60

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3.3 ASSESSMENT OF COMPLIANCE WITH 10 CFR 60

Skeleton Text Has Not Been Developed For This Section

REFERENCES

1. Section No. & Title: 3.3 ASSESSMENT OF COMPLIANCE WITH 10 CFR 60

2. Lead Author & Phone No. John A. Blair 202-488-2308
Placeholder for TBD

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   [Statements similar to the following should be made in a potential license application: This section describes the geology, geophysics, hydrogeology, geochemistry, climatology, and meteorology of Yucca Mountain, Nevada (10CFR60.21(c) (1) (ii) (A)). Analyses of these factors has determined the degree to which potentially favorable or unfavorable conditions are present. (10CFR60.21 (c) (1) (ii) (B)).]

   [Sufficient investigations have been conducted to assess critical pathways for radionuclide migration from the underground facility to the accessible environment and to analyze the pre-wastes-emplacement ground-water travel time along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment.]

   [Natural barriers important to the isolation of high-level waste from the accessible environment including barriers that may or may not themselves be part of the geologic repository operations area have been identified and evaluated for effectiveness against the release of radioactive material to the environment. (10CFR60.21(c) (1) (ii) (D)).]

6. Opening Statement:

   [A statement similar to the following should be made in a potential license application: This section describes how the Yucca Mountain Project Site complies with the requirements of 10CFR60 with respect to the geologic, geophysical, hydrogeologic, geochemical, climatologic, and meteorologic requirements.]

7. Main Body Outline:

3.3 ASSESSMENT OF COMPLIANCE WITH 10 CFR PART 60

3.3.1 Geologic System

3.3.1.1 Assessment of Favorable Conditions

3.3.1.1.1 Tectonic and geomorphic processes which by their nature and rate as demonstrated during the Quaternary Period would affect the waste isolation capability favorably or would not adversely affect the repository. (10 CFR 60.122(b) (1))

3.3.1.1.2 Conditions permitting waste emplacement at a minimum depth of 300 meters below ground surface. (10 CFR 60.122(b) (5)).

3.3.1.1.3 A low population density within the geologic setting and a controlled area remote from population centers. (10 CFR 60.122 (b) (6)).

3.3.1.2 Assessment of Potentially Adverse Conditions

3.3.1.2.1 Evidence for or against dissolutioning. (10 CFR 60.122(c) (10))

3.3.1.2.2 Evaluation of structural deformation during the Quaternary Period. (10 CFR 60.122 (c) (11))

3.3.1.2.3 Historic earthquakes that could significantly affect the site if repeated. (10 CFR 60.122 (c) (12))

3.3.1.2.4 Evaluation to determine if the frequency or magnitude of earthquakes may increase. (10 CFR 60.122(c) (13))

3.3.1.2.5 Evaluation to determine if the frequency of earthquakes is higher than the regional frequency. (10 CFR 60.122(c) (14))

3.3.1.2.6 Evaluation to determine extent of igneous activity since the start of the Quaternary Period. (10 CFR 60.22(c) (15))

7. Main Body Outline (Continued)

3.3.1.2.7 Evaluation to determine extent of erosion during the Quaternary Period. (10 CFR 60.22(c) (16))

3.3.1.2.8 Evaluation of naturally occurring materials whether identified or undiscovered specifically to determine if:

3.3.1.2.8.1 Economic extraction is currently feasible or potentially feasible during the foreseeable future. (10 CFR 60.122 (c) (17) (i)).

3.3.1.2.8.2 Such materials have greater gross or net value than the average for other areas of similar size that are representative of and located within the geologic setting. (10 CFR 60.122(c) (17) (ii)).

3.3.1.2.9 Results of exploration for evidence of subsurface mining for resources within the site. (10 CFR 60.122(c) (18))

3.3.1.2.10 Results of exploration for evidence of drilling for any purpose within the site. (10 CFR 60.122(c) (19))

3.3.1.2.11 Evaluation to determine if geomechanical properties permit design of underground openings that will remain stable through permanent closure. (10 CFR 60.122(c) (21)_).

3.3.2 Hydrologic System

3.3.2.1 Favorable Conditions

3.3.2.1.1 Hydrogeologic processes which by their nature and rate as demonstrated during the Quaternary Period would affect the waste isolation capability favorably or would not adversely affect the repository. (10 CFR 60.122 (b) (1))

7. Main Body Outline (Continued)

3.3.2.1.2 Pre-waste-emplacement ground-water travel time along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment that substantially exceeds 1000 years. (10 CFR 60.122 (b) (7))

3.3.2.1.3 Favorable conditions for disposal in the unsaturated zone.

3.3.2.1.3.1 Results of search for evidence of low moisture flux in the host rock and in the overlying and underlying hydrogeologic units. (10 CFR 60.122 (b) (8) (i))

3.3.2.1.3.2 Results of search for evidence of a water table sufficiently below the underground facility such that fully saturated voids contiguous to the water table do not encounter the underground facility. (10 CFR 60.122(b) (8) (ii))

3.3.2.1.3.3 Results of exploration for evidence of a laterally extensive low-permeability hydrogeologic unit above the host rock that would inhibit the forward movement of water or divert downward moving water to a location beyond the limits of the underground facility. (10 CFR 60.122(b) (8) (iii))

3.3.2.1.3.4 Results of exploration for evidence that the host rock provides for free drainage. (10 CFR 60.122(b) (8) (iv))

3.3.2.2 Potentially Adverse Conditions

3.3.2.2.1 Potential for flooding the underground facility. (10 CFR 60.122(c) (1))

7. Main Body Outline (Continued)

3.3.2.2.2 Potential for adverse effects on the ground-water withdrawal system by human activity. (10 CFR 60.122(c) (2))

3.3.2.2.3 Potential for impoundments to form by natural catastrophic means so as to adversely impact the ground-water with respect to the repository. (10 CFR 60.122(c) (3))

3.3.2.2.4 Potential for geologic structural deformation to adversely affect the regional ground-water flow system. (10 CFR 60.122(c) (4)

3.3.2.2.5 Potential for changes in hydrologic conditions that would adversely affect migration of radionuclides to the accessible environment. (10 CFR 60.122(c) (5))

3.3.2.2.6 Evaluation of rock or ground-water conditions to determine the extent to which complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts might be required. (10 CFR 60.122(c) (20))

3.3.2.2.7 Potential for the water table to rise sufficiently to cause saturation of the facility. (10 CFR 60.122(c) (22))

3.3.2.2.8 Potential for existing or future perched water bodies that may saturate portions of the underground facility or provide a faster flow path from an underground facility located in the unsaturated zone to the accessible environment. (10 CFR 60.122(c) (23))

3.3.3 Geochemical System

The description of the analyses of favorable and potentially adverse conditions related to the geochemical system.

7. Main Body Outline (Continued)

3.3.3.1 Favorable Chemical Conditions

Analyses and results used to determine the degree by which each favorable condition has been characterized and to which it contributes to isolation.

3.3.3.1.1 Geochemical Processes

Nature and rates of geochemical processes operating within the geologic setting during the Quaternary Period that, when projected, would not affect or would favorably affect the ability of the repository to isolate waste. (See Figure 3.3.3.1.1A). Reference 10 CFR 60.122(b)(1).

Analyses of the geochemical process (i.e., modelling efforts, laboratory testing, etc.).

3.3.3.1.2 Geochemical Conditions

Summary of Geochemical Conditions.

Conditions that promote precipitation or sorption of radionuclides. Reference 10 CFR 60.122 (b)(3)(i).

Conditions that inhibit the formation of particulates, colloids, and inorganic and organic complexes that increase the mobility of radionuclides. Reference 10 CFR 60.122 (b)(3)(ii).

Condition that inhibit the transport of radionuclides by particulates, colloids, and complexes. References 10 CFR 60.122 (b)(3)(iii).

3.3.3.1.3 Mineral Assemblages

Mineral assemblages and analyses which when subjected to anticipated thermal loading, will remain unaltered or alter to mineral assemblages having equal or increased capacity to inhibit radionuclide migration. (See Table 3.3.3.1.3A).

7. Main Body Outline (Continued)

3.3.3.2 Potentially Adverse Geochemical Conditions

This section describes the potentially adverse conditions. (See Table 3.3.3.2A).

3.3.3.2.1 Groundwater Conditions

Groundwater conditions in the host rocks, including chemical composition, high ionic strength, or ranges of Eh-ph, that could increase the solubility or chemical reactivity of the Engineered Barrier System (EBS), Reference 10 CFR 60.122 (c)(7).

3.3.3.2.2 Evaluation of Geochemical Processes

Evaluation of geochemical processes that might reduce sorption of radionuclides, result in degradation of the rock strength, or adversely affect the performance of the engineered barrier system. Reference 10 CFR 60.122 (c)(8).

3.3.3.2.3 Evaluation of Evidence

Evaluation of evidence to determine if groundwater conditions in the host rock are not reducing. Reference 10 CFR 60.122 (c)(9).

3.3.3.2.4 Potential Radionuclide Movement

Potential for the movements of radionuclides in a gaseous state through air filled spaces of an unsaturated geologic medium to the accessible environment. Reference 10 CFR 60.122 (c)(24).

3.3.4 Climatological and Meteorological Systems

Describe analyses that resulted in determination of favorable and potentially adverse conditions (present or absent).

For favorable conditions found to be present, describe analysis determining degree to which each condition has been characterized.

7. Main Body Outline (Continued)

For favorable conditions found to be present, describe analysis determining extent to which each contributes to isolation.

For potentially adverse conditions found to be present, describe analysis determining degree to which each condition has been characterized.

For potentially adverse conditions found to be present, describe analysis determining extent to which each detracts from isolation.

- Also, describe analysis demonstrating that:

The condition has been adequately investigated

- Include extent to which the condition may be undetected considering degree of resolution achieved by investigations.

The effect of the condition has been adequately evaluated:

- Use analyses that are sensitive to the potentially adverse condition.
- Use assumptions that are not likely to underestimate the condition's effects.

The condition does not significantly affect the ability of the repository to meet the performance objectives or:

- The condition is compensated by favorable conditions.
- The condition can be remedied.

Describe criteria used to determine that any potentially adverse condition is compensated by the presence of one or more favorable conditions or that the potentially adverse condition can be remedied

Provide an explanation of measures supporting the models used to perform analyses.

- Support analyses and models used to predict future conditions and changes in the system by using an appropriate combination of methods:
    - Field tests
    - In-situ tests

7. Main Body Outline (Continued)

- Laboratory tests representing field conditions
- Monitoring data
- Natural analog studies.

  -- Discuss variability and uncertainty of data and the propagation of errors
  -- Discuss evaluations of data representativeness and uncertainties associated with extrapolation of data
  -- Discuss conceptualizations and the documentation and validation of codes and models with respect to:

- Uncertainties related to the data on which the model is based
- Applicability of specific models
- Appropriateness of assumptions used in modelling
- Sensitivity of model results to the uncertainty of the input data.
- Provide input and output data and interpretations, with the bases for the interpretations to:

  -- Provide sufficient detail to allow independent analysis of results
  -- Document the role of expert judgement, when needed.

3.3.4.1 Favorable Conditions

Evaluation of potential for favorable conditions as shown by evidence for a climatic regime in which the average annual historic precipitation is a small percentage of the average annual potential evapotranspiration. 10 CFR 60.122 (b)(8)(v).

3.3.4.2 Potentially Adverse Conditions

Evaluation of evidence for adverse conditions as shown by potential for changes in hydrologic conditions resulting from reasonably foreseeable climatic changes. Ref. 10 CFR 60.122 (c)(6).

3.3.5 Assessment of Compliance with Performance Objectives

Assessment of Compliance with Performance Objectives. Ref. 10 CFR 60.113 (a)(2)/10 CFR 60.113 (b)/10 CFR 60.122 (a)(1).

7. Main Body Outline (Continued)

3.3.5.1 Disturbed Zone

Description of the boundaries of the disturbed zone and documentation and description of the criteria and analytic techniques to establish those boundaries.

3.3.5.2 Ground Water Travel Time

Description of the pre-waste-emplacement ground-water travel time along the fastest path of radionuclide travel from the disturbed zone to the accessible environment. Reference 10 CFR 60.113 (b)/Section 3.1.2 (Hydrologic System). 10 CFR 60.122.

3.3.6 Effectiveness of Natural Barriers Against the Release of Radioactive Material to the Environment

Identification of natural barriers that may not themselves be part of the GROA, but important to isolating HLW from the accessible environment. Also determine the effectiveness of those barriers against the release of radioactive material to the environment. Reference Section 3.1/3.3.1/3.3.4/3.3.5.

8. Conclusion:

[A statement similar to the following should be made in a potential license application: Evaluation of the Yucca Mountain Repository Site shows that the majority of natural characteristics are such that the site is favorable for the construction of a nuclear waste repository. Those features that are not favorable are mitigated by proper repository design.]

9. Support Authors and their assignments:

TBD.

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: **3.3 ASSESSMENT OF COMPLIANCE WITH 10 CFR 60**

Lead Author & Phone No. John A. Blair 202-488-2308
Placeholder for TBD

A. Figure/Table No. To Be Determined.

Caption/Title:

Content:

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title:

Content:

MGDS Annotated Outline Planning Package Date: 9/30/92
Form 3: References

Section No. & Title: 3.3 ASSESSMENT OF COMPLIANCE WITH 10 CFR 60

Lead Author & Phone No. John A. Blair 202-488-2308
Placeholder for TBD

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer' Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

1. Numerous references are listed i the SCP dealing with this subject. These references should be examined to determine which ones are still relevant. Many other references remain to be developed including topical reports on volcanism, erosion, seismicity, and calcite-silica deposits.

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MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 4/17/92

1. Log number:
2. Section no. & title: 3.3 **ASSESSMENT OF COMPLIANCE WITH 10 CFR 60**
3. Lead author & phone no: **J. A. Blair (202) 488-2308**
4. Information request date:
5. Work location:
6. Type of information needed:
7. What is the information needed for?
8. What group is the probable information supplier?
9. When is the information needed?
10. What kind of related information is already available in references, etc.?

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11. Response by (name):
12. Response date:
13. Response:

MGDS Annotated Outline Information Need Form Date 9/30/92
Form B: Information Response

1. Section No. & Title:

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester):

Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log Number on this form should be identical to the Log Number of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Oultine Information Need Form Date: 9/30/92
Form C: Information Request Tracking Log

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

MGDS Annotated Outline

Chapter 4.0 Geologic Repository Operations Area: Physical Facilities

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4.0 GEOLOGIC REPOSITORY OPERATIONS AREA: PHYSICAL FACILITIES

Skeleton Text Has Not Been Developed For This Section

REFERENCES

1. Section No. & Title: 4.0 GEOLOGIC REPOSITORY OPERATIONS AREA: PHYSICAL FACILITIES

2. Lead Author & Phone No.: TBD
[T.M. Williamson 702-794-1821]

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

This chapter presents information describing the physical facilities for the Geologic Repository Operations Area (GROA). It also demonstrates compliance with all applicable regulatory requirements for GROA surface facilities, shafts, ramps, and underground facilities. Sufficient information is provided to facilitate an independent review of GROA design and verification of compliance. Structures, systems, and components (SSCs) important to safety, isolation, and retrievability are identified and justified. Physical measures to provide radiation protection are described in detail. Section 4.1 describes the physical facilities and Sections 4.2-4.5 demonstrate compliance with all applicable regulatory requirements.

6. Opening Statement:

[A statement similar to the following should be made in a potential license application: GROA SSCs are designed to prevent or mitigate the consequences of design basis accidents, ensure waste isolation, and facilitate waste retrievability. Analyses provided in this chapter demonstrate that GROA SSCs comply with all applicable regulatory requirements.]

7. Main Body Outline:

4.0 INTRODUCTION

- Provide a general description of the repository or reference the general description in preceding chapters.

7. Main Body Outline (Continued)

- The overall repository layout is shown in Figure 4.0-A. [This figure may be provided in preceding chapters.].
- Use the above opening statement, summary, and closing statement to introduce the chapter.

4.1 DESCRIPTION OF THE GROA STRUCTURES, SYSTEMS, AND COMPONENTS

- Refer to Planning Package for Section 4.1

4.2 ASSESSMENT OF COMPLIANCE FOR SURFACE FACILITIES

- Refer to Planning Package for Section 4.2

4.3 ASSESSMENT OF COMPLIANCE FOR SHAFTS AND RAMPS

- Refer to Planning Package for Section 4.3

4.4 ASSESSMENT OF COMPLIANCE FOR UNDERGROUND FACILITIES

- Refer to Planning Package for Section 4.4

4.5 INTEGRATED GROA COMPLIANCE WITH PERFORMANCE OBJECTIVES

- Refer to Planning Package for Section 4.5

8. Conclusion:

[A statement similar to the following should be made in a potential license application: GROA SSCs are designed to prevent or mitigate the consequences of design basis accidents, ensure waste isolation, and facilitate waste retrievability. Analyses provided in this chapter demonstrate that GROA SSCs comply with all applicable regulatory requirements. Therefore, there are no credible circumstances by which GROA operations threaten the health and safety of plant personnel or the public.]

9. Support Authors & Their Assignments:

T.M. Williamson (M&O Licensing)

Section No. & Title: **4.0** **GEOLOGIC REPOSITORY OPERATIONS AREA: PHYSICAL FACILITIES [Chapter Introduction]**

Lead Author & Phone No.: TBD
T.M. Williamson (702) 794-1821

A. Figure No. **4.0A**

Caption: **Repository Layout**

Content:

General arrangement drawing of the entire repository with major features identified. Local surface facilities, shafts and ramps, and underground facility. Show site boundary.

[This drawing may be found in preceding changes.]

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title:

Content:

!!

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title:

Lead Author & Phone No.

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

1.

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II

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number:

2. Section no. & title: 4.0 GEOLOGIC REPOSITORY OPERATIONS AREA: PHYSICAL FACILITIES [Chapter Introduction]

3. Lead author & phone no: T. M. Williamson (702) 794-1821

4. Information request date:

5. Work location:

6. Type of information needed:

7. What is the information needed for?

8. What group is the probable information supplier?

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form B: Information Response

Date: 9/30/92

1. Section No. & Title:

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester): Marshall Weaver (702) 794-1871

Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form C: Information Request Tracking Log

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

MGDS Annotated Outline

Section 4.1 Description of the GROA Structures, Systems, and Components

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4.1 DESCRIPTION OF THE GROA STRUCTURES, SYSTEMS AND COMPONENTS

Skeleton Text Has Not Been Developed For This Section

REFERENCES

1. Section No. & Title: 4.1 DESCRIPTION OF THE GROA STRUCTURES, SYSTEMS, AND COMPONENTS

2. Lead Author & Phone No. TBD
T. M. Williamson 702-794-1821

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   In this section, a general overview of Geologic Repository Operations Area (GROA) physical facilities is followed by detailed descriptions of the surface facilities, ramps and shafts, and underground facilities. The detailed descriptions of GROA structures, systems, and components (SSCs) include the purpose, function, design, location, and layout of SSC features. Design bases are provided, including the characteristics of the waste and its package, the characteristics of the site, and repository functional requirements. Those SSCs important to safety, waste retrievability, and waste isolation are identified. Supporting information is provided in the form of flow diagrams, instrumentation diagrams, equipment drawings, and plant layout drawings to facilitate an independent review of GROA SSCs. Sufficient information is provided to demonstrate compliance with all applicable regulatory requirements. Compliance with applicable regulatory requirements is assessed in Section 4.2.

6. Opening Statement:

   [A statement similar to the following should be made in a potential license application: GROA SSCs are designed to prevent or mitigate the consequences of design basis accidents, facilitate waste retrievability, and ensure waste isolation.]

7. Main Body Outline:

4.1 DESCRIPTION OF THE GROA STRUCTURES, SYSTEMS, AND COMPONENTS

4.1.0 Introduction

7. Main Body Outline (Continued)

- General description of GROA (include quote of 10 CFR 60.2 definition)
- Discuss site features that affect GROA design and performance
- Location of GROA relative to accessible environment is shown in Figures 4.1A and B
- Schedules for GROA construction, receipt of waste, and emplacement of waste are provided in Table 4.1A.

4.1.0.1 Selected Design

- Describe major design features important to waste isolation.
- Describe the overall purpose, function, and design features of GROA SSCs
- The location and layout of GROA SSCs is shown in Figure 4.1C.
- Flow diagrams, piping drawings, and instrumentation diagrams are provided in Sections 4.1.1, 4.1.2, and 4.1.3, as appropriate.
- Describe the design bases for GROA SSCs.
- The principal design criteria and the resulting value of design parameters are provided in Table 4.1B. Specific system and component design parameters are provided in Sections 4.1.1, 4.1.2, and 4.1.3.
- Describe the design of GROA SSCs including the design bases.
- Discuss the bases of the principal design parameters, including the uncertainties associated with each parameter and the treatment of parameter uncertainties.
- The applicable standards and codes used in the design are provided for each GROA SSC in Table 4.1C.
- Waste design basis information is summarized in Table 4.1D. The characteristics and history of the waste are described in detail in Section 5.1. Waste treatment processes are also described in Section 5.1, including waste treatment processes.
- Waste package design basis information is summarized in Table 4.1E. Detailed waste package design information is provided in Section 5.1.
- Discuss site design basis, including compilation and interpretation of all physical data relevant to GROA design, including:

7. Main Body Outline (Continued)

1) Interpretation of site geology such as stratigraphy, structural features, major and minor faults, old volcanos, and history of seismic activity. The physical geologic data is provided in Section 3.1.1.

2) Interpretation of surface and groundwater hydrologic data including surface drainage characteristics, drainage through strata penetrated by ramps and shafts, above and below ground. The physical data are provided in Section 3.1.2.

3) Soil properties and other relevant data for the design of foundations are provided in Table 4.1F.

4) Interpretation of weather and other relevant meteorological, including human-induced phenomena such as nuclear detonations and aircraft travel. The data are provided in Section 3.1.4.

5) Interpretation of rock data and properties that are relevant to the design of surface facilities, shafts and ramps, and the underground facility.

6) Interpretation of engineered components that are placed within the underground facility. These data are provided in Table 4.1I.

4.1.0.2 Alternative Designs

- Discuss comparative evaluations of the selected design features.
- Emphasize alternatives that would provide for longer waste isolation.

4.1.0.3 Regulatory Design Criteria

- Discuss general descriptions of design criteria of 10 CFR 60, DOE documents, system and subsystem design requirements documents, and DOE mission plans. These requirements are summarized in Table 4.1J.

7. Main Body Outline (Continued)

- Discuss how GROA meets any other Federal, State, and local design requirements such as OSHA, mine safety, EPA, etc. [FCRG comment]

4.1.0.4 Regulatory Performance Objectives

- Discuss regulatory GROA performance objectives.

4.1.0.5 Identification of SSCs Important to Safety, Retrievability, and Isolation

- Discuss activities and events, either planned or unplanned, that could interfere with SSC performance.
- The SSCs important to safety, retrievability, or isolation are identified in Table 4.1K.
- Discuss framework for identification.

4.1.0.6 SSCs Requiring Design Verification

- Identify SSCs requiring R&D to confirm adequacy of design.
- Discuss programs to confirm adequacy.
- Justify proceeding with construction before research is complete, if necessary, including contingency if design is not confirmed.

4.1.1 Surface Facilities

- Cross reference section 1.4 "Certification of Safeguards" and Section 1.5 "Physical Security Plan" to address as necessary.
- The location and layout of surface facilities is shown in Figure 4.1C.
- The design bases and design descriptions are provided for all surface facility SSCs.

4.1.1.1 Hot Cell Waste-Handling System, Buildings, and Equipment

- Describe the design bases for the hot cell for receiving, transporting, handling, storing, treating, or preparing waste for transfer and disposal.
- Provide design descriptions including features that are important to safety.

7. Main Body Outline (Continued)

- Describe all features, systems, or special handling techniques that are important to safety under both normal and off-normal conditions. Instrumentation diagrams are provided in Figure 4.1D. Major components are illustrated in Figure 4.1E. Major component design parameters are listed in Table 4.1J.
- Describe any temporary storage facilities. Figure 4.1C shows their location.
- Describe waste retrievability operations.

4.1.1.2 On-Site Radioactive Waste Management System

- Describe system and subsystem design basis.
- Describe each waste source.
- For each waste source, describe collection, treatment, packaging, and disposal system and subsystem designs. Flow diagrams and piping drawings are provided in Figures 4.1F and 4.1G, respectively. Major component design parameters are listed in Table 4.1J.
- Describe effluent control and monitoring systems during normal operations. Instrumentation diagrams are provided in Figure 4.1H.

4.1.1.3 Fire and Explosion Protection System

- Describe surface facility fire and explosion protection system design bases. A list of unusually hazardous or combustible materials is provided in Table 4.1L.
- Describe system design, including building features that contribute to the prevention of fires. Flow diagrams and piping drawings are provided in Figures 4.1I and 4.1J, respectively. Major component design parameters are listed in Table 4.1M. The locations of fire walls are shown in Figure 4.1K. Sprinkler coverage is illustrated in Figure 4.1L. The locations of fire extinguishes, alarms, and stand pipes are shown in Figure 4.1M.

4.1.1.4 Emergency Systems

- To provide design bases of GROA emergency systems to maintain control of radioactive waste and effluent
- [Describe system design]
- Discuss system failures and emergency situations:

7. Main Body Outline (Continued)

- Offsite power failures
- Floods
- Seismic events
- Sabotage
- Military action
- Other emergencies.

• Provide design bases
• Describe system design within GROA and to offsite locations:

  - Surface
  - Surface to underground.

4.1.1.5 Communications Systems

• Provide design bases
• Describe system design within GROA and to offsite locations:

  - Surface
  - Surface to underground
  - Within underground.

• The location of communication devices and alarms are shown in Figure 4.1N.

4.1.1.6 Utility Systems

• Provide design bases for utility systems
• Describe designs including operating feature for each system including:

  - Electrical power
  - Compressed air
  - Water supply
  - Steam supply
  - Fuels supply
  - Sanitary sewage treatment
  - Chemical sewage treatment
  - Auxiliary or back-up systems.

7. Main Body Outline (Continued)

- Flow diagrams and piping drawings are provided in Figures 4.1O and 4.1P, respectively. Electrical system one-line diagrams are provided in Figure 4.1Q. Major component design parameters are listed in Table 4.1N.
- Discuss operating features, including redundant design features that are essential to safety under normal and accident conditions. Instrumentation diagrams are provided in Figure 4.1R.

4.1.1.7 Instrumentation and Control Systems

- Add data management (including support to waste management and tracking) to the listing of computer systems. Also add data management systems that track personnel.

- Describe design of GROA computer systems, including:

  - Data acquisition
  - Meteorological monitoring
  - Hydrological monitoring
  - Geophysical monitoring
  - Seismic monitoring
  - Surface-based testing
  - In situ testing
  - Performance conformation.

- Describe monitoring instruments and control systems that monitor and control safety related systems and equipment. The architecture of computers and controls is provided in Figure 4.1S. The control room is illustrated in Figure 4.1T.

4.1.1.8 Onsite Transportation Systems

- Provide the design bases for the onsite transportation systems.

- Describe the system designs. Figure 4.1U illustrates location of onsite railroads and paved roads. Detailed engineering of hoist buildings and ramp buildings is provided in Figure 4.1V.

7. Main Body Outline (Continued)

4.1.1.9 Ventilation Systems

- HVAC system design parameters are provided in Table 4.1O.
- Describe surface facilities' systems including:
  - Surface portion supporting underground
  - Emplacement vent system
  - Development system
  - HEPA filters
  - Absorption systems
  - Vent monitoring systems
  - Refrigeration plant system.
- Include safety measures for operation under normal and accident conditions.
- Major component design parameters are provided in Table 4.1P. Flow diagrams and duct drawings are provided in Figures 4.1W and 4.1X, respectively.

4.1.1.10 Operations Support Systems

- Describe the design and operations of support systems, including:
  - Maintenance shop
  - Supplies warehouse
  - Storage yard
  - Lockers and showers
  - Visitors center
  - Office buildings.
- The physical location of the support facilities is shown in Figure 4.1C. A general arrangement drawing of each of the support facility buildings is provided in Figures 4.1Y through 4.1AD.

4.1.1.11 Decommissioning System

- Describe all equipment, systems, or facilities requiring decommissioning. These are identified in Table 4.1Q.
- Describe decommissioning methods and procedures, reclamation of land, installation of fences, and markers.

7. Main Body Outline (Continued)

- Describe procedures for decommissioning of surface facilities:

  - Waste handling building
  - Waste treatment building
  - Performance conformation building
  - Ventilation exhaust building
  - Decontamination building.

- Discuss decommissioning operations that may impact long-term isolation of waste.

4.1.1.12 Other Surface Systems

- Describe the design bases for any other surface facility, including:

  - Much piles
  - Surface lagoons.

4.1.2 Shafts and Ramps

- Provide the layout, overall design bases, and overall design descriptions of all shafts and ramps. The layout of all shafts and ramps is illustrated in Figure 4.1E. The shaft and ramp SSCs are identified in Table 4.1R. Schedules for SCC inspections, testing, and maintenance are provided in Tables 4.1S, T, and U.

4.1.2.1 Waste Shaft or Ramp

- Add roof control plan, mining method, etc.
- Describe all other mining equipment .
- Describe design bases for ramp.
- Describe the ramp design in detail. Detailed engineering drawings are provided in Figure 4.1AG.
- The general arrangement and layout of the waste ramp is provided in Figure 4.1AF.
- Provide the following details:

  - Portals
  - Liners (if any)
  - Hauling arrangements.

7. Main Body Outline (Continued)

- Describe hauling equipment. Hauling equipment is illustrated in Figure 4.1AH. Design parameters of hauling equipment are provided in Table 4.1V.
- Cross sections at various rock types are provided in Figure 4.1AF.
- Waste types, volumes, and weights are summarized in Table 4.1W. Details regarding wastes are provided in Section 5.1.
- Discuss safety measures
- Provide detailed information about:
  - Ventilation
  - Operational and post-closure seals (if any)
  - Drainage
  - Instrumentation and control systems for the ramp and design validation and performance monitoring. Instrumentation diagrams are provided in Figure 4.1AI.
- Schedules for operations and maintenance are provided in Table 4.1S, T, and U.
- [This section changes slightly if we go with waste shaft instead of ramp.]

4.1.2.2 Muck Shaft or Ramp

- Describe all other mining equipment .
- Add roof control plan, mining method, etc.
- Describe design bases for ramp.
- Describe the ramp design in detail. Detailed engineering drawings are provided in Figure 4.1AJ
- The general arrangement and layout of the muck ramp is provided in Figure 4.1AK.
- Provide the following details:
  - Portals
  - Liners (if any)
  - Hauling arrangements.
- Describe hauling equipment. Hauling equipment is illustrated in Figure 4.1L. Design parameters of hauling equipment are provided in Table 4.1X.
- Cross sections at various rock types are provided in Figure 4.1AK.

7. Main Body Outline (Continued)

- Waste types, volumes, and weights are summarized in Table 4.1W. Details regarding wastes are provided in Section 5.1.
- Discuss safety measures.
- Provide detailed information about:

    - Ventilation
    - Operational and post-closure seals (if any)
    - Drainage
    - Instrumentation and control systems for the ramp and design validation and performance monitoring. Instrumentation diagrams are provided in Figure 4.1AM.

- Schedules for operations and maintenance are provided in Table 4.1S, T, and U.
- [This section changes slightly if we go with muck shaft instead of ramp.]

4.1.2.3 Ventilation Intake Shafts

- Provide shaft sealing method and reference Mine Safety Plan
- Describe design bases for shaft.
- Describe the shaft design in detail. Detailed engineering drawings are provided in Figure 4.1AN.
- The general arrangement and layout of the vent intake shaft is provided in Figure 4.1AO.
- Provide the following details:

    - Shaft collar
    - Liners
    - Average and maximum quantities of air.

- Cross sections at various rock types are provided in Figure 4.1AO.
- Provide detailed information about:

    - Operational and post-closure seals (if any)
    - Linings (if any)
    - Drainage
    - Instrumentation and control systems for the shaft and design validation and performance monitoring. Instrumentation diagrams are identified in Figure 4.1AP.

7. Main Body Outline (Continued)

- Schedules for operations and maintenance are provided in Table 4.1S, T, and U.

4.1.2.4 Ventilation Exhaust Shafts

- Provide shaft sinking method and safety plan or reference Mine Safety Plan.
- Describe design bases for shaft.
- Describe the shaft design in detail. Detailed engineering drawings are provided in Figure 4.1AQ.
- The general arrangement and layout of the vent exhaust shaft is provided in Figure 4.1AR.
- Provide the following details:

  - Shaft collar
  - Liners
  - Average and maximum quantities of air.

- Cross sections at various rock types are provided in Figure 4.1AR.
- Provide detailed information about:

  - Operational and post-closure seals (if any)
  - Linings (if any)
  - Drainage
  - Instrumentation and control systems for the shaft and design validation and performance monitoring. Instrumentation diagrams are identified in Figure 4.1AS.

- Schedules for operations and maintenance are provided in Table 4.1S, T, and U.

4.1.2.5 Personnel and Materials Shafts

- Add the shaft sinking method and the ventilation plan for the shaft.
- Describe design bases for shaft.

- Describe the shaft design in detail. Detailed engineering drawings are provided in Figure 4.1AT.
- The general arrangement and layout of the personnel and materials shaft is provided in Figure 4.1AU.

7. Main Body Outline (Continued)

- Provide the following details:

  - Shaft colar
  - Liners.

- Describe hoisting equipment including cage capacity. Hoisting equipment is illustrated in Figure 4.1L. Design parameters of hoisting equipment are provided in Table 1Y.
- Cross sections at various rock types are provided in Figure 4.1AU.
- Provide detailed information about:

  - Operational and post-closure seals (if any)
  - Linings (if any)
  - Drainage
  - Instrumentation and control systems for the shaft and design validation and performance monitoring. Instrumentation diagrams are identified in Figure 4.1AX.

- Discuss safety measures to prevent free falling and other accidents
- Schedules for operations and maintenance are provided in Table 4.1S, T, and U.

4.1.2.6 Decommissioning System

- Describe backfilling and sealing system to close shafts and ramps.
- The proposed materials for backfilling and sealing and the method for emplacement are provided in Table 4.1Z.
- Describe methods of emplacement and installation of plugs and bulkheads.
- Discuss operational seals and whether they will remain in place.

4.1.2.7 Other Shaft or Ramp Systems

- Provide the same detailed information for any other shaft or ramp.

7. Main Body Outline (Continued)

4.1.3 Underground Facility

- Provide overall underground facility design bases and design descriptions. Include:

  - Development and emplacement areas
  - Other underground areas such as:
  - Maintenance shops
  - Personnel showers
  - Decontamination facilities.

- The underground facility is illustrated in Figure 4.1AX.
- Underground facility SSCs are identified and classified in Table 4.1AA.
- Schedules for SCC inspections, testing, and maintenance are provided in Tables 4.1AB, AC, and AD.

4.1.3.1 Excavation and Ground Support Systems

- Provide design bases, design descriptions, and operating descriptions for each of the excavation and support systems. Design parameters for excavation equipment are provided in Table 4.1AE. The equipment used for excavation is shown in Figure 4.1Z. Ground support equipment is shown in Figure 4.1BA.
- Discuss the extent of damaged zone including:

  - Mechanical
  - Thermomechanical
  - Hydrological
  - Chemical
  - Drill and blast methods (if any)
  - Mechanical methods
  - Boring machines
  - Ground support systems used to support excavated openings
  - Response of support systems under thermal loading and retrieval operations
  - Tonnages of excavated rock
  - Rates of advance.

7. Main Body Outline: (Continued)

- The configuration of machinery is shown in Figure 4.1AZ.

4.1.3.2 Muck Handling System

- Provide design bases, design descriptions, and operating descriptions for each of the muck handling systems. Design parameters for muck handing equipment are provided in Table 4.1AF. The layout of muck handling equipment is shown in Figure 4.1BB. Include:

  - Units or systems such as load-haul-dump and belt conveyors
  - Disposition of tuff rock removed from development and emplacement areas.

4.1.3.3 Ventilation System

- Add construction and emplacement air cooling requirements.

- Provide design bases for both development and emplacement areas. The general layout is illustrated in Figure 4.1BC. The design capacities and other parameters are provided in Table 4.1AG. The design parameters for major equipment, including fans, are provided in Table 4.1AH.
- Discuss requirements for air cooling for:

  - Test
  - Maintenance
  - Retrieval operations
  - Number of days needed to cool drifts.

- Determination of ability of system to meet requirements.
- Discuss instrumentation for control and maintenance system.
- Schedules are provided in Tables 4.1AB, AC, and AD.

4.1.3.4 Waste Emplacement System

- The characteristics of waste and packages are provided in Section 5.1.
- The general arrangement of emplacement drifts is provided in Figure 4.1BD. The EBS is described in Section 5.1, including bore hole, liners power per package, etc.

7. Main Body Outline: (Continued)

- Waste emplacement construction is discussed in Section 4.1.3.1.
- Discuss transport methods to emplacement areas.
- Waste emplacement equipment design parameters are provided in Table 4.1AI. It is illustrated in Figure 4.1BE.
- Discuss emplacement operations.

4.1.3.5 Waste Retrieval System

- Provide design bases and detailed retrieval plans to locate, access, retrieve, and transport waste packages to surface.
- Discuss drift roof and wall supports. Ventilation system requirements during retrieval are provided in Section 4.1.3.3.
- Discuss operations under normal and off-normal conditions.
- Discuss shielding requirements.

4.1.3.6 Emergency Systems

- Add emergency response equipment, vehicle recovery systems, underground ambulance support, and other emergency systems.
- Add mine evacuation plan, ventilation plan in case of fire, and mine rescue stations.
- Discuss emergency systems, including:

  - Alarm systems
  - Emergency power systems
  - Systems to prevent the spread of floods and fires

4.1.3.7 Communication System

- The system design within the underground facility and to the surface is described in Section 4.1.1.5.

4.1.3.8 Operations Support System

- Describe the designs and operating features of the support systems within the underground facility, including:

  - Mine waste-water drainage
  - Lighting system
  - Power systems
  - Electrical

7. Main Body Outline (Continued)

- Compressed air
- Fuels supply
- Steam supply
- Water supply
- Auxiliary systems or back-up systems
- Maintenance shops
- Supply rooms
- Offices.

• Discussions should include design features considered important to safety under normal and accident conditions.

[Much of this material is covered in 4.1.1 with surface facility systems.]

4.1.3.9 Decommissioning System

• Backfilling and sealing systems, materials, and equipment are described in Section 4.1.2.6.
• Discuss provisions for dealing with sealing fractures, perched water zones, and fault areas.
• Discuss in detail sealing waste emplacement areas, including consideration of:

- Boreholes
- Drifts
- Panels
- Removal of underground equipment
- Removal of operational underground systems and structures, including:

  -- Belt conveyors
  -- Ventilation doors
  -- Regulators

- Bulkheads
- Ways of dealing with operations seals
- Injection of grouts.

• Discuss long term repository drainage.

7. Main Body Outline (Continued)

4.1.3.10 Other Underground Systems

- Provide descriptions of all systems that are part of the underground facility in similar detail.

4.1.4 Radiation Protection

- Describe general features of the GROA design that permit safe handling of radioactive material during operations and retrieval.
- Layout for radiation protection and radiological design features are provided below.

4.1.4.1 Layout Drawings of Radiological Areas and Facilities

- Layout drawings of the GROA are provided in Figure 4.1BF. The drawings show the following:

  - Location of shield walls
  - Thickness of shield walls
  - Controlled access areas
  - Equipment decontamination areas
  - Traffic patterns
  - Location of health physics facilities
  - Location of laboratories
  - Location of counting room.

  - Describe facilities and equipment involved, including equipment especially designed for radiation protection.
  - Describe type of controls for contaminated areas.

4.1.4.2 ALARA Design Consideration

- Describe ALARA design principles for GROA systems. Refer to Figure 4.1BF for layout of equipment.
- Describe how experience from past applications has been incorporated to minimize contamination incidents.
- The descriptions should include radiological safety features for:

  - Processing radwaste
  - Transporting radwaste
  - Handling radwaste
  - Storage of radwaste

7. Main Body Outline (Continued)

- Retrieval of radwaste-emplacement of radwaste
- Isolation of radwaste.

- Describe how designs are directed toward:

  - Reducing equipment maintenance
  - Reducing radiation levels and maintenance time
  - Controlling contamination in handling, transfer, and storage of radioactive material.

- Describe how design guidance in Position 2 of Regulatory Guide 8.8 was followed. Indicate alternatives to guidance, if any.
- Identify ventilation and off-gas treatment systems by reference to Figures 4.1X, W, and BC. Describe the following:

  - Releases will be ALARA during normal operation
  - Capacity is sufficient to confine material during projected operating conditions
  - Adequate monitors are incorporated
  - Design features are incorporated to interface with other effluent and vent systems
  - Spread of material will be controlled.

- Discuss program for measuring the efficiency of filters and treatment devices. Discuss how filter changes facilitate ALARA.

4.1.4.3 Characterization of Shielding

- Describe the source radiations used and design basis information in shielding design for each of the facilities in Section 4.1. All radioactive sources are tabulated in Table 4.1AJ.
- X-ray, gamma ray, and neutron sources are characterized in Table 4.1AK.
- The location of storage containers, tanks, and other equipment expected to require shielding is identified in Figure 4.1BG.
- Describe the shielding used for each of the sources identified. Design parameters for shielding are provided in Table 4.1AK.
- Describe geometric arrangement, specialized protection features, or remote handling to ensure dose to workers is ALARA. Refer to Section 4.1.4.2.
- Describe use of portable shielding, if applicable.

7. Main Body Outline (Continued)

4.1.4.4 Radiological Monitoring Instrumentation

- Describe fixed-area monitors and continuous airborne monitoring instrumentation. The location of monitors is shown in Figure 4.1BF. The equipment is illustrated in Figure 4.1BH, including sample pumps and collectors.
- Describe criteria for setpoints for alarms.
- Monitoring instrumentation design parameters are tabulated in Table 4.1AL.
- Provide details of represented sample gathering.

4.1.5 Interface of Structures, Systems, and Components

- Discuss interfaces between the GROA and waste management systems such as transportation systems.

- Describe SSCs that provide interface between surface facilities, shafts and ramps, and the underground facility. These SSCs are identified in Table 4.1AM. The discussion should include:

  - Ventilation system
  - Hoisting system
  - Communication system
  - Instrumentation and control system
  - Utility system
  - Operation support system
  - Emergency system.

- Discuss interface between safety-related and non-safety-related systems. Reference the above sections where appropriate.

8. Conclusion:

[A statement similar to the following should be made in a potential license application: GROA SSCs are designed to prevent or mitigate the consequences of design basis accidents, facilitate waste retrievability, and ensure waste isolation. Therefore, there are no credible circumstances by which repository operations threaten the health and safety of plan personnel or the public.]

9. Support Authors & Their Assignments:

Section 4.1.1 - Jerry Fredrickson
Section 4.1.2 - Paul McKie
Section 4.1.3 - Paul McKie
Section 4.1.4 - Mark Fourtesch
Section 4.1.5 - Don Schutt

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Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. **4.1A**

Caption: **Location of GROA Relative to Accessible Environment Surface Facilities**

Content:

Map showing GROA surface facilities relative to accessible environment boundary.

B. Figure No. **4.1B**

Caption: **Location of GROA Underground Facility Relative to Accessible Environment**

Content:

Map showing GROA Underground Facility superimposed on map of accessible environment.

C. Table No. **4.1A**

Title: **Schedules for GROA Construction, Receipt of Waste, and Emplacement of Waste**

Content:

	2001	2002	2003	-	-	-	2040
GROA Construction							
Receipt of Waste							
Emplacement of Waste							
Etc.							

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Section No. & Title: **4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS**

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. **4.1C**

Caption: **Location of GROA SSCs**

Content:

General arrangement drawing including plan views, elevation views, and appropriate section drawings of GROA. SSCS are identified on drawings.

B. Table No. **4.1B**

Title: **Principal Design Parameters**

Content:

These should be site related design parameters

Parameter	Criteria	Design Value
Design Basis Earthquake		
Maximum Acceleration		
Maximum Displacement		
etc.		

C. Table No. **4.1C**

Title: **Applicable Code and Standards Used in Design**

Content:

SSC	Standards and/or Codes

Section No. & Title: **4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS**

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. **4.1D**

Title: **Radioactive Waste Design Bases**

Content:

<u>Waste Type</u>	<u>Quantity</u>	<u>Receipt Rates</u>	<u>Thermal Output</u>
Spent Fuel			
Defense HLW			
etc.			

B. Table No. **4.1E**

Title: **Waste Package/Container Design Bases**

Content:

	<u>Design Parameters</u>
Waste Containment	
Waste Container	
Waste Package	

C. Table No. **4.1F**

Title: **Soil Properties and Other Relevant Foundation Design Data**

Content:

<u>Foundation Design Parameter</u>	<u>Design Bases</u>	<u>Data</u>
Soil Properties, etc.		

Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
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A. Table No. 4.1G

Title: Weather and Other Relevant Meteorological Data

Content:

Parameter	Design Basis Value
Annual Rain	
Maximum Wind	
Average Wind	
etc.	

B. Table No. 4.1H

Title: Rock Data Pertinent to GROA Design

Content:

Rock Type	Mechanical Data	Thermal Data	Thermo-Chemical Data	Hydrological Data	Geochemical Data

C. Table No. 4.1I

Title: Engineered Components Design Basis Data-Underground Facility

Content:

Component	Material	Permeability	Absorption Coefficient, etc
Injected Grouts			
Backfill in boreholes			
Backfill in Drifts, Shafts, and Ramps			
Liners			

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Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.1J

Title: **Summary of Regulatory Design Criteria and Performance Objectives**

Content:

SSC	10 CFR 60	DOE Requirements	EPA
Waste Handling System			
Etc.			

B. Table No. 4.1K

Title: **SSCs Important to Safety, Retrievability, or Isolation**

Content:

SSC	Safety	Retrievability	Isolation

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
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A. Figure No. 4.1AF

Caption: **Layout of Waste Ramp**

Content:

General arrangements - Elevation view
Plan view

B. Figure No. 4.1AG

Caption: **Engineering Drawings - Waste Ramp**

Content:

Cross sections, etc.

C. Figure No. 4.1AH

Caption: **Hauling Equipment Drawings**

Content:

Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. 4.1AJ

Caption: Layout of Muck Ramp

Content:

General arrangements - Elevation view
Plan view

B. Figure No. 4.1AK

Caption: Engineering Drawings - Muck Ramp

Content:

Cross sections, etc.

C. Figure No. 4.1AL

Caption: Hauling Equipment Drawings

Content:

Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
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A. Figure No. **4.1AO**

Caption: **Layout of Ventilation Intake Shaft**

Content:

General arrangements - Elevation view
Plan view

B. Figure No. **4.1AN**

Caption: **Engineering Drawings - Ventilation Intake Shaft**

Content:

Cross sections, etc.

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Section No. & Title: **4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS**

Lead Author & Phone No. TBD
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A. Figure No. **4.1AR**

Caption: **Layout of Ventilation Exhaust Shaft**

Content:

Cross sections, etc.

B. Figure No. **4.1AQ**

Caption: **Engineering Drawings - Ventilation Exhaust Shaft**

Content:

General arrangement - Elevation view
Plan view

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Section No. & Title: **4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS**

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. **4.1F**

Caption: **Flow Diagrams-On-Site Radioactive Waste Management System**

Content:

Many figures.

B. Figure No. **4.1G**

Caption: **Piping Drawings On-Site Radioactive Waste Management System**

Content:

Many figures.

C. Figure No. **4.1H**

Caption: **Instrumentation Diagrams On-Site Radioactive Waste Management System**

Content:

Many figures.

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Section No. & Title: **4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS**

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. **4.1K**

Caption: **Fire Wall Locations**

Content:

General arrangement drawing of surface facilities with fire walls cross-hatched.

B. Figure No. **4.1L**

Caption: **Sprinkler Coverage**

Content:

General arrangement drawing with sprinkler coverage cross-hatched.

C. Figure No. **4.1M**

Caption: **Fire Extinguisher, Alarms, and Standpipe Locations**

Content:

General arrangement drawing with legend marks for fire extinguishes, standpipes and fire alarms.

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Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. 4.1N

Caption: **Communications Devices and Alarms**

Content:

General arrangements drawing with legend marks.

B. Figure No. 4.1O

Caption: **Flow Diagram - Utility System**

Content:

Many figures (>10).

C. Figure No. 4.1P

Caption: **Piping Drawings Utility Systems**

Content:

Many figures.

Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. 4.1Q

Caption: Electrical One-Line Diagrams

Content:

Many diagrams.

B. Table No. 4.1N

Title: Major Component-Utility Systems

Content:

Many tables.

C. Figure No. 4.1R

Caption: Instrumentation Diagram-Utility System

Content:

Many figures.

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Section No. & Title: **4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS**

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. **4.1S**

Caption: **Computer and Control System Architecture**

Content:

Logic diagram illustrating structure of system.

B. Figure No. **4.1T**

Caption: **Control Room Layout**

Content:

Many drawings.

C. Figure No. **4.1U**

Caption: **Location of On-Site Transportation Systems**

Content:

Maps showing railroads and paved roads.

Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. 4.1V

Caption: **Detailed Engineering Drawings of Hoist Building and Ramp Buildings**

Content:

Many drawings.

B. Table No. 4.1P

Title: **Major Component Design Parameters - Ventilation Systems**

Content:

Component

Fans
Filters

C. Table No. 4.1O

Title: **HVAC System Design Parameters**

Content:

Area	Temp	Humidity	Purity, etc.
Waste Handling Building			
Etc.			

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Section No. & Title: **4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS**

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. **4.1W**

Caption: **Flow Diagrams - Ventilation Systems**

Content:

Many figures.

B. Figure No. **4.1X**

Caption: **Duct Work Drawings - Ventilation Systems**

Content:

Many drawings.

C. Figure No. **4.1Y through - AD**

Caption: **General Arrangement of Support System Buildings**

Content:

Many drawings.

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Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. **4.1AT**

Caption: **Engineering Drawings - Personnel and Materials Shaft**

Content:

Drawings.

B. Figure No. **4.1AU**

Caption: **Layout of Personnel and Material Shaft**

Content:

General arrangement - Elevation view
Plan view

C. Figure/Table No.

Caption/Title:

Content:

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Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.1XX

Title: **Design Parameters for Hauling Equipment**

Content:

Equipment	Load Capacity	Etc.
Crane		
Etc.		

B. Figure No. 4.1AM

Caption: **Instrumentation Diagrams - Waste Ramp**

Content:

General arrangement - Elevation view
Plan view

C. Figure/Table No.

Caption/Title:

Content:

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Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.1V

Title: Design Parameters for Hauling Equipment

Content:

Equipment	Load Capacity	Etc.
Crane		
Etc.		

B. Table No. 4.1W

Title: Waste Types to be Transported in Ramp

Content:

Waste Type	Volume	Weight
Spent Fuel		
Etc.		

C. Figure No. 4.1AI

Caption: Instrumentation Diagrams - Waste Ramp

Content:

Diagrams.

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Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. **4.1Q**

Title: **Equipment, Systems, or Facilities Requiring Decommissioning**

Content:

System, Facility or Equipment	Location	Decontamination Required	Radwaste Volume
Waste Handling Sys			
Etc.			

B. Figure No. **4.1AE**

Caption: **Layout of GROA Shafts and Ramps**

Content:

General arrangement drawing of shafts and ramp - elevation view and plan view.

C. Table No. **4.1R**

Title: **Identification of Shaft and Ramp SSCs**

Content:

SSC	Safety	Retrievability	Isolation

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MGDS Annotated Outline Planning Package
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Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.1L

Title: **Hazardous and/or Combustible Materials**

Content:

Material	Properties		Location
	Heating Value	Self-Ignition Temp	

B. Figure No. 4.1J

Caption: **Piping Drawings - Fire and Explosion Protection System**

Content:

Many figures.

C. Table No. 4.1M

Title: **Major Components Fire and Explosion Protection System**

Content:

Component	Design Parameters
Pump	
Tanks	
Etc.	

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Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. **4.1S**

Title: **Schedule for SSC Inspections**

Content:

Milestone Chart

SSC	2001	-	-	-	-	2050

B. Table No. **4.1T**

Title: **Schedule for SSC Testing**

Content:

Milestone Chart

SSC	2001	-	-	-	-	2050

C. Table No. **4.1U**

Title: **Schedule for SSC Maintenance**

Content:

Milestone Chart

SSC	2001	-	-	-	-	2050

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Section No. & Title: **4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS**

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. **4.1AP**

Caption: **Instrumentation Diagram - Ventilation Intake Shaft**

Content:

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title:

Content:

Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.1J

Title: **Major Component Design Parameters - Hot Cell System**

Content:

Component	Lifting Capacity	Etc.
Cranes		
Etc.		

B. Table No. 4.1K

Title: **Major Component Design Parameters - On-Site Radioactive Waste Management System**

Content:

Component	Flow	Head	Type	HP	etc.
Pump					
Etc.					

C. Figure No. 4.1I

Caption: **Flow Diagram - Fire and Explosion Protection System**

Content:

Diagram.

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: **4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS**

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. 4.1AS

Caption: **Instrumentation Diagrams - Ventilation Exhaust Shaft**

Content:

Diagram.

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title:

Content:

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MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 4.1 **DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS**

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. **4.1Y**

Title: **Design Parameters for Hoisting Equipment**

Content:

Equipment	Load Capacity
Crane	
Etc.	
Cage Capacity	

B. Figure No. **4.1AV**

Caption: **Instrumentation Diagrams-Personnel and Materials Shaft**

Content:

C. Table No. **4.1Z**

Title: **Shaft and Ramp Backfill and Sealing Materials**

Contents:

Shaft or Ramp	Backfill Material	Method of Employment	Equipment Used in Emplacement

MGDS Annotated Outline Planning Package Date: 9/30/92
Form 2: Figures & Tables

Section No. & Title: 4.1 **DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS**

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. **4.1AX**

Caption: **Underground Facility Layout Drawing**

Content:

General arrangement of underground facility
- Elevation view
- Plan view

B. Table No. **4.1AA**

Title: **Identification and Classification of Underground Facility SSCs**

Content:

SSC	Safety	Retrievability	Isolation

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MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. 4.1AZ

Caption: **Excavation Equipment Drawing**

Content:

B. Figure No. 4.1BA

Caption: **Ground Support Equipment Drawings**

Content:

C. Table No. 4.1AE

Title: **Excavation Equipment Design Parameters**

Content:

Equipment	Rate of Advance	Tonnage of Excavation Rock	Etc.
Boring Machine			

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Date: 9/30/92

Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. **4.1AF**

Title: **Muck Handling Equipment Design Parameters**

Content:

Equipment	Design Parameters

B. Figure No. **4.1BB**

Caption: **Layout of Muck Handling Equipment**

Content:

Elevation view
Plan view

C. Figure No. **4.1BC**

Caption: **General Layout of Ventilation System**

Content:

Elevation and plan view of ductwork include mains and submains and panel layout.

Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. **4.1AB**

Title: **Schedule for Underground Facility SSC Inspections**

Content:

SSC	2001	:	:	:	:	2050

B. Table No. **4.1AC**

Title: **Schedules for Underground Facility SSC Testing**

Content:

SSC	2001	:	:	:	:	2050

C. Table No. **4.1AD**

Title: **Schedules for Underground Facility SSC Maintenance**

Content:

SSC	2001	:	:	:	:	2050

Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.1AG

Title: Ventilation System Design Parameters

Content:

System	System Capacity	Max. Vent. Require-ments	Design Air Velocity	System Leakage	Drift Wall Temp	Drift Air Temp
Dev. Area						
Emplacement Area						
Refrigeration Plant						

B. Table No. 4.1AH

Title: Ventilation Equipment Design Parameters

Content:

Equipment	Design Flow	Design Head	Other Characteristics
Fans			

C. Figure No. 4.1BD

Caption: Waste Emplacement Drift General Arrangement

Contents:

Plan view
Elevation view

Section No. & Title: **4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS**

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. **4.1AI**

Title: **Waste Emplacement Equipment Design Parameters**

Content:

Equipment	Load Capacity	etc.	Shielding
Upender			

B. Figure No. **4.1BE**

Caption: **Waste Emplacement Outline Drawings**

Content:

C. Figure No. **4.1BF**

Caption: **Layout Drawings of Radiological Areas and Facilities**

Content:

General arrangement drawing including:
- Location of shield walls
- Thickness of shield walls
- Controlled access areas
- Equipment decontamination areas
- Contamination control areas
- Traffic patterns
- Location of health physics areas
- Location of radiation monitors
- Location of control panels for radwaste equipment
- Location of labs and counting room.

II

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.1AM

Title: **Identification of SSCs That Perform Interface Functions**

Content:

SSC	Surface Facilities	Shafts and Ramps	Underground Facility
Ventilation System			
Hoisting System			
Communication System			
I&C System			

B. Figure No.

Caption:

Content:

C. Figure/Table No.

Caption/Title:

Content:

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MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.1AK

Title: **Shielding Design Parameters**

Content:

Source	Material	Thickness	Coefficient	Attenuation Factor	Buildup Assumptions	Codes
Spent Fuel						
HLW						
Tank A						
Tank B						

B. Figure No. 4.1BH

Caption: **Outline Drawing of Radiation Monitors**

Content:

C. Table No. 4.1AL

Title: **Radiation Monitor Instrumentation Design Parameters**

Content:

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No.

Title:

Content:

B. Figure No. **4.1D**

Caption: **Instrumentation Diagrams - Hot Cell System**

Content:

Many Figures.

C. Figure No. **4.1E**

Caption: **Major Component Illustrations - Hot Cell System**

Content:

Many Figures.

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.1AJ

Title: Tabulation of Radioactive Sources by Isotopic Composition

---

Content:

Radioactive Source	
Spent Fuel:	
	ST
	AL
	U
NLW:	
	-
	-
Tank:	
	-
	-
Equipment:	
	-
	-

B. Table No. 4.1AM

Table: X-Ray, Gamma Ray, and Neutron Source Characteristics (Grouped by Energy - 0=Max Energy)

Content:

Source	Neutron Yield	Photon Yield	Geometry
Tank A			

Section No. & Title: **4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS**

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

C. Figure No. **4.1BG**

Caption: **Location of Radiation Sources in GROA**

Content:

Scaled general arrangement and layout drawing of GROA with legend identifying sources.

Include designations of each restricted area, including boundary of area and type of interface (partition, locked door, or barriers).

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MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title:

Lead Author & Phone No.

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

1.

2.

3.

4.

5.

6.

7.

8.

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MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number:

2. Section no. & title: 4.1 DESCRIPTION OF GROA STRUCTURES, SYSTEMS, AND COMPONENTS

3. Lead author & phone no: T. M. Williamson (702) 794-1821

4. Information request date:

5. Work location:

6. Type of information needed:

7. What is the information needed for?

8. What group is the probable information supplier?

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form B: Information Response

Date: 9/30/92

1. Section No. & Title:
2. Person Supplying Information:
3. Phone No.:
4. Lead Author (Requester): Marshall Weaver (702) 794-1871

   Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

MGDS Annotated Outline

Section 4.2 Assessment of Compliance for Surface Facilities

TABLE OF CONTENTS

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LIST OF FIGURES

Page

4.2 ASSESSMENT OF COMPLIANCE FOR SURFACE FACILITIES

Skeleton Text Has Not Been Developed For This Section

REFERENCES

n

MGDS Annotated Outline Planning Package
Form 1: Text

Date: 9/30/92

1. Section No. & Title: 4.2 ASSESSMENT OF COMPLIANCE FOR SURFACE FACILITIES

2. Lead Author & Phone No.: TBD
[T.M. Williamson 702-794-1821]

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   Analyses of surface facility SSCs are provided in this section to demonstrate compliance with all applicable regulatory requirements, particularly 10 CFR 60. Appropriate design parameters are provided and the bases for their compliance with 10 CFR 60 are discussed. Specific requirements other than those established by 10 CFR 60 are identified and compliance is demonstrated for each surface facility system. Sufficient information is provided to facilitate an independent verification of compliance with all applicable regulatory requirements.

6. Opening Statement:

   [A statement similar to the following should be made in a potential license application: Analyses provided in this section demonstrate that GROA surface facility SSCs comply with all applicable regulations.]

7. Main Body Outline:

4.2 ASSESSMENT OF COMPLIANCE FOR SURFACE FACILITIES

4.2.0 Introduction

- Refer to surface facility descriptions in Section 4.1
- Provide a general description of the regulatory requirements and overall methods for assessing compliance.

7. Main Body Outline (Continued)

4.2.0.1 Compliance with 10 CFR 60 Requirements

- All of the surface facility SSCs in each subsection of Section 4.1 that are subject to 10 CFR 60 requirements are listed in Table 4.2A.
- Provide an analysis demonstrating compliance with applicable 10 CFR 60 requirements for each SSC.

  - Demonstrate compliance with general requirements applicable to all GROA SSCs
  - Demonstrate compliance with individual design requirements applicable to GROA systems.

- Describe how design parameters presented in Section 4.1 result in compliance with 10 CFR 60 requirements.
- Justify how applicable industry codes and standards used in the design result in compliance with 10 CFR 60 requirements.

4.2.0.2 Accident Analyses

- Describe overall approach to accident analyses including the selection of the accident scenarios
- Discuss (list) accidents that SSCs are designed to withstand and how each system is intended to perform during each accident
- Demonstrate that surface facility SSCs are designed to withstand the effects of each accident
- Describe design features that prevent accidents, including those caused by natural phenomena. [Provide DOE Petition for Rulemaking, 55 FR28771, 7/13/90.]

4.2.0.3 Basis for Identification of SSCs Important to Safety

- Provide the bases for the SSCs important to safety, waste isolation, and retrievability. These SSCs are listed in Table 4.1K.
- Provide an analysis that demonstrates the margin of safety in the design under normal conditions and anticipated operational occurrences, including those of natural origin.

7. Main Body Outline (Continued)

4.2.0.4 Description of Models

- The models used to perform the analyses are listed in Table 4.2B.
- Explain measures supporting models used in both design applications and accident analyses.
- Support analyses and models used to predict future conditions with an appropriate combination of the following:

  - Field tests
  - In situ tests
  - Laboratory tests
  - Monitoring data
  - Natural analog studies.

- Discuss variability and uncertainty of data and the propagation of errors.
- Discuss the representativeness of data and uncertainties associated with extrapolation of data.
- Discuss conceptualizations, documentation, and validation of models and codes with respect to:

  - Uncertainties in the input data
  - Applicability of specific models
  - Appropriateness of assumptions
  - Sensitivity of results to the uncertainty of input data.

- Input and output data for each of the models are provided in Table 4.2C.
- Provide interpretations of input and output data along with the basis of interpretations. Provide sufficient detail to facilitate independent analysis of results.
- Document role of expert judgement.

4.2.1 Applicable Requirements and Criteria

- [Consider FCRG comment to bulletize list of SSC's in section 4.1.]

4.2.1.0 Introduction

7. Main Body Outline (Continued)

- In this subsection, compliance is demonstrated for all surface subsystems with the additional requirements and criteria presented herein, as applicable.

4.2.1.1 Airborne Radioactive Materials

- Demonstrate that the concentrations of airborne radioactive materials in restricted areas (including discharges from other GROA systems) are consistent with the inhalation limits as required by 10 CFR 20.103. The restricted areas are shown in Figure 4.2A. The estimated concentrations in each restricted area is provided in Table 4.2D.
- Each source term used to estimate these concentrations is provided in Table 4.2E.
- Those areas potentially contaminated with airborne radioactivity that are accessible to operating personnel are shown in Figure 4.2B.
- Estimates of maximum individual and total person-hours of occupancy are provided in Table 4.2F. Anticipated concentrations during occupancy are provided in Table 4.2D.
- Projected concentrations and estimated intake of radionuclides in restricted areas until permanent closure are provided in Table 4.2G.
- Models and model parameters used in calculations are provided in Table 4.2H.
- A comparison of projected intakes to intake limits in 10 CFR 20 are provided in Table 4.2I.
- Indicate provisions for personnel protective measures such as respiratory equipment or exhaust hoods.

4.2.1.2 Occupancy Time

- Demonstrate the means to limit the occupancy time required to perform work in restricted areas.
- Ensure each system is designed for compliance with 10 CFR 20 requirements for occupancy time.

7. Main Body Outline (Continued)

4.2.1.3 Shielding

- Demonstrate that each system is provided with suitable shielding. Refer to Section 4.1 for locations of shielding.
- Provide cost/benefit analysis for each shield to demonstrate compliance with ALARA conditions of 10 CFR 20 and dose limitations requirements of 10 CFR 20.101.

4.2.1.4 Contamination Control

- Demonstrate the means to monitor and control the dispersal of radioactive contamination between radiation zones in restricted areas. The radiations zones are illustrated in Figure 4.1BF.
- Ensure compliance with ALARA requirements in 10 CFR 20.1(c), dose limitations in 10 CFR 20.101, and concentration in air required by 10 CFR 20.103.

4.2.1.5 Access Control

- Describe means to control access to high-radiation areas or airborne radioactivity areas.
- Describe the monitoring of access.

4.2.1.6 Radiation Alarm Systems

- Describe radiation alarm systems that warn operating personnel of:
  - Significant increases in radiation levels
  - Significant increases in airborne material concentrations
  - Increased radioactivity in effluents.
- Describe provisions for calibration and operability testing. [Reference provided here.]

4.2.1.7 Dose Rates in Restricted Areas

- Demonstrate that the levels of radiation in restricted areas are in compliance with 10 CFR 20.101.
- Provide the objectives and criteria for design dose rates in various areas. [What are various areas?]

7. Main Body Outline (Continued)

- Estimates of the annual collective person-rem doses are provided in Table 4.2J.
- Estimated annual occupancy times for each restricted area are provided in Table 4.2F. Provide the bases, models, assumptions for values presented. [See Section 4.2.1.1]
- Identify dose conversion factors and illustrate how they are used to calculate exposure.
- Describe biological and dosimetry models and ensure compliance with 10 CFR 20.

4.2.1.8 ALARA

- Describe how exposures and effluent discharges are ALARA for each system per 10 CFR 20.1(c).
- Describe management policy regarding ALARA in sources and with respect system design and operation.
- Describe how guidelines in Reg Guide 8.8 were used for each individual system. If not used, justify. [Reference provided here.]

4.2.1.9 Natural Phenomena and Environmental Conditions

- Demonstrate that the SSCs important to safety are designed so that natural phenomena and environmental conditions do not interfere with safety functions.

4.2.1.10 Dynamic Effects

- Demonstrate that the SSCs important to safety are designed to withstand missile impacts, etc, without loss of safety function operability.

4.2.1.11 Performance During and After Fires and Explosions

- Demonstrate that the SSCs important to safety are designed to perform safety functions during and after credible fires and explosions. [Reference Section 4.1.1.3.]

4.2.1.12 Noncombustible and Heat-resistant Materials

- Demonstrate that the SSCs important to safety are designed to incorporate the use of noncombustible and heat-resistant materials. [Reference Section 4.1.1.3.]

7. Main Body Outline (Continued)

4.2.1.13 Fire and Explosion Protection Systems

- Demonstrate that the GROA is designed with sufficient fire and explosion system capacity and redundancy to reduce adverse effects of fires and explosions on SSCs important to safety. [Reference Section 4.1.1.3.]

4.2.1.14 Adverse Safety Effects of Fire and Explosion System Operation or Failure

- Demonstrate that GROA surface facility SSCs are designed to withstand the effects of fire protection system operation or failure and still perform safety function. [Reference Section 4.1.1.3.]

4.2.1.15 Control of Radioactive Materials

- Demonstrate that SSCs important to safety are designed to maintain control of radioactive waste and effluents, safely shutdown, and permit safe evacuation during an emergency. [Reference Section 4.1.1.4.]

4.2.1.16 Response to Emergency Conditions

- Demonstrate how emergency systems are designed to include facilities and services that ensure safe and timely response to emergency conditions. [Reference Section 4.1.1.4.]
- Demonstrate that emergency system facilitate the us of offsite services such as:
  - Fire
  - Police
  - Medical
  - Ambulance.

4.2.1.17 Utility System Performance During Normal and Accident Conditions

- Demonstrate that each utility system important to safety is designed to perform intended safety functions under both accident and normal conditions. [Reference Section 4.1.1.6.]

7. Main Body Outline (Continued)

4.2.1.18 Utility System Redundancy

- Demonstrate that utility system design incorporates adequate redundancy to perform safety functions. [Reference Section 4.1.1.6.]

4.2.1.19 Emergency Power

- Demonstrate that emergency power is available in the event of a loss of primary power for the following:

  - Instruments
  - Utility systems
  - Operating systems
  - Alarm systems.

4.2.1.20 SSC Operability Verification

- Demonstrate that SSCs important to safety have been design to facilitate periodic inspection, testing, and maintenance to ensure operability.

4.2.1.21 Criticality

- Demonstrate that all systems dealing with nuclear material are designed in compliance with the Double Contingency Principle precluding nuclear criticality.
- Demonstrate that each system has been designed for criticality safety under normal and accident conditions.
- Ensure that k_{eff} is sufficiently below unity to show at least 5% margin after allowances for the bias in calculation methods and validation. The effective multiplication factor for all masses and configurations of radioactive material is shown in Table 4.2K.

4.2.1.22 Instrumentation

- Demonstrate that instrumentation and control systems include adequate provisions to monitor and control systems important to safety over anticipated ranges of normal operation and accident conditions. [Reference Section 4.1.1.7.]

7. Main Body Outline (Continued)

4.2.1.23 Worker Protection

- Demonstrate that the design includes adequate provisions for worker protection to assure that SSCs important to safety can perform intended function. [Reference Federal Mine Safety and Health Act of 1977.]

- Note any deviations from the design requirements of 30 CFR Chapter I, subchapters D, E, and N.

4.2.1.24 Hoists

- Demonstrate that hoists important to safety are designed to:

  - Preclude cage freefall
  - Have a reliable cage location system
  - Have a reliable system of interlocks that will fail safely upon malfunction
  - Include two independent indicators to indicate when waste packages are in place and ready for transfer.

4.2.1.25 Handling and Storage of Wastes

- Demonstrate that GROA surface facilities are designed to zallow safe handling and storage of wastes during emplacement and retrieval operations.

4.2.1.26 Ventilation Systems

- Demonstrate that surface facility ventilation systems are designed to protect against radiation exposures and offsite release during the following operations:

  - Waste transfer
  - Waste inspection
  - Decontamination
  - Waste processing
  - Waste packaging.

- [Reference Section 4.1.1.9.]

7. Main Body Outline (Continued)

4.2.1.27 Radioactive Effluents

- Demonstrate that surface facilities are designed to control the release of radioactive materials on effluents during normal operations in compliance with 10 CFR 60.111(a).

4.2.1.28 Effluent Monitoring

- Demonstrate that the effluent monitoring systems are designed to measure the amount and concentration of radionuclides with adequate precision. The accuracy and effluent monitoring equipment is provided in Table 4.2L
- Demonstrate that the monitoring systems include alarms that can be periodically tested.

4.2.1.29 Radioactive Waste Treatment

- Demonstrate that the radioactive waste treatment systems are designed to process all radioactive wastes at the GROA into forms suitable for safe storage onsite or transportation offsite, meeting all applicable regulations.

4.2.2 System Specific Compliance with Applicable Requirements and Criteria

4.2.2.0 Introduction

- Provide a general description of surface facility design requirements and the procedures for identifying regulatory requirements and ensuring compliance. System specific compliance is demonstrated in this section for all surface facility systems.

  [The FCRG outline requirement for system specific treatment of requirements will be repetitive.]

4.2.2.1 Hot Cell

- Demonstrate compliance with all applicable requirements and criteria.

4.2.2.2 Onsite Radioactive

7. Main Body Outline (Continued)

- Demonstrate compliance with all applicable requirements and criteria.

4.2.2.3 Fire and Explosion Protection Systems

- Demonstrate compliance with all applicable requirements and criteria.

4.2.2.4 Emergency Systems

- Demonstrate compliance with all applicable requirements and criteria.

4.2.2.5 Communication Systems

- Demonstrate compliance with all applicable requirements and criteria.

4.2.2.6 Utility Systems

- Demonstrate compliance with all applicable requirements and criteria.

4.2.2.7 Instrumentation and Controls

- Demonstrate compliance with all applicable requirements and criteria.

4.2.2.8 Onsite Transportation System

- Demonstrate compliance with all applicable requirements and criteria.

4.2.2.9 Ventilation systems

- Demonstrate compliance with all applicable requirements and criteria.

4.2.2.10 Operations Support Systems

- Demonstrate compliance with all applicable requirements and criteria.

7. Main Body Outline (Continued)

4.2.2.11 Decommissioning System

- Demonstrate compliance with all applicable requirements and criteria.

4.2.2.12 Other Surface Systems

- Demonstrate compliance with all applicable requirements and criteria.

8. Conclusion:

[A statement similar to the following should be made in a potential license application: Analyses provided in this section demonstrate that GROA surface facility SSCs comply with all applicable regulatory requirements. Therefore, there are no credible circumstances by which surface facility operations threaten the health or safety of plant personnel or the public.]

9. Support Authors & Their Assignments:

Tom Williamson (M&O Licensing)

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 4.2 ASSESSMENT OF COMPLIANCE FOR SURFACE FACILITIES

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.2A

Title: Surface Facility SSCs and Applicable 10 CFR 60 Requirements

Content:

SSC	Reference to 10 CFR 60 Requirement	Description of Requirement
Systems Structures Component	10 CFR 60.20i [ex]	

B. Table No. 4.2B

Title: Analytical Models for Surface Facilities

Content:

Model	Analysis

C. Table No. 4.2C

Title: Data for Surface Facility Models and Codes

Content:

Code or Model	Input Data	Output Data

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

Section No. & Title: 4.2 ASSESSMENT OF COMPLIANCE FOR SURFACE FACILITIES

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. 4.2A

Caption: **Restricted Areas in the Surface Facilities**

Content:

Plant layout showing restricted areas with legend.

B. Table No. 4.2D

Title: **Estimated Concentration of Airborne Radioactive Materials for the Restricted Areas in Surface Facilities**

Content:

Area	Concentration

C. Table No. 4.2E

Title: **Source Terms in Surface Facilities**

Content:

Source Term	Quantity Discharged per Unit Time	Particle Size (AMAD)	Chemical Form	Physical Form	Lung Solubility Class

11

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 4.2 ASSESSMENT OF COMPLIANCE FOR SURFACE FACILITIES

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. 4.2B

Caption: Areas Potentially Contaminated with Radioactive Materials that are Accessible to Operating Personnel in the Surface Facilities

---

Content:

Layout drawing of GROA surface facilities with subject areas cross-hatched.

B. Table No. 4.2F

Title: Maximum Individual and Total Person-Hours of Occupancy in the Surface Facilities

---

Content:

Area	Individual Person-Hours/yr.	Total Person-Hours/yr.

C. Table No. 4.2G

Title: Radionuclide Concentration and Intake Estimates During Operational Activities in the Surface Facilities

---

Content:

Operation Activity	Projected Concentration	Estimated Intake
Handling		
Storage		
Retrieval		
Emplacement		
Isolation		

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 4.2 **ASSESSMENT OF COMPLIANCE FOR SURFACE FACILITIES**

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. **4.2H**

Title: **Analytical Models and Model Parameters for the Surface Facilities**

Content:

Analysis	Model	Model Parameters
Concentration Estimates		
Intake Estimates		
Etc.		

B. Table No. **4.2I**

Title: **Comparison of Projected Intakes to 10 CFR 20 Limits in the Surface Facilities**

Content:

Area	Projected Intake	Intake Limit

C. Table No. **4.2J**

Title: **Collective Person - Rem Doses by Function in the Surface Facilities**

Content:

Function	Annual Collective	Estimated Annual Time (Person Hours)
Spent Fuel Transfer		
HLW Transfer		
Off-Gas Handling		
Waste Treatment		
Maintenance		
Rad Waste Handling		
Decontamination		
In-Service Inspections		

11

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 4.2 ASSESSMENT OF COMPLIANCE FOR SURFACE FACILITIES

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.2K

Title: Multiplication Factors (Keff) for the Surface Facilities

Content:

System or Component	Worst Case Calculated Keff
Transportation Cask	0.9
Radwaste Storage Container	0.6
Etc.	Etc.
Etc.	

B. Table No. 4.2L

Title: Effluent Monitoring Equipment in the Surface Facilities

Content:

Effluent	Equipment	Accuracy Quantity/Concentration	Setpoint	Alarm

---

C. Figure No.

Caption:

Content:

1

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title:

Lead Author & Phone No.

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

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MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number:
2. Section no. & title: 4.2 ASSESSMENT OF COMPLIANCE FOR SURFACE FACILITIES
3. Lead author & phone no: T. M. Williamson (702) 794-1821
4. Information request date:
5. Work location:
6. Type of information needed:
7. What is the information needed for?
8. What group is the probable information supplier?
9. When is the information needed?
10. What kind of related information is already available in references, etc.?

---

11. Response by (name):
12. Response date:
13. Response:

MGDS Annotated Outline Information Need Form
Form B: Information Response

Date: 9/30/92

1. Section No. & Title:

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester): Marshall Weaver (702) 794-1871

   Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

MGDS Annotated Outline

Section 4.3 Assessment of Compliance for Shafts or Ramps

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4.3 ASSESSMENT OF COMPLIANCE FOR SHAFTS OR RAMPS

Skeleton Text Has Not Been Developed For This Section

REFERENCES

1. Section No. & Title: 4.3 ASSESSMENT OF COMPLIANCE FOR SHAFTS OR RAMPS

2. Lead Author & Phone No. TBD
[T.M. Williamson 702-794-1821]

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   Analysis of shaft and ramp SSCs are provided in this section to demonstrate compliance with all applicable regulatory requirements, particularly 10 CFR 60. Appropriate design parameters are provided and the bases for their compliance with 10 CFR 60 are described. Specific requirements other than those established by 10 CFR 60 are identified and compliance is established for each shaft and ramp system. Sufficient information is provided to facilitate an independent verification of compliance with all applicable regulatory requirements.

6. Opening Statement:

   [A statement similar to the following should be made in a potential license application: Analyses provided in this section demonstrate that GROA shaft and ramp SSCs comply with all applicable regulations.]

7. Main Body Outline:

4.3 ASSESSMENT OF COMPLIANCE FOR SHAFTS OR RAMPS

4.3.0 Introduction

- Refer to shaft and ramp descriptions in Section 4.1
- Provide a general description of the regulatory requirements and overall methods for assessing compliance.

4.3.0.1 Compliance with 10 CFR 60 Requirements

7. Main Body Outline (Continued)

- All of the shaft and ramp SSCs in each subsection of Section 4.2 that are subject to 10 CFR 60 requirements are listed in Table 4.3A.
- Provide an analysis demonstrating compliance with applicable 10 CFR 60 requirements for each SSC.
  - Demonstrate compliance with general requirements applicable to all GROA SSCs
  - Demonstrate compliance with individual design requirements applicable to GROA systems.
- Describe how design parameters presented in Section 4.1 result in compliance with 10 CFR 60 requirements.
- Justify how applicable industry codes and standards used in the design result in compliance with 10 CFR 60 requirements.

4.3.0.2 Accident Analyses

- Describe overall approach to accident analyses including the selection of the accident scenarios
- Discuss (list) accidents that SSCs are designed to withstand and how each system is intended to perform during each accident
- Demonstrate that shaft and ramp SSCs are designed to withstand the effects of each accident
- Describe design features that prevent accidents, including those caused by natural phenomena.

4.3.0.3 Basis for Identification of SSCs Important to Safety

- Provide the basis for the SSCs important to safety, waste isolation, and retrievability. These SSCs are listed in Table 4.1K.
- Provide an analysis that demonstrates the margin of safety in the design under normal conditions and anticipated operational occurrences, including those of natural origin.

4.3.0.4 Description of Models

- The models used to perform the analyses are listed in Table 4.3B.

7. Main Body Outline (Continued)

- Explain measures supporting models used in both design applications and accident analyses.

- Support analyses and models used to predict future conditions with an appropriate combination of the following:

  - Field tests
  - In situ tests
  - Laboratory tests
  - Monitoring data
  - Natural analog studies.

- Discuss variability and uncertainty of data and the propagation of errors.
- Discuss the representativeness of data and uncertainties associated with extrapolation of data.
- Discuss conceptualizations, documentation, and validation of models and codes should be discussed with respect to:

  - Uncertainties in the input data
  - Applicability of specific models
  - Appropriateness of assumptions
  - Sensitivity of results to the uncertainty of input data.

- Input and output data for each of the models are provided in Table 4.3C.
- Provide interpretations of input and output data along with the basis of interpretations. Provide sufficient detail to facilitate independent analysis of results.
- Document role of expert judgement.

4.3.1 Applicable Requirements and Criteria

- [Consider FCRG comment to bulletize list of SSC's listed in Section 4.1]

4.3.1.0 Introduction

- In this subsection, compliance is demonstrated for all shaft and ramp subsystems with the additional requirements and criteria presented herein, as applicable.

7. Main Body Outline (Continued)

[Note that organization of this subsection differs from Section 4.2.1.]

4.3.1.1 Airborne Radioactive Materials

- Demonstrate that the concentrations of airborne radioactive materials in restricted areas (including discharges from other GROA systems) are consistent with the inhalation limits as required by 10 CFR 20.103. The restricted areas are shown in Figure 4.3A. The estimated concentrations in each restricted area is provided in Table 4.3D.
- Each source term used to estimate these concentrations is provided in Table 4.3E.
- Those areas potentially contaminated with airborne radioactivity that are accessible to operating personnel are shown in Figure 4.3B.
- Estimates of maximum individual and total person-hours of occupancy are provided in Table 4.3F. Anticipated concentrations during occupancy are provided in Table 4.3D.
- Projected concentrations and estimated intake of radionuclides in restricted areas until permanent closure are provided in Table 4.3G.
- Models and model parameters used in calculations are provided in Table 4.3H.
- A comparison of projected intakes to intake limits in 10 CFR 20 are provided in Table 4.3I.
- Indicate provisions for personnel protective measures such as respiratory equipment or exhaust hoods.
    - Ensure compliance with ANSI N13.1-1969. [Reference provided here.]

4.3.1.2 Contamination Control

- Demonstrate the means to monitor and control the dispersal of radioactive contamination between radiation zones in restricted areas. The radiations zones are illustrated in Figure 4.1BF.
- Ensure compliance with ALARA requirements in 10 CFR 20.1(c), dose limitations in 10 CFR 20.101, and concentration in air required by 10 CFR 20.103.

7. Main Body Outline (Continued)

4.3.1.3 Dose Rates in Restricted Areas

- Demonstrate that the levels of radiation in restricted areas are in compliance with 10 CFR 20.101.
- Provide the objectives and criteria for design dose rates in various areas. [What are various areas?]
- Estimates of the annual collective person-rem doses are provided in Table 4.3J.
- Estimated annual occupancy times for each restricted area are provided in Table 4.3F. Provide the bases, models, assumptions for values presented. [See Section 4.3.1.1]
- Identify dose conversion factors and illustrate how they are used to calculate exposure.
- Describe biological and dosimetry models and ensure compliance with 10 CFR 20.

4.3.1.4 Natural Phenomena and Environmental Conditions

- Demonstrate that the SSCs important to safety are designed so that natural phenomena and environmental conditions do not interfere with safety functions.

4.3.1.5 Dynamic Effects

- Demonstrate that the SSCs important to safety are designed to withstand missile impacts, etc, without loss of safety function operability.

4.3.1.6 Performance During and After Fires and Explosions

- Demonstrate that the SSCs important to safety are designed to perform safety functions during and after credible fires and explosions.

4.3.1.7 Noncombustible and Heat-resistant Materials

- Demonstrate that the SSCs important to safety are designed to incorporate the use of noncombustible and heat-resistant materials.

7. Main Body Outline (Continued)

4.3.1.8 Fire and Explosion Protection Systems

- Demonstrate that the GROA fire protection and suppression systems have sufficient capacity to reduce adverse effects on SSCS important to safety. [Reference Section 4.1.1.3.]

4.3.1.9 Adverse Safety Effects of Fire and Explosion System Operation or Failure

- Demonstrate that GROA shaft and ramp SSCs are designed to withstand the effects of fire protection system operation or failure and still perform safety function. [Reference Section 4.1.1.3.]

4.3.1.10 Control of Radioactive Materials

- Demonstrate that SSCs important to safety are designed to maintain control of radioactive waste and effluents, safely shutdown, and permit safe evacuation during an emergency. [Reference Section 4.1.1.4.]

4.3.1.11 Utility System Performance During Normal and Accident Conditions

- Demonstrate that each utility system important to safety is designed to perform intended safety functions under both accident and normal conditions. [Reference Section 4.1.1.6.]

4.3.1.12 Utility System Redundancy

- Demonstrate that utility system design incorporates adequate redundancy to perform safety functions. [Reference Section 4.1.1.6.]

4.3.1.13 Emergency Power

- Demonstrate that emergency power is available in the event of a loss of primary power for the following:

7. Main Body Outline (Continued)

- Instruments
- Utility systems
- Operating systems
- Alarm systems.

4.3.1.14 SSC Operability Verification

- Demonstrate that SSCs important to safety have been designed to facilitate periodic inspection, testing, and maintenance to ensure operability.

4.3.1.15 Criticality

- Demonstrate that all systems dealing with nuclear material are designed in compliance with the Double Contingency Principle precluding nuclear criticality.
- Demonstrate that each system has been designed for criticality safety under normal and accident conditions.
- Ensure that K_{eff} is sufficiently below unity to show at least 5% margin after allowances for the bias in calculation methods and validation. The effective multiplication factor for all masses and configurations of radioactive material is shown in Table 4.2K. [Assume that shaft and ramp configurations are bounded by surface facility configurations.]

4.3.1.16 Instrumentation

- Demonstrate that instrumentation and control systems include adequate provisions to monitor and control systems important to safety over anticipated ranges of normal operation and accident conditions. [Reference Section 4.1.1.7.]

4.3.1.17 Worker Protection

- Demonstrate that the design includes adequate provisions for worker protection to assure that SSCs important to safety can perform intended functions. [Reference Federal Mine Safety and Health Act of 1977.]
- Note any deviations from the design requirements of 30 CFR Chapter I, subchapters D, E, and N.

7. Main Body Outline (Continued)

4.3.1.18 Shaft and Borehole Seals

- Demonstrate that seals for shafts and boreholes are designed so that they do not become pathways that compromise the GROA's ability to meet performance objectives following permanent closure. [Reference NRC technical position on seals.]

4.3.1.19 Seal Materials and Placement Methods

- Demonstrate that seal materials and placement methods are selected to reduce:

  - Creation of a pathway for water to contact waste packages
  - Radionuclide migration through existing pathways.

4.3.2 System Specific Compliance with Applicable Requirements and Criteria

4.3.2.0 Introduction

- Provide a general description of shaft and ramp design requirements and the procedures for identifying regulatory requirements and ensuring compliance. System specific compliance is demonstrated in this section for all shafts or ramps systems.

  [The FCRG outline requirement for system specific treatment of requirements will be repetitive.]

4.3.2.1 Waste Shaft or Ramp

- Demonstrate compliance with all applicable requirements and criteria.

4.3.2.2 Muck Shaft or Ramp

- Demonstrate compliance with all applicable requirements and criteria.

7. Main Body Outline (Continued)

4.3.2.3 Ventilation Intake Shafts

- Demonstrate compliance with all applicable requirements and criteria.

4.3.2.4 Ventilation Exhaust Shafts

- Demonstrate compliance with all applicable requirements and criteria.

4.3.2.5 Personnel and Materials Shafts

- Demonstrate compliance with all applicable requirements and criteria.

4.3.2.6 Decommissioning System

- Demonstrate compliance with all applicable requirements and criteria.

4.3.2.7 Other Shaft or Ramp Systems

- Demonstrate compliance with all applicable requirements and criteria.

8. Conclusion:

[A statement similar to the following should be made in a potential license application: Analyses provided in this section demonstrate that GROA shaft and ramp SSCs comply with all applicable regulatory requirements. Therefore, there are no credible circumstances by which shaft and ramp operations threaten the health or safety of plant personnel or the public.]

9. Support Authors & Their Assignments:

Tom Williamson (M&O Licensing)

Section No. & Title: 4.3 ASSESSMENT OF COMPLIANCE FOR SHAFTS AND RAMPS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.3A

Title: **Shaft and Ramp SSCs and Applicable 10 CFR 60 Requirements**

Content:

SSC	Reference to 10 CFR 60 Requirement	Description of Requirement
Systems Structures Component	10 CFR 60.20i [ex]	

B. Table No. 4.3B

Title: **Analytical Models for Shafts and Ramps**

Content:

Model	Analysis

C. Table No. 4.3C

Title: **Data for Shaft and Ramp Models and Codes**

Content:

Code or Model	Input Data	Output Data

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 4.3 ASSESSMENT OF COMPLIANCE FOR SHAFTS AND RAMPS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. 4.3A

Caption: **Restricted Areas in Shafts and Ramps**

Content:

Plant layout showing restricted areas with legend.

B. Table No. 4.3D

Title: **Estimated Concentration of Airborne Radioactive Materials for the Restricted Areas; Shafts and Ramps**

Content:

Area	Concentration

C. Table No. 4.3E

Title: **Source Terms in Ramps or Shafts**

Content:

Source Term	Quantity Discharged per Unit Time	Particle Size (AMAD)	Chemical Form	Physical Form	Lung Solubility Class

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

Section No. & Title: 4.3 ASSESSMENT OF COMPLIANCE FOR SHAFTS AND RAMPS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. 4.3B

Caption: **Areas Potentially Contaminated with Radioactive Materials that are Accessible to Operating Personnel in Shafts and Ramps**

Content:

Layout drawing of GROA shafts and ramps with subject areas cross-hatched.

B. Table No. 4.3F

Title: **Maximum Individual and Total Person-Hours of Occupancy in Shafts and Ramps**

Content:

Area	Individual Person-Hours/yr.	Total Person-Hours/yr.

C. Table No. 4.3G

Title: **Radionuclide Concentration and Intake Estimates During Operational Activities in Shafts and Ramps**

Content:

Operational Activity	Projected Concentration	Estimated Intake
Handling		
Storage		
Retrieval		
Emplacement		
Isolation		

Section No. & Title: 4.3 ASSESSMENT OF COMPLIANCE FOR SHAFTS AND RAMPS

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.3H

Title: **Analytical Models and Model Parameters for Shaft and Ramp Analyses**

Content:

Analysis	Model	Model Parameters
Concentration Estimates		
Intake Estimates		
Etc.		

B. Table No. 4.3I

Title: **Comparison of Projected Intakes to 10 CFR 20 Limits in Shafts and Ramps**

Content:

Area	Projected Intake	Intake Limit

C. Table No. 4.3J

Title: **Collective Person - Rem Doses by Function in Shafts and Ramps**

Content:

Function	Annual Collective	Estimated Annual Time (Person Hours)
Spent Fuel Transfer		
HLW Transfer		
Off-Gas Handling		
Waste Treatment		
Maintenance		
Rad Waste Handling		
Decontamination		
In-Service Inspections		

Section No. & Title: **4.3 ASSESSMENT OF COMPLIANCE FOR SHAFTS AND RAMPS**

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. **4.3K**

Title: **Effective Multiplication Factors (Keff) for Shafts and Ramps**
[This might be redundant.]

Content:

System or Component	Worst Case Calculated Keff
Transportation Cask	0.9
Radwaste Storage Container	0.6
Etc.	Etc.
Etc.	

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title:

Content:

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title:

Lead Author & Phone No.

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

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The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number:

2. Section no. & title: 4.3 ASSESSMENT OF COMPLIANCE FOR SHAFTS AND RAMPS

3. Lead author & phone no: T. M. Williamson (702) 794-1821

4. Information request date:

5. Work location:

6. Type of information needed:

7. What is the information needed for?

8. What group is the probable information supplier?

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form B: Information Response

1. Section No. & Title:

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester): Marshall Weaver (702) 794-1871

   Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

MGDS Annotated Outline

Section 4.4 Assessment of Compliance for Underground Facilities

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4.4 ASSESSMENT OF COMPLIANCE FOR UNDERGROUND FACILITIES

Skeleton Text Has Not Been Developed For This Section

REFERENCES

1. Section No. & Title: 4.4 ASSESSMENT OF COMPLIANCE FOR UNDERGROUND FACILITIES

2. Lead Author & Phone No. TBD
[T.M. Williamson 702-794-1821]

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   Analyses of underground facility SSCs are provided in this section to demonstrate compliance with all applicable regulatory requirements, particularly 10 CFR 60. Appropriate design parameters are provided and the bases for their compliance with 10 CFR 60 are discussed. Specific requirements other than those established by 10 CFR 60 are identified and compliance is demonstrated for each underground facility system. Sufficient information is provided to facilitate an independent verification of compliance with all applicable regulatory requirements.

6. Opening Statement:

   [A statement similar to the following should be made in a potential license application: Analyses provided in this section demonstrate that GROA underground facility SSCs comply with all applicable regulations.]

7. Main Body Outline:

4.4 ASSESSMENT OF COMPLIANCE FOR UNDERGROUND FACILITIES

4.4.0 Introduction

- Refer to underground facility descriptions in Section 4.1.
- Provide a general description of the regulatory requirements and overall methods for assessing compliance.

7. Main Body Outline (Continued)

4.4.0.1 Compliance with 10 CFR 60 Requirements

- All of the underground facility SSCs in each subsection of Section 4.1 that are subject to 10 CFR 60 requirements are listed in Table 4.4A.
- Provide an analysis demonstrating compliance with applicable 10 CFR 60 requirements for each SSC.

  - Demonstrate compliance with general requirements applicable to all GROA SSCs
  - Demonstrate compliance with individual design requirements applicable to GROA systems.

- Describe how design parameters presented in Section 4.1 result in compliance with 10 CFR 60 requirements.
- Justify how applicable industry codes and standards used in the design result in compliance with 10 CFR 60 requirements.

4.4.0.2 Accident Analyses

- Describe overall approach to accident analyses including the selection of the accident scenarios
- Discuss (list) accidents that SSCs are designed to withstand and how each system is intended to perform during each accident
- Demonstrate that underground facility SSCs are designed to withstand the effects of each accident
- Describe design features that prevent accidents, including those caused by natural phenomena.

4.4.0.3 Basis for Identification of SSCs Important to Safety

- Provide the basis for the SSCs important to safety, waste isolation, and retrievability. These SSCs are listed in Table 4.1K.

- Provide an analysis that demonstrates the margin of safety in the design under normal conditions and anticipated operational occurrences, including those of natural origin.

7. Main Body Outline (Continued)

4.4.0.4 Description of Models

- The models used to perform the analyses are listed in Table 4.4B.
- Explain measures supporting models used in both design applications and accident analyses.
- Support analyses and models used to predict future conditions with an appropriate combination of the following:

    - Field tests
    - In situ tests
    - Laboratory tests
    - Monitoring data
    - Natural analog studies.

- Discuss variability and uncertainty of data and the propagation of errors.
- Discuss the representativeness of data and uncertainties associated with extrapolation of data.
- Discuss conceptualizations, documentation, and validation of models and codes with respect to:

    - Uncertainties in the input data
    - Applicability of specific models
    - Appropriateness of assumptions
    - Sensitivity of results to the uncertainty of input data.

- Input and output data for each of the models are provided in Table 4.4C.
- Provide interpretations of input and output data along with the basis of interpretations. Provide sufficient detail to facilitate independent analysis of results.
- Document role of expert judgement.

4.4.1 Applicable Requirements and Criteria

- [Consider FCRG comment to bulletize list of SSC's in Section 4.1]

7. Main Body Outline (Continued)

4.4.1.0 Introduction

- In this subsection, compliance is demonstrated for all underground subsystems with the additional requirements and criteria presented herein, as applicable.

4.4.1.1 Airborne Radioactive Materials

- Demonstrate that the concentrations of airborne radioactive materials in restricted areas (including discharges from other GROA systems) are consistent with the inhalation limits as required by 10 CFR 20.103. The restricted areas are shown in Figure 4.4A. The estimated concentrations in each restricted area is provided in Table 4.4D.
- Each source term used to estimate these concentrations is provided in Table 4.4E.
- Those areas potentially contaminated with airborne radioactivity that are accessible to operating personnel are shown in Figure 4.4B.
- Estimates of maximum individual and total person-hours of occupancy are provided in Table 4.4-F. Anticipated concentrations during occupancy are provided in Table 4.4-D.
- Projected concentrations and estimated intake of radionuclides in restricted areas until permanent closure are provided in Table 4.4G.
- Models and model parameters used in calculations are provided in Table 4.4H.
- A comparison of projected intakes to intake limits in 10 CFR 20 are provided in Table 4.4I.
- Indicate provisions for personnel protective measures such as respiratory equipment or exhaust hoods.

4.4.1.2 Personnel Occupancy Time

- Demonstrate the means to limit the occupancy time required to perform work in restricted areas.
- Ensure each system is designed for compliance with 10 CFR 20 requirements for occupancy time.

7. Main Body Outline (Continued)

4.4.1.3 Shielding

- Demonstrate that each system is provided with suitable shielding. Refer to Section 4.1 for locations of shielding.
- Provide cost/benefit analysis for each shield to demonstrate compliance with ALARA conditions of 10 CFR 20 and dose limitations requirements of 10 CFR 20.101.

4.4.1.4 Contamination Control

- Demonstrate the means to monitor and control the dispersal of radioactive contamination between radiation zones in restricted areas. The radiations zones are illustrated in Figure 4.1BF.
- Ensure compliance with ALARA requirements in 10 CFR 20.1(c), dose limitations in 10 CFR 20.101, and concentration in air required by 10 CFR 20.103.

4.4.1.5 Access Control

- Describe means to control access to high-radiation areas or airborne radioactivity areas
- Describe the monitoring of access.

4.4.1.6 Radiation Alarm Systems

- Describe radiation alarm systems that warn operating personnel of:
    - Significant increases in radiation levels
    - Significant increases in airborne material concentrations
    - Increased radioactivity in effluents.
- Describe provisions for calibration and operability testing [Reference provided here.]

4.4.1.7 Dose Rates in Restricted Areas

- Demonstrate that the levels of radiation in restricted areas are in compliance with 10 CFR 20.101.

7. Main Body Outline (Conitnued)

- Provide the objectives and criteria for design dose rates in various areas. [What are various areas?]

- Estimates of the annual collective person-rem doses are provided in Table 4.4J.
- Estimated annual occupancy times for each restricted area are provided in Table 4.4F. Provide the bases, models, assumptions for values presented. [See Section 4.4.1.1.]
- Identify dose conversion factors and illustrate how they are used to calculate exposure.
- Describe biological and dosimetry models and ensure compliance with 10 CFR 20.

4.4.1.8 ALARA (As low as reasonably achievable)

- Describe how exposures and effluent discharges are ALARA for each system per 10 CFR 20.1(c).
- Describe management policy regarding ALARA in sources and with respect system design and operation.
- Describe how guidelines in Reg Guide 8.8 were used for each individual system. If not used, justify. [Reference here.]

4.4.1.9 Natural Phenomena and Environmental Conditions

- Demonstrate that the SSCs important to safety are designed so that natural phenomena and environmental conditions do not interfere with safety functions.

4.4.1.10 Dynamic Effects

- Demonstrate that the SSCs important to safety are designed to withstand missile impacts, etc., without loss of safety function operability.

4.4.1.11 Performance During and After Fires and Explosions

- Demonstrate that the SSCs important to safety are designed to performed safety functions during and after credible fires and explosions. [Reference 4.1.1.3.]

7. Main Body Outline (Continued)

4.4.1.12 Noncombustible and Heat-resistant Materials

- Demonstrate that the SSCs important to safety are designed to incorporate the use of noncombustible and heat-resistant materials. [Reference Section 4.1.1.3.]

4.4.1.13 Fire and Explosion Protection Systems

- Demonstrate that the GROA fire protection and suppression systems have sufficient capacity to reduce adverse effects on SSCs important to safety. [Reference Section 4.1.1.3.]

4.4.1.14 Adverse Safety Effects of Fire and Explosion System Operation or Failure

- Demonstrate that GROA underground facility SSCs are designed to withstand the effects of fire protection system operation or failure and still perform safety function. [Reference Section 4.1.1.3.]

4.4.1.15 Control Of Radioactive Materials

- Demonstrate that SSCs important to safety are designed to maintain control of radioactive waste and effluents, safely shutdown, and permit safe evacuation during an emergency. [Reference Section 4.1.1.4.]

4.4.1.16 Use of Offsite Services

- Demonstrate how emergency systems are designed to include facilities and services that ensure safe and timely response to emergency conditions. [Reference Section 4.1.1.4.]
- Demonstrate that emergency system facilitate the use of offsite services such as:

  - Fire
  - Police
  - Medical
  - Ambulance.

7. Main Body Outline (Continued)

4.4.1.17 Utility System Performance During Normal and Accident Conditions

- Demonstrate that each utility system important to safety is designed to perform intended safety functions under both accident and normal conditions. [Reference Section 4.1.1.6.]

4.4.1.18 Utility System Redundancy

- Demonstrate that utility system design incorporates adequate redundancy to perform safety functions. [Reference Section 4.1.1.6.]

4.4.1.19 Emergency Power

- Demonstrate that emergency power is available in the event of a loss of primary power for the following:
  - Instruments
  - Utility systems
  - Operating systems
  - Alarm systems.

4.4.1.20 SSC Operability Verification

- Demonstrate that SSCs important to safety have been designed to facilitate periodic inspection, testing, and maintenance to ensure operability.

4.4.1.21 Criticality

- Demonstrate that all systems dealing with nuclear material are designed in compliance with the Double Contingency Principle precluding nuclear criticality.
- Demonstrate that each system has been designed for criticality safety under normal and accident conditions.
- Ensure k_{eff} is sufficiently below unity to show at least 5% margin after allowances for the bias in calculation methods and validation. The effective multiplication factor for all masses and configurations of radioactive material is shown in Table 4.4K.

7. Main Body Outline (Continued)

4.4.1.22 Instrumentation

- Demonstrate that instrumentation and control systems include adequate provisions to monitor and control systems important to safety over anticipated ranges of normal operation and accident conditions. [Reference Section 4.1.1.7.]

4.4.1.23 Worker Protection

- Demonstrate that the design includes adequate provisions for worker protection to ensure that SSCs important to safety can perform intended function. [Reference Federal Mine Safety and Health Act of 1977]
- Note any deviations from the design requirements of 30 CRF Chapter I, subchapters D, E, and N.

4.4.1.24 Orientation and Depth

- Demonstrate that the orientation, layout, and depth of the underground facility and the design of the underground facility engineered barriers contribute to the containment and isolation of radionuclides.

4.4.1.25 Disruptive Events

- Demonstrate that the underground facility design ensures that credible disruptive events during the period of operations do not spread through the facility.

  - Fires
  - Floods
  - Explosions.

4.4.1.26 Flexibility

- Demonstrate that the underground facility has been designed with sufficient flexibility to allow adjustments to accommodate site specific conditions identified through:

  - In situ monitoring
  - Testing
  - Excavation.

7. Main Body Outline (Continued)

4.4.1.27 Retrieval of Waste

- Demonstrate that the underground facility has designed to permit retrieval of waste in accordance with the performance objective of 10 CFR 60.11.

4.4.1.28 Water or Gas Intrusion

- Demonstrate that the underground facility design controls water or gas intrusion.

4.4.1.29 Openings

- Demonstrate that openings in the underground facility are designed for safe operations and retrievability.

4.4.1.30 Structural Integrity of Openings

- Demonstrate that openings are designed to reduce the potential for deleterious rock movement or fracturing of overlying or surrounding rock.

4.4.1.31 Excavation Methods

- Demonstrate that the excavation methods do not create a preferential pathway for ground water to contact the waste packages and contribute to radionuclide migration to the accessible environment.

4.4.1.32 Ventilation Systems

- Demonstrate that the ventilation systems are designed to:

  - Control transport or radioactive particulate and gases within the underground facility in accordance with 10 CFR 60.111(a)
  - Control transport of radioactive particulate and gases from the underground facility in accordance with 10 CFR 60.111(a)
  - Ensure continued functions during normal operations and under accident conditions

7. Main Body Outline (Continued)

- Separate the ventilation of excavation and waste emplacement areas.

4.4.1.33 Engineered Barriers

- Demonstrate that the engineered barriers in the underground facility are designed to assist the natural setting in meeting the performance objectives after permanent closure.

4.4.1.34 Thermal and Thermochemical Response

- Demonstrate that the underground facility design meets performance objectives taking into account predicted thermal and thermochemical response of the:
  - Host rock
  - Surrounding area
  - Ground-water system.

4.4.2 System Specific Compliance with Applicable Requirements and Criteria

- Provide a general description of underground facility design requirements and the procedures for identifying regulatory requirements and ensuring compliance. System specific compliance is demonstrated in this section for all underground facility systems. [The FCRG outline requirements for system specific treatment of requirements will be repetitive.]

4.4.2.1 Excavation and Ground Support Systems

- Demonstrate compliance with all applicable requirements and criteria.

4.4.2.2 Muck Handling System

- Demonstrate compliance with all applicable requirements and criteria.

4.4.2.3 Ventilation System

- Demonstrate compliance with all applicable requirements and criteria.

7. Main Body Outline (Continued)

4.4.2.4 Waste Emplacement System

- Demonstrate compliance with all applicable requirements and criteria.

4.4.2.5 Waste Retrieval System

- Demonstrate compliance with all applicable requirements and criteria.

4.4.2.6 Emergency Systems

- Demonstrate compliance with all applicable requirements and criteria.

4.4.2.7 Communication System

- Demonstrate compliance with all applicable requirements and criteria.

4.4.2.8 Operations Support System

- Demonstrate compliance with all applicable requirements and criteria.

4.4.2.9 Decommissioning System

- Demonstrate compliance with all applicable requirements and criteria.

4.4.2.10 Other Underground Systems

- Demonstrate compliance with all applicable requirements and criteria.

8. Conclusion:

[A statement similar to the following should be made in a potential license application: Analyses provided in this section demonstrate that GROA underground facility SSCs comply with all applicable regulatory requirements. Therefore, there are no credible circumstances by which underground facility operations threaten the health or safety of plant personnel or the public.]

9. Support Authors & Their Assignments:

Tom Williamson (M&O Licensing)

Section No. & Title: 4.4 ASSESSMENT OF COMPLIANCE FOR UNDERGROUND FACILITIES

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.4A

Title: Underground Facility SSCs and Applicable 10 CFR 60 Requirements

Content:

SSC	Reference to 10 CFR 60 Requirement	Description of Requirement
Systems Structures Component	10 CFR 60.20i [ex]	

B. Table No. 4.4B

Title: Analytical Models of the Underground Faulting

Content:

Model	Analysis

C. Table No. 4.4C

Title: Data for Underground Facility Models and Codes

Content:

Code or Model	Input Data	Output Data

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 4.4 ASSESSMENT OF COMPLIANCE FOR UNDERGROUND FACILITIES

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. 4.4A

Caption: Restricted Areas in the Underground Facility

Content:

Plant layout showing restricted areas with legend.

B. Table No. 4.4D

Title: Estimated Concentration of Airborne Radioactive Materials for the Restricted Areas in the Underground Facilities

Content:

Area	Concentration

C. Table No. 4.4E

Title: Source Terms in the Underground Facility

Content:

Source Term	Quantity Discharged per Unit Time	Particle Size (AMAD)	Chemical Form	Physical Form	Lung Solubility Class

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 4.4 ASSESSMENT OF COMPLIANCE FOR UNDERGROUND FACILITIES

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. 4.4B

Caption: Areas Potentially Contaminated with Radioactive Materials that are Accessible to Operating Personnel in the Underground Facility

Content:

Layout drawing of GROA surface facilities with subject areas cross-hatched.

B. Table No. 4.4F

Title: Maximum Individual and Total Person-Hours of Occupancy in the Underground Facility

Content:

Area	Individual Person-Hours/yr.	Total Person-Hours/yr.

C. Table No. 4.4G

Title: Radionuclide Concentration and Intake Estimates During Operational Activities in the Underground Facility

Content:

Operation Activity	Projected Concentration	Estimated Intake
Handling		
Storage		
Retrieval		
Emplacement		
Isolation		

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

Section No. & Title: 4.4 ASSESSMENT OF COMPLIANCE FOR UNDERGROUND FACILITIES

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.4H

Title: Analytical Models and Model Parameters for the Underground Facility

Content:

Analysis	Model	Model Parameters
Concentration Estimates		
Intake Estimates		
Etc.		

B. Table No. 4.4I

Title: Comparison of Projected Intakes to 10 CFR 20 Limits in the Underground Facility

Content:

Area	Projected Intake	Intake Limit

C. Table No. 4.4J

Title: Collective Person - Rem Doses by Function in the Underground Facility

Content:

Function	Annual Collective	Estimated Annual Time (Person Hours)
Spent Fuel Transfer		
HLW Transfer		
Off-Gas Handling		
Waste Treatment		
Maintenance		
Rad Waste Handling		
Decontamination		
In-Service Inspections		

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 4.4 **ASSESSMENT OF COMPLIANCE FOR UNDERGROUND FACILITIES**

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. **4.4K**

Title: **Effective Multiplication Factors (Keff) for the Underground Facility [This might be redundant.]**

Content:

System or Component	Worst Case Calculated Keff
Transportation Cask	0.9
Radwaste Storage Container	0.6
Etc.	Etc.
Etc.	

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title:

Content:

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Planning Package Date: 9/30/92
Form 3: References

Section No. & Title:

Lead Author & Phone No.

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

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MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number:

2. Section no. & title: 4.4 ASSESSMENT OF COMPLIANCE FOR UNDERGROUND FACILITIES

3. Lead author & phone no: T. M. Williamson (702) 794-1821

4. Information request date:

5. Work location:

6. Type of information needed:

7. What is the information needed for?

8. What group is the probable information supplier?

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form B: Information Response

1. Section No. & Title:

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester): Marshall Weaver (702) 794-1871

   Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form C: Information Request Tracking Log

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

MGDS Annotated Outline

Section 4.5 Integrated GROA Compliance with Performance Objectives

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4.5 INTEGRATED GROA COMPLIANCE WITH PERFORMANCE OBJECTIVES

Skeleton Text Has Not Been Developed For This Section

REFERENCES

1. Section No. & Title: 4.5 INTEGRATED GROA COMPLIANCE WITH PERFORMANCE OBJECTIVES

2. Lead Author & Phone No. TBD
[T.M. Williamson 702-794-1821]

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
(Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   Analyses of integrated GROA systems are provided in this section to demonstrate compliance with the performance objectives in 10 CFR 60 related to radiation protection for the public and waste retrievability. Appropriate design parameters are provided and the bases for their compliance with 10 CFR 60 are provided and the bases for their compliance with 10 CFR 60 are discussed. Specific requirements other than those established by 10 CFR 60 are identified for the GROA as a system, and compliance with each is demonstrated. Sufficient information is provided to facilitate an independent verification of compliance with 10 CFR 60 performance objectives.

6. Opening Statement:

   [A statement similar to the following should be made in a potential license application: Analyses provided in this section demonstrate that the GROA as a system complies with all applicable performance objectives.]

7. Main Body Outline:

4.5 INTEGRATED GROA COMPLIANCE WITH PERFORMANCE OBJECTIVES

4.5.0 Introduction
- Refer to the general description of the GROA in Section 4.0.
- Provide a general description of the performance objectives and overall methods for assessing compliance.
- Compliance with 10 CFR 60 performance objectives associated with public radiation protection is demonstrated for the GROA as a system in Section 4.5.1.

7. Main Body Outline (Continued)

- Compliance with 10 CFR 60 performance objectives associated with waste retrievability is demonstrated for the GROA as a system in Section 4.5.2.

4.5.0.1 Compliance with 10 CFR 60 Performance Objectives

- Demonstrate compliance with applicable 10 CFR 60 performance objectives as follows:
  - Demonstrate compliance with general requirements applicable to all GROA systems discussed in previous sections
  - Demonstrate compliance with individual design requirements applicable to specific GROA systems.
- Include those engineered barrier subsystems described in Chapter 5 that interact with or otherwise effect the ability of the GROA to meet performance objectives.
- Describe how design parameters presented in Section 4.1 result in compliance with 10 CFR 60 performance objectives.
- Justify how applicable industry codes and standards used in the design result in compliance with 10 CFR 60 objectives.

4.5.0.2 Accident Analyses and Prevention

- Describe overall approach to accident analyses including the selection of the accident scenarios.
- Discuss (list) accidents that SSCs are designed to withstand and how each system is intended to perform during each accident.
- Demonstrate that GROA SSCs are designed to withstand the effects of each accident.
- Describe design features that prevent accidents, including those caused by natural phenomena.

4.5.0.3 Basis for Identification of SSCs Importance to Safety

- Provide the basis for the SSCs importance to safety, waste isolation, and retrievability. These SSCs are listed in Table 4.1K.
- Provide an analysis that demonstrates the margin of safety in the design under normal conditions and anticipated operational occurrences, including those of natural origin.

7. Main Body Outline (Continued)

4.5.0.4 Description of Models

- The models used to perform the analyses are listed in Table 4.5A.
- Explain measures supporting models used in both design applications and accident analyses.
- Support analyses and models used to predict future conditions with an appropriate combination of the following:
    - Field tests
    - In situ tests
    - Laboratory tests
    - Monitoring data
    - Natural analog studies.
- Discuss variability and uncertainty of data and the propagation of errors.
- Discuss the representativeness of data and uncertainties associated with extrapolation of data.
- Discuss conceptualizations, documentation, and validation of models and codes with respect to:
    - Uncertainties in the input data
    - Applicability of specific models
    - Appropriateness of assumptions
    - Sensitivity of results to the uncertainty of input data.
- Input and output data for each of the models are provided in Table 4.5C.

- Provide interpretations of input and output data along with the basis of interpretations. Provide sufficient detail to facilitate independent analysis of results.
- Document role of expert judgement.

4.5.1 Protection Against Radiation Exposures and Releases of Radioactive Material to Unrestricted Areas

4.5.1.0 Introduction

- Demonstrate that the design of the GROA complies with the requirements for radiological safety of the public in 10 CFR 60.

7. Main Body Outline (Continued)

- The projected levels of radiation and the concentrations of radionuclides expected are provided in Table 4.5B for normal operations and anticipated operational occurrences.
- The projected levels of radiation and the concentrations of radionuclides expected are provided in Table 4.5C for accident conditions.
- Demonstrate that the GROA is designed to maintain radiation exposures and levels, and concentrations of radioactive materials released to unrestricted areas within the limits specified in 10 CFR 20.105 & 106. Also demonstrate compliance with applicable standards for radioactivity established by EPA.
- Refer to the Section 4.1.4 for information concerning radiation protection.
- The models used to estimate concentrations and exposures for the GROA as a system are provided in Table 4.5D, including references to Chapter 3 for meteorological data.
- The estimated values are compared to numerical limits to demonstrate compliance in Table 4.5E.
- Discuss compliance with ALARA requirements of 10 CFR 20.1(c).
- Describe mathematical or physical models required to perform analyses of radiological consequences of the activities associated with the GROA. Include simplifications and assumptions and provide sufficient detail for independent verification of results.
- Discuss uncertainties in calculational methods and equipment performance.
- Describe conservatism in assumptions.
- Reference published data used in analyses.
- Identify computer programs used in analyses.
- Provide computer listings of input data and output from all analytical models. [This will add many tables to the section or make up an Appendix.]

4.5.1.1 Radioactivity in Effluents to Unrestricted Areas

- Demonstrate compliance with 10 CFR 20.106 for the following wastes discharged from the GROA:
  - Airborne gaseous and particulate effluents
  - Liquid effluents
  - Solid wastes.

7. Main Body Outline (Continued)

- The consequence analyses for effluents are supported by the following information:
  - Each effluent and type of waste is identified in Table 5.5F.
  - Source terms for each radionuclide discharged are provided in Table 4.5G.
  - The locations beyond the restricted areas that are potentially impacted by radioactive materials in effluents are shown in Figure 4.5A.
  - The anticipated concentrations of each radionuclide at the boundary of the restricted areas and the contribution of each to the radiation dose to humans is provided in Table 4.5H.
  - Provide sample calculations and explain measures to support biological and transport models, emphasizing critical pathways to humans.
  - Describe the constraints imposed on process systems and equipment for each affluent to ensure compliance with 10 CFR 60.111(a) performance objectives.

4.5.1.2 Compliance with Permissible Levels of Radiation in Unrestricted Areas

- Demonstrate that the levels of radiation in unrestricted areas comply with the dose limits in 10 CFR 20.105.
- Anticipated average radiation levels and occupancy times are provided for each unrestricted area in Table 4.5I.
- Describe the characteristics pertinent to its release and eventual biological impact for each radionuclide that contributes more than 10% of the total dose in unrestricted areas.
- Provide details of assumptions and sample calculations with emphasis on critical pathways to humans.

4.5.1.3 Compliance with Environmental Radiation Protection Standards

- Demonstrate that the GROA complies with 40 CFR 191, Section 191.03. [FCRG comment]
- Estimates of the largest annual dose equivalent to any member of the public are provided in Table 4.5J for the following:

7. Main Body Outline (Continued)

- Discharge of radioactive material
- Direct radiation
- All operations covered by 40 CFR 190

• The annual whole body collective doses (and affected organ doses) attributable to effluents and direct radiation for each compass section and radii are provided in Table 4.5K. The GROA compass sectors are illustrated in Figure 4.5B.

4.5.1.4 Compliance with ALARA Principles

• Demonstrate that radiation exposures and releases of radioactive materials in effluents to unrestricted areas are ALARA as required by 10 CFR 20.1(c).
• Describe the management policy that ensures that radiation exposure to the public is ALARA. The ALARA organizational structure is shown in Figure 4.5C.
• Describe the applicable activities of individuals having responsibility for radiation protection.
• Describe the policy with respect to designing and operating the GROA to achieve ALARA objectives.

4.5.2 Retrievability of Waste

• Demonstrate that the GROA is designed to preserve the option of waste retrieval:

- Throughout emplacement
- Until the completion of a performance conformation program and subsequent NRC review of performance conformation program
- Within the same time devoted to construction of the GROA and the emplacement of wastes.

8. Conclusion:

[A statement similar to the following should be made in a potential license application: Analyses provided in this section demonstrate that the GROA as a system complies with all applicable regulatory requirements and performance objectives. Therefore, there are no credible circumstances by which GROA operations threaten the health or safety of plant personnel or the public.]

9. Support Authors & Their Assignments:

Tom Williamson (M&O Licensing)

Section No. & Title: 4.5 INTEGRATED GROA COMPLIANCE WITH PERFORMANCE OBJECTIVES

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.5A

Title: **Analytical Models for Integrated GROA**

Content:

Model	Analysis

B. Table No. 4.5B

Title: **Projected Levels of Radiation and Concentrations of Radionuclides for Discharges of Radioactive Materials During Normal Operations and Anticipated Operational Occurrences Until Permanent Closures**

Content:

Operations (Normal Operations)	Discharge of Radioactive Materials (Concentrations of Radionuclides)		Radiation Fields (Radiation Levels)	
	Unrestricted Areas	General Environment	Unrestricted Areas	General Environment
Waste Handling				
Waste Storage				
Waste Retrival				
Waste Emplacement				
Waste Isolation				
Anticipated Operational Occurrences				

C. Table No. 4.5C

Title: **Projected Levels of Radiation and Concentrations of Radionuclides after Failure of Radiological Monitoring Equipment During Accident Conditions**

Content:

Accident	Discharge of Radioactive Materials (Concentrations of Radionuclides)		Radiation Fields (Radiation Levels)	
	Unrestricted Areas	General Environment	Unrestricted Areas	General Environment
Waste Handling				
Equipment Failure #1				
Equipment Failure #2				
Waste Storage				
Equipment Failure #1				
Equipment Failure #2				
Waste Retrival				
Equipment Failure #1				
Equipment Failure #2				
Waste Emplacement				
Equipment Failure #1				
Equipment Failure #2				
Waste Isolation				
Equipment Failure #1				
Equipment Failure #2				
Anticipated Operational Occurrences				
Equipment Failure #1				
Equipment Failure #2				

Section No. & Title: 4.5 INTEGRATED GROA COMPLIANCE WITH PERFORMANCE OBJECTIVES

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.5D

Title: Computer Codes and Models Used in Radiological Analyses

Content:

Analysis	Computer Codes or Model	Release Rate (Source Term)	Meteorological Date (Reference to Chapter 3)

B. Table No. 4.5E

Title: Analytical Results of Radiological Calculations vs. Numerical Limits

Content:

Analysis	Results	Regulatory Requirements Numerical Limits	Margin of Compliance

C. Table No. 4.5F

Title: Effluents and Types of Wastes

Content:

Effluent Source	Types of Wastes	Amount of Effluent Generated Per Metric Ton of Waste Stored per Unit Time
Treated Process Effluents		
Sewage		
Drinking Water		
Rain Runoff		
Laundry Waste		
Others		

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 4.5 INTEGRATED GROA COMPLIANCE WITH PERFORMANCE OBJECTIVES

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.5G

Title: **Source Terms for Radionuclides Discharged as Airborne or Liquid Effluent**

Content:

Effluent Stream Radionclide	Particle Size (AMAD)	Chemical Form	Physical Form	Lung Solubility Classes	Total Quantity and Concentration of Radionuclide Disharged per Unit Time
Treated Process Effluents	StU Co				
Sewage	N/A				
Drinking Water	N/A				
Rain Runoff					
Laundry Wastes					

B. Figure No. 4.5A

Caption: **Locations Beyond the Restricted Areas that are Potentially Affected by Radioactive Materials in Effluents**

Content:

General arrangement drawing showing cross-hatched areas.

C. Table No. **4.5H**

Title: **Radionuclide Concentrations at Restricted Area Boundary**

Content:

Radionuclide	Concentration	Contribution to Total Dose (%)	Characteristics Pertinent to Release (If >10% Dose)	Biological Impact (If>10% Dose)
St90				
C060				
U238				
etc.				

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 4.5 INTEGRATED GROA COMPLIANCE WITH PERFORMANCE OBJECTIVES

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Table No. 4.5I

Title: Anticipated Average Radiation Levels and Occupancy Times in Unrestricted Areas

Content:

Unrestricted Area	Anticipated Average Radiation Level	Average Occupancy Time

B. Table No. 4.5J

Title: Estimated Maximum Annual Dose Equivalents

Content:

C. Table No. 4.5K

Title: **Annual Collective Whole Body Doses Estimates Attributable to Effluents and Direct Radiation**

Content:

	Compass Sector	Radii (mi)	Whole Body Dose (person-rem/SV)	Thyroid	Organ Dose Kidney	Lung P&C
	1	1				
		2				
		3				
		4				
		5				
		10				
		20				
		30				
		40				
		50				
	2					
thru	16					

MGDS Annotated Outline Planning Package **Date: 9/30/92**
Form 2: Figures & Tables

Section No. & Title: **4.5 INTEGRATED GROA COMPLIANCE WITH PERFORMANCE OBJECTIVES**

Lead Author & Phone No. TBD
T. M. Williamson (702) 794-1821

A. Figure No. 4.5B

Caption: GROA Compass Sectors

Content:

General arrangements drawing overlaid by 16 compass sectors. Each radii should be shown as a circle out to 50 mi. (1,2,3,4,5,10,20,30,40,50 mi.)

B. Figure No. 4.5C

Caption: ALARA Organization Structure

Content:

Organizational chart of ALARA group.

C. Figure No.

Title:

Content:

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title:

Lead Author & Phone No.

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

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MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number:
2. Section no. & title: 4.5 INTEGRATED GROA COMPLIANCE WITH PERFORMANCE OBJECTIVES
3. Lead author & phone no: T. M. Williamson (702) 794-1821
4. Information request date:
5. Work location:
6. Type of information needed:
7. What is the information needed for?
8. What group is the probable information supplier?
9. When is the information needed?
10. What kind of related information is already available in references, etc.?

---

11. Response by (name):
12. Response date:
13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form B: Information Response

1. Section No. & Title:

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester): Marshall Weaver (702) 794-1871

Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form C: Information Request Tracking Log

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Chapter 5.0 Engineered Barrier Systems

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5.0 ENGINEERED BARRIER SYSTEMS

Chapter 5 is divided into Section 5.1, Description of the Engineered Barrier Systems, and Section 5.2, Engineered Barrier System Compliance with 10 CFR 60.

[Section 5.1, Description of the Engineered Barrier System, will provide complete information on the selected engineered barrier system including the waste containers and the waste forms contained therein, the methods of emplacement of the waste packages in the repository, and the backfill and other materials surrounding them. The waste forms discussed will include both spent nuclear fuel and high level waste glass. Design parameters and operational considerations of the repository which affect the waste packages will be presented and discussed. Included will be the hydrological and geochemical attributes and processes which will in part determine the long-term performance of the waste packages. Also to be discussed are the expected radiation exposures resulting from emplacement of waste packages containing spent nuclear fuel and high level waste glass with the expected range of characteristics.]

[Section 5.2, Engineered Barrier System Compliance with 10 CFR 60, is divided into three sub-sections. One sub-section will discuss compliance with the design criteria and one will evaluate compliance with the performance objectives of 10 CFR 60. The third sub-section will provide information pertaining to radiation protection.]

The intent of Chapter 5 is to present all relevant information that will be needed to determine whether the engineered barrier systems meet the containment and controlled release requirements of the regulations with sufficient margin for uncertainty. Insuring the health and safety of the public and MGDS workers through compliance with the regulations is the primary requirement. It is also necessary to discuss whether the design of engineered barrier system can be reliably fabricated and used within the total waste management system with minimum reasonable radiation risk to the workers involved and to the public at large. Finally, it is necessary to discuss whether the total cost of the engineered barrier system when the waste containers are manufactured, the spent nuclear fuel assemblies and high level waste glass canisters are loaded therein, and the waste packages are sealed and emplaced in the repository will be within reasonable limits.

[10CFR60.21(c)(1)(ii)(D) requires "a comparative evaluation of alternatives to the major design features that are important to waste isolation." It has not been decided whether to include complete (detailed) comparisons in this chapter or to summarize these results in a table(s) and reference a separate document that contains these required comparisons.]

REFERENCES

1

MGDS Annotated Outline Planning Package
Form 1: Text

Date: 9/30/92

1. Section No. & Title: 5.0 ENGINEERED BARRIER SYSTEMS

2. Lead Author & Phone No. Hugh Benton 702-794-1891

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
   (Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   This description and evaluation of the engineered barrier systems (EBS) includes a discussion of the overall purpose and function of the EBS and how the EBS fulfills the requirements of 10 CFR 60.

6. Opening Statement: None.

7. Main Body Outline:

   - EBS purpose, function, description and evaluation (Reference 5.1).

   - How the EBS fulfills 10 CFR 60 requirements (Reference 5.2).

8. Conclusion: See Item 5 (above) and Section 5.2.

9. Support Authors & Their Assignments:

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title:

Lead Author & Phone No.

A. Figure/Table No.

Caption/Title:

Content:

B. Figure/Table No.

Caption/Title:

Content:

C. Figure/Table No.

Caption/Title:

Content:

MGDS Annotated Outline Planning Package Date: 9/30/92
Form 3: References

Section No. & Title:

Lead Author & Phone No.

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

1.

2.

3.

4.

5.

6.

7.

8.

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number:
2. Section no. & title: **5.0 ENGINEERED BARRIER SYSTEMS**
3. Lead author & phone no: **Hugh Benton (702) 794-1891**
4. Information request date:
5. Work location:
6. Type of information needed:
7. What is the information needed for?
8. What group is the probable information supplier?
9. When is the information needed?
10. What kind of related information is already available in references, etc.?

---

11. Response by (name):
12. Response date:
13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form B: Information Response

1. Section No. & Title:

2. Person Supplying Information:

3. Phone No.:

4. Lead Author (Requester): Hugh Benton 702-794-1871

   Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log Number on this form should be identical to the Log Number of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

The above Annotated Outline text is guidance that may be used for the future development of an MGDS License Application.

MGDS Annotated Outline Information Need Form
Form C: Information Request Tracking Log

Date: 9/30/92

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log. No.	Section	Date Issued	Date Response Received

MGDS Annotated Outline

Section 5.1 Description of the Engineered Barrier Systems

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5.1 DESCRIPTION OF THE ENGINEERED BARRIER SYSTEMS

5.1.1 Waste Package Design Description

5.1.1.1 Waste Package Design

5.1.1.2 Alternative Design

5.1.1.3 Comparative Evaluation of Alternative Waste Package Designs

The comparative evaluation of waste package designs involves the complete list of performance requirements including:

- Fabricability
- Handling
- Closure
- Inspection
- Emplacement
- Retrievability
- Criticality
- Containment
- Isolation
- Reliability
- Performance confirmation.

[The evaluation of substantially complete containment (SCC) (Issue 1.4) and radionuclide release from the EBS (Issue 1.5) will be evaluated by performance assessment (PA). Details of the approach will be found in Sections 5.2.2.1 and 5.2.2.2, respectively.] Briefly, PAs are performed to determine whether the reference and alternative designs meet the requirements of SCC and release as defined in 10 CFR 60.113. [The parameter values given in the SCP will be compared with those generated as a result of the test program. The testing program will include all the identified degradation modes, and the assessments will include a range of environmental scenarios. This will permit the calculation of the number of early failures, the number of failures during the containment period, and the release of radionuclides from the EBS. The margin of uncertainty will also be evaluated.]

[The results will be compared to the performance objectives for SCC and release to determine if they have been met with sufficient confidence such that the NRC can make a finding of reasonable assurance, that radioactive materials can be disposed in the repository without unreasonable risk to the health and safety of the public.]

It will be necessary to determine whether the final reference and alternative designs will meet the NRC requirements with sufficient margin. The selection of the license application design will depend on other factors such as cost of the entire waste package container fabrication and emplacement system, the maturity of the technology, and hence the schedule its use would require, the degree of risk entailed with the option, and other technical or programmatic considerations.]

5.1.2 Waste Forms Characteristics and Acceptance

Waste forms to be received and packaged for disposal will include both unreprocessed spent fuel from commercial power reactors, and canisters of solidified high-level wastes from commercial and defense fuel reprocessing operations. These waste forms are specified in the DOE Code of Federal Regulation, 10CFR 961 (Reference). The commercial high-level waste will be received from the West Valley Demonstration Project in New York (WVDP). High-level wastes from the defense program activities at Savannah River, Hanford, and Idaho may also be disposed of in the repository. Characteristics of the waste from the Defense Waste Processing Facility (DWPF) at the Savannah River Plant have been established. Development of defense high-level waste acceptance documentation is governed by a Memorandum of Agreement (MOA) between DOE/EM and DOE/RW (Reference). [Definitive information is not yet available for defense wastes from the Hanford and Idaho sites.]

5.1.2.1 Waste Forms Descriptions and Sources

Spent Fuel. Spent fuel is enriched uranium oxide, transuranic nuclides, and fission and activation products resulting from operation of commercial light water power reactors (LWR) and the zirconium alloy or stainless steel cladding, which also contains activation products. Intact spent fuel assemblies include many other metallic components, such as end fittings, flow channels, guide tubes, springs, and spacer grids, each of which contain activation products.

Standard spent fuel is defined in 10 CFR Part 961, the Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Wastes, as nuclear fuel with a minimum age of 5 years after discharge from the reactor.

The burnup of LWR fuel is expressed as the fission (thermal) energy released per unit of initial uranium weight loaded into a reactor core. A commonly used unit is megawatt-days per metric ton uranium (MWd/MTU). The build-up of fission products in the fuel is proportional to the energy generated in the reactor. These fission products, and the actinides formed by neutron capture reactions, are the principal sources of radioactivity in spent fuel. Thus the spent fuel burnup, together with the fuel age, determines the radionuclide inventory. Radioactive decay of this inventory produces the thermal energy that must be dissipated in the repository.

Fuel in pressurized water reactor (PWR) and boiling water reactor (BWR) assemblies is presently enriched to approximately 3.2 and 2.6 weight percent fissile U-235, respectively, and is irradiated to achieve burnups of about 33,000 and 27,500 MWd/MTU. As nuclear power plants have matured, the average burnup of spent fuel assemblies has increased toward these values. The evolving economics of the nuclear power industry has produced an incentive to increase enrichments to allow higher burnups. A recent survey of fuel vendors indicated that approximately two-thirds of the present U.S. nuclear power plants have made commitments toward the purchase of fuels with higher enrichments to allow longer fuel residence times in reactor cores, that will result in higher burnups.

For an industry-predicted average PWR fuel burnup of 35,000 MWd/MTU in 2020, a number of cases in excess of the average would occur. If a PWR plant were to discharge a batch of fuel with an average burnup of 42,000 MWd/MTU, a small number of assemblies would be expected to be as high as 60,000 MWd/MTU.

High-Level Waste Glass. High-level radioactive wastes from the DWPF at Savannah River and the West Valley Demonstration Project (WVDP) will be received in solidified form. The radionuclides will be immobilized in a borosilicate glass matrix contained in 304L stainless steel pour canisters. Because of concerns that thermal cycles associated with the glass pouring operation will result in the pour canisters being highly stressed, pour canisters will not be used as the primary barrier to meet the containment performance objective.

5.1.2.2 Quantity of HLW to be Emplaced

Spent Fuel. [A summary of the quantities of spent fuel expected to be received at the repository will be shown in Table 5.1A [HB1]. After the repository startup phase, a receipt rate of 3,000 MTU per year is anticipated. The spent fuel will be packaged and emplaced as soon as possible after receipt. Table 5.1B [HB2] will give a tabulation of the anticipated burnup distribution and age at repository receipt of spent fuel as a function of time from 2010 to 2032.]

High-Level Waste Glass. Delivery of high-level waste glass to the repository is scheduled to begin approximately 5-6 years after repository start-up. [A summary of the quantities of HLW Glass expected to be received at the repository will be given in Table 5.1C [HB3]]. The HLW glass canisters will be packaged and emplaced as soon as possible after receipt. After the repository startup phase, a receipt rate of 400MTU/yr or 800 glass canisters per year is anticipated.

5.1.2.3 Waste Form Characteristics

Spent Fuel. [Table 5.1D [HB-4] will present typical chemical, thermal, and radiological characteristics of 5, 10, 15 and 20 year old spent fuel to be received at the repository. There is a wide variation of PWR and BWR fuel rod and fuel assembly dimensions, and these limits will be depicted in Table 5.1E [HB-5].]

High-Level Waste Glass. [Table 5.1F [HB-6] will present typical characteristics of DWPF HLW glass to be received at the repository.] The pour canisters are 61 cm in diameter, 3.0 m long and nominally 1 cm thick 304L stainless steel, and are essentially identical for both WVDP and DWPF glass.

5.1.2.4 Waste Form Acceptance and Handling

Spent Fuel. Spent fuel may be received at the repository either as intact assemblies or canisters of fuel rods that may or may not have been consolidated at the reactors or other facilities. Intact assemblies include many other metallic components such as end fittings, flow channels, guide tubes, springs, and spacer grids. These non-fuel hardware components will also be packaged for repository disposal. The standard contract specifies that the oldest fuel will have the highest priority ranking for acceptance by DOE. During the early years of the repository receiving and emplacement period, the average spent fuel age will be greater than 10 years. This average age will steadily decline and will be reduced to the five year minimum during the last several years of operation. The waste package and repository designs must be capable of receiving and disposing standard spent fuel on a routine basis. Fuel cooled less than five years will remain in the storage system.

The utilities with the oldest spent fuel will be given the highest priority rankings for delivery of fuel to DOE. The utilities will then recommend whatever fuel they want for delivery, subject to DOE approval. This could be fuel of high burnup, freshly discharged. It could mean that the utilities recommend later delivery of their spent fuel in dry storage. The implication is that the repository may be in a position of receiving older, lower burnup spent fuel during the later years of operation.

Spent fuel may be received at the repository in at least three forms. The majority will be in the form of intact assemblies that contain undamaged fuel rods. Some of these fuel rods may have minor cladding breach defects, but would not be structurally damaged to the extent that the fuel is not safely contained. The second form is fuel that has been preconsolidated by being disassembled at the reactors or other facilities, with the rods packaged in canisters whose dimensions approximate those of an intact assembly. The reference consolidation factor is 2:1 (i.e., a canister contains the fuel rods from two fuel assemblies). [No reference form for the configuration of nonfuel hardware resulting from these preconsolidation operations has been established. Hence, no provisions have been made for this material in the conceptual designs for either the waste package or repository surface facilities.] The third form in which spent fuel is expected to be received is "failed fuel" that has been structurally damaged to the extent that the fuel assemblies must be placed in a canister to contain the particulate fuel materials during handling and shipment from the reactor. The 10 CFR 961 requires that "non-standard" spent nuclear fuel be treated as "failed fuel". [No reference dimensions have been established for this category, but it is assumed that the canisters will be only slightly larger than the assemblies they contain.]

The reference form for disposal of spent fuel is fuel rods that are removed from intact assemblies and consolidated at the repository. The option of disposing of intact spent fuel assemblies as they are received is retained in the reference design because it may not be possible to consolidate assemblies that are received at the repository in a damaged or failed condition. In addition, current planning envisages loading fuel with very high burnup and short cooling times into containers as intact assemblies in quantities dictated by the waste form temperature limitations.

5.1.3 Underground Facility Design Description

5.1.4 Engineered Barrier System Emplacement Environment

[Characterization of the engineered barrier system environment, after waste emplacement, must be developed to help demonstrate compliance with PA goals and to provide the information necessary to carry out materials and design tests. The following subsections will describe the

Yucca Mountain site conditions as they exist now at the potential waste emplacement horizon and as they would be modified as a result of waste package emplacement.]

Pre-Emplacement Site Conditions. The Yucca Mountain Site Characterization Project has selected the Topopah Spring Member of the Paintbrush Tuff as the recommended repository horizon for a potential repository of high-level nuclear waste at Yucca Mountain. The investigations that led to this selection are discussed in the unit evaluation report (Johnstone et al, 1984). The recommended horizon is the welded, devitrified section of Topopah Spring tuff that lies above the basal vitrophyre of the unit. The choice of the unsaturated zone as the location for the reference repository horizon marks a departure from the conventional environment that has been considered for repository siting. [The pre-emplacement site conditions will be discussed in detail in Section 3.1 of the potential License Application, Description of Individual Systems and Characteristics of the Site.]

Post-Emplacement Environment. Construction of a repository and the emplacement of heat and radiation generating waste in the repository would cause changes in the physical and chemical characteristics of the environment. [A thorough understanding of the changes in the environment that would occur with time as affected by the repository construction and waste emplacement needs to be developed.] The effects that can be expected from development of the repository and emplacement of the waste packages are: 1) physical changes in the rock unit due to mining activities, 2) changes in the physical and chemical properties of the rock and vadose water due to the waste-related radiation field, 3) changes in the chemical properties of the water due to manmade materials, 4) heat-induced mechanical effects, 5) modification of moisture conditions due to mining ventilation, and 6) modification of the ambient rock/water system, and hydrodynamic regime due to the thermal load generated by the waste packages.

Stability of Emplacement Openings. Stability of emplacement openings is of concern during construction, after emplacement, but before closure when the option to retrieve the waste package must be maintained; and for the 1,000 year period after closure when substantially complete containment must be achieved.

[Emplacement opening thermomechanical analyses must be conducted to establish the potential for loading of waste packages.] Loading of packages due to thermomechanical forces could result from either failure of intact rock (matrix) or by movement of rocks along preexisting discontinuity planes. The analyses show that ____.

The primary effect of temperature changes on the near field rock will be a change in rock volume due to isobaric thermal expansion. Except for quartz and cristobalite, the isobaric thermal expansion of most silicate minerals, on average, is 3x10-5/K (Helgeson et al, 1978). The maximum rock temperature attained by the near field environment, based on the analyses described below, results in a total volume change of about ______ percent using the average thermal expansion value.

Cristobalite, which is present in the near field rock, undergoes a structural transition from tetragonal (alpha-cristobalite) to cubic (beta-cristobalite) symmetry. This phase transition results in a volume increase of about five percent (Helgeson et al., 1978). The temperature at which this phase transition occurs has been measured for naturally occurring cristobalite at Yucca Mountain (Wolfsberg and Vaniman, 1984), and has been found to be 225 +/- 25 C.

The alpha-to-beta cristobalite transition temperature falls within the temperature range expected for the very near field rock. The effect of the associated volume change on waste package loading is ____.

Anticipated Thermal History and Effects. The waste package design will accommodate a thermal loading of __________ for spent fuel and will generate ____________ when loaded with processed high-level waste in the form of borosilicate glass. [Figure 5.1A will show a typical thermal history for the reference spent fuel waste package and its immediate surroundings.] For an unventilated emplacement drift, the rock at the emplacement opening would reach a maximum temperature of ______ at ____ years after package emplacement. Due to edge effects, waste package environments along the perimeter of a repository will have a thermal history different from that depicted in Figure 5.1A.

At the elevation of the repository horizon, the unconfined boiling point of pure water is approximately 96C. Differences in flow paths and residence time have contributed to varying pore water compositions at Yucca Mountain. Although concentration of the solute species will occur during boiling and evaporation, elevation of the boiling point is less than 1C (DePoorter, 1986; Montana, 1986), for solutions that are as much as 100 times more concentrated than the reference ground waters (Wells J-13, H-3, P-1, and Yang's pore water extracts). Expected geochemical reaction paths during evaporation, boiling, and condensation of reference waters have been determined by ____________ to assess their corrosive potential, and to determine limiting solubilities of waste components. It has been shown that ________________.

Vaporization of unconfined and unbound pore fluid can therefore be assumed to be complete at approximately 97C. This phenomenon will result in the development of a dehydration zone around the waste package, the width and duration of which will depend on the migration behavior of the boiling point isotherm. [The thermal profile history that will be presented in Figure 5.1.4-1 suggests that the rock will be at temperatures in excess of the boiling point, and therefore dehydrated, for at least ______ years. The effect of large scale heterogeneities that could provide liquid pathways from zones of fluid accumulation back to the repository will be evaluated, and ___________.] The role of such heterogeneities as gas pathways has been shown to be ___________.

Radiation Field Effects. The types of ionizing radiation that interact with the rock/water/vapor system will be neutron and gamma radiation; alpha and beta radiation will not penetrate the intact waste container. The absorbed dose from gamma radiation will dominate over that from neutron radiation by more than four orders of magnitude (Van Konynenburg, 1984). The total radiation field at the container outer surface will be less than __________ rads/hour. The gamma radiation is expected to result in negligible damage to silicate rock (Durham et al., 1985). Less than three percent of the total thermal energy released by the waste package will be deposited in the host rock by gamma radiation (Van Konynenburg, 1984).

The waste package has been designed to prevent significant gamma radiolysis effects on the environment at the outer surface of the containment barrier(s). [Experimental and numerical analysis work must be performed to demonstrate that the gamma radiolysis effects will be negligible.] This work shows that ____.

Water Flow in the Vicinity of Waste Packages. Modeling of the effect of the thermal perturbation on local hydrologic transport must demonstrate that _______________. [Experimental studies and numerical analyses must be conducted to determine the extent to which liquid-vapor cycling phenomena will occur in a natural system, and the effect of this behavior on near field water chemistry.] It has been shown that ______________________.

Water transport within the repository horizon occurs by a combination of vapor transport, water migration through the matrix, and fracture flow (Montazer and Wilson, 1984). The relative importance of each flow mechanism is a function of the bulk saturation, flux of water through the rock, temperature gradients, fracture network characteristics, and matrix permeability. [It has been established that the fracture density within this lower nonlithophysal zone varies between ____ and ____ fractures per cubic meter, with a mean matrix porosity of ____ percent and a mean saturation of ____ percent.]

[The net flux of water through the repository has been determined to be _____ mm/year in the upward direction, although a downward flux of ______ to ______ mm/year occurs as matrix flow and _____ to _____ mm/year as fracture flow. The current matrix potential of the Topopah Spring tuff is approximately _____ kPa which results in __________ fracture flow except during episodic "flooding" events. This conclusion is based on the assumption of a fracture-matrix equilibrium, that has been shown to exist except __________.]

[Because water enhances the corrosion of metal barriers and is the main agent for the transport of radionuclides, experimental and numerical modeling studies must be conducted to characterize fluid flow and the geochemistry of water/rock interactions in the Topopah Spring tuff. The effects of manmade materials on the ground water chemistry will be determined also.] These studies have shown that ________________________________.

5.1.5 Underground Operations Radiation Protection

5.1.5.1 Direct Exposure

5.1.5.2 Effluent Release and Contamination

[During pre-closure of the MGDS, exposure of personnel to radiation will be governed by the Code of Federal Regulations 10 CFR 20. The exposure of personnel will be minimized and will follow the ALARA principle. Detailed operational procedures governing all aspects of exposure of personnel to radiation will be developed, promulgated and enforced.]

Table 5.1A. Summary of Quantity of Spent Fuel Receipt at Repository

Table 5.1B. Anticipated Burn-up Distribution/Age at Repository/2010-2032

Table 5.1C. Summaries of The Quantities of HLW Glass Expected to be Received at the Repository

Table 5.1D. Characteristics of 5 and 10 Year Old Spent Fuel at Repository

Table 5.1E. Variation Between PWR/BWR Fuel Rod and Assembly Dimensions

Table 5.1F. Typical Characteristics of DWPF HLW Glass Received at the Repository

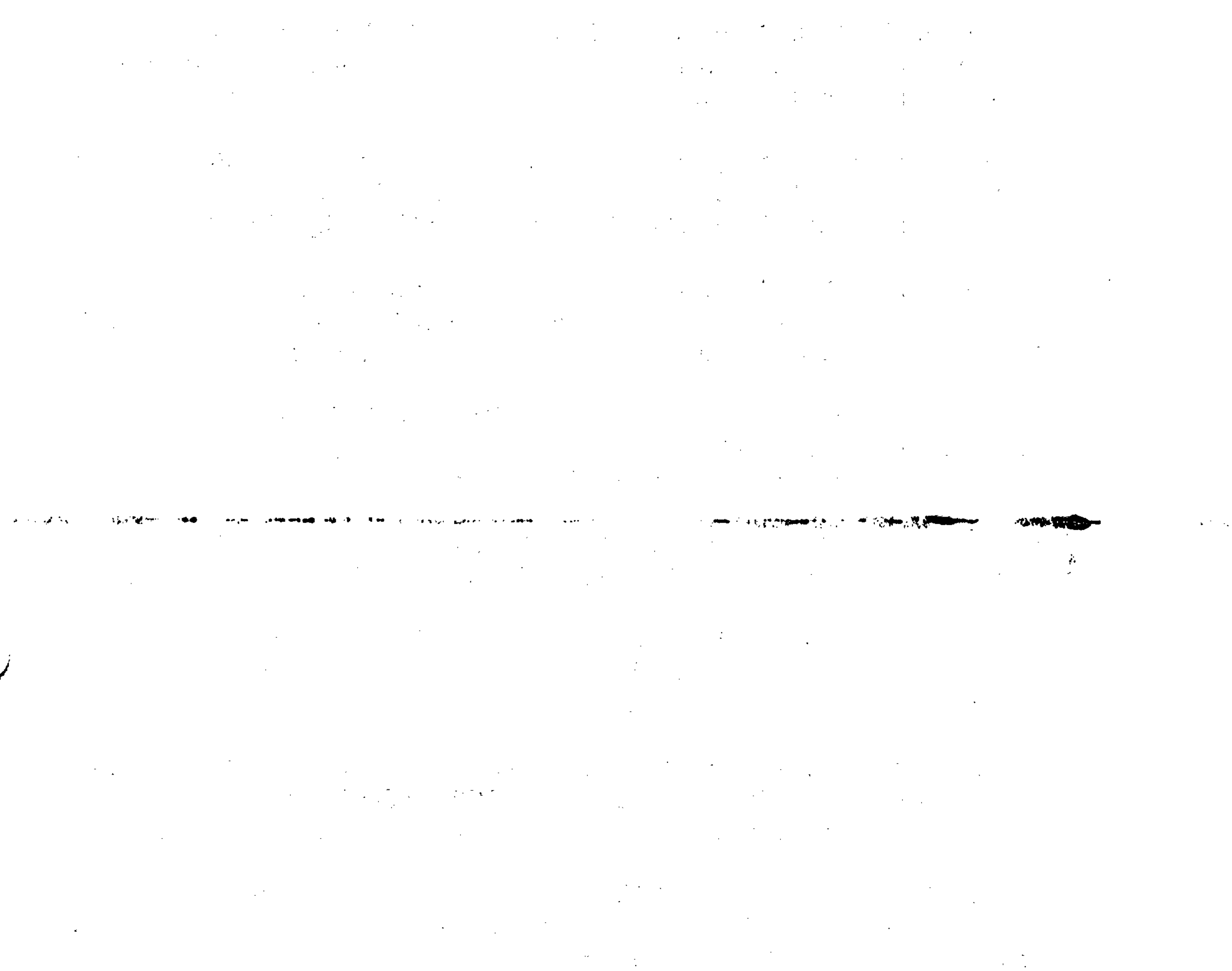

Figure 5.1A. Typical Thermal History - Spent Fuel Waste Package and Surroundings

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5.1A Johnstone, J. K., R. R. Peters, and P. F. Gnirk, 1984. Unit Evaluation at Yucca Mountain, Nevada Test Site: Summary Report and Recommendation, SAND83-0372, Sandia National Laboratories, Albuquerque, N. Mexico.

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5.1C Wolfsberg, K., and D. T. Vaniman, (Comps.), 1984. Research and Development Related to the Nevada Nuclear Waste Storage Investigations, October 1 -- December 31, 1983, LA-10032-PR, Los Alamos National Laboratory, Los Alamos, N. Mex.

5.1D DePoorter, G. L., 1986. Letter from G. L. DePoorter (LANL) to M. D. Valentine (DOE/NV), TWS-ES-NP/01-86-28, January 17, 1986; regarding adjustment for correct mole fraction by dividing solute concentration by 55.5.

5.1E Montan, D. N., 1986. Memorandum from D. N. Montan (LLNL) to L. B. Ballou (LLNL), May 9, 1986; regarding the boiling point of water - theme and variations.

5.1F Van Konynenburg, R. A., 1984. Radiation Doses in Granite Around Emplacement Holes in the Spent Fuel Test -- Climax (Final Report), UCRL-53580, Lawrence Livermore National Laboratory, Livermore, Calif.

5.1G Durham, W. B., J. M. Beiriger, M. Axelrod, and S. Trettenero, 1985. The Effect of Gamma Irradiation on the Strength and Elasticity of Climax Stock and Westerly Granites, UCRL-92526, preprint, Lawrence Livermore National Laboratory, Livermore, Calif.

5.1H Montazer, P., and W. E. Wilson, 1984. Conceptual Hydrologic Model of Flow in the Unsaturated Zone, Yucca Mountain, Nevada, USGS-WRI-84-4345, Water-Resources Investigations Report, U.S. Geological Survey.

1. Section No. & Title: 5.1 DESCRIPTION OF THE ENGINEERED BARRIER SYSTEMS

2. Lead Author & Phone No. Hugh Benton (702) 794-1891

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
   (Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   This section will provide a description of the EBS and components as well as their intended functions and relations in the overall repository design. The section will identify structures, systems, and components of the EBS, and it will indicate whether or not they have been classified as important to safety, retrievability, or isolation.

6. Opening Statement: None.

   The purpose of this section is to determine whether the EBS, consisting of multiple barriers, will ensure isolation of the high-level nuclear waste in accordance with applicable federal regulatory requirements.

7. Main Body Outline:

5.1 DESCRIPTION OF THE ENGINEERED BARRIER SYSTEMS

5.1.1 Waste package Design Description

5.1.1.1 Waste Package Design

- Waste Package Component Descriptions
  - Waste Form
  - Filler/structural framework
  - Shielding
  - Containers (include any coatings)
  - Packing/Absorbent Materials

7. Main Body Outline (Continued)

- Liners
- Material specification and any applicable manufacturing details; functions and performance allocation will be included with description of respective components.

  [Note that closure/seals are not separated, but are included with each component as appropriate.]

- Waste Package Fabrication/Assembly Description

5.1.1.2 Alternative Design

Same outline as above.

5.1.1.3 Comparative Evaluation of Alternative Waste Package Designs

- Evaluations of substantially complete containment (Issue 1.4)
- Evaluations of effect on radionuclide release from EBS (Issue 1.5)
- Cost and schedule evaluations.

5.1.2 Waste Form Characteristics And Acceptance

[Cross reference to other discussions of the same subject. If they are not responsive to the FCRG, then use the outline below.]

5.1.2.1 Waste Forms Descriptions and Sources

- Spent Fuel
- Glass HLW.

5.1.2.2 Quantity of HLW to be Emplaced

- Spent Fuel
- Glass HLW
- Emplacement Schedule.

5.1.2.3 Waste Form Characteristics

- Spent Fuel

  - Physical

7. Main Body Outline (Continued)

- Chemical
- Thermal
- Radiological

• Glass HLW

- Physical
- Chemical
- Thermal
- Radiological

5.1.2.4 Waste Form Acceptance and Handling

Waste form acceptance procedures and activities are described. Any special waste form handling, consolidation and/or canisterization will be described.

5.1.3 Underground Facility Design Description

[Expect cross reference to 4.1.3.]

• General description

- Waste Emplacement Areas
- Panels
- Emplacement drifts
- Boreholes

• Descriptions of portions of the underground facility that are part of the EBS

- Provisions for retrieval

• Backfill materials

- Particle size distributions
- Physical and chemical characteristics with time, mechanical, thermal, and thermomechancical properties.

• Emplacement machinery
• Capability for retrieval or removal

7. Main Body Outline (Continued)

5.1.4 Engineered Barrier System Emplacement Environment

- Pre-emplacement site conditions
  - Ambient temperature
  - Mechanical, physical, and chemical properties of the host rock
  - Geology of the site
    - Faultic information
    - Seismic information
- Post-emplacement environment
  - Changes in emplacement environment caused by construction of the repository and emplacement of wastes surrounded by backfill
  - Expected post closure temperature profile with time of the backfill or packing around waste packages
  - Characteristics of the ground water at the outermost boundary of the waste package compared with that of the interface of the backfill or packing and the next package component.

5.1.5 Underground Operations Radiation Protection

[Cross reference as appropriate to Chapter 4.]

5.1.5.1 Direct Exposure

- Remote handling - description of system for
- Biological shielding - describe measures

5.1.5.2 Effluent Release and Contamination

- Worker Safety Measures
  - Measures to be taken to maintain the radiological safety of workers in the underground facility during:
    - Handling
    - Storage
    - Retrieval
    - Emplacement
    - Isolation

7. Main Body Outline (Continued)

- Address the above for:

  - Normal operations
  - Anticipated operation occurrences
  - Accident conditions
  - Evaluation of Radiation Exposure Potential to Workers

- Physical and chemical properties of any radioactive and hazardous effluent expected to be discharged into the underground facility as a result of any operational occurrences and accident conditions.

- Evaluation of Radiation Exposure Potential

  - Characteristics of any effluent that could be released from the underground facility that result in a projected radiation exposure to members of the public or to workers in the surface facility. For each effluent, this section provides an estimate of the dose to the public and to workers.

5.1.5.3 Monitoring

- Detection - description of system for
- Remediation - measures for
- Records - maintenance and analysis of

8. Conclusion:

See Item 5.2, Item 8.

9. Support Authors & Their Assignments:

Paul McKie, Underground Facility (5.1.3)
Tom Statton (5.1.4, Pre-emplacement portion)
M. Foitsch (5.1.5)

Section No. & Title: 5.1 DESCRIPTION OF THE ENGINEERED BARRIER SYSTEMS

Lead Author & Phone No. Hugh Benton (702) 794-1891

A. Figure No. 5.1A

Title: Summary of Quantity of Spent Fuel Receipt at Repository

Content: This table contains a summary of the quantities of spent fuel expected to be received at the repository.

B. Table No. 5.1B

Title: Anticipated Burn-up Distribution/Age at Repository/2010-2032

Content: This table contains a tabulation of the anticipated burn-up distribution and age of spent fuel at the repository as a function of time between 2010 and 2032.

C. Table No. 5.1C

Title: Summaries of the Quantities of HLW Glass Expected to be Received at the Repository

Content: This table provides a description of the quantities of HLW glass expected to be received at the repository.

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 5.1 **DESCRIPTION OF THE ENGINEERED BARRIER SYSTEMS**

Lead Author & Phone No. Hugh Benton (702) 794-1891

A. Table No. **5.1D**

Title: **Characteristics of 5 and 10 Year Old Spent Fuel at Repository**

Content: This table represents the typical characteristics of 5 and 10 year old spent fuel to be received at the repository.

	Characteristics			
Waste Form	Physical	Chemical	Thermal	Radiological

B. Table No. **5.1E**

Title: **Variation Between PWR/BWR Fuel Rod and Assembly Dimensions**

Content: This table presents PWR and BWR fuel rod and fuel assembly dimensional limits.

C. Table No. **5.1F**

Title: **Typical Characteristics of DWPF HLW Glass Received at the Repository**

Content: This table presents the typical characteristics of the DWPF HLW glass to be received at the repository.

	Characteristics			
Waste Form	Physical	Chemical	Thermal	Radiological

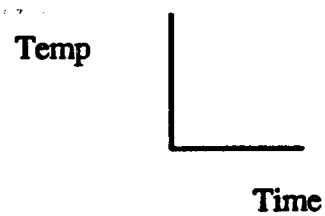
Section No. & Title: **5.1 DESCRIPTION OF THE ENGINEERED BARRIER SYSTEMS**

Lead Author & Phone No. Hugh Benton (702) 794-1891

A. Figure No. **5.1A**

Caption: **Typical Thermal History - Spent Fuel Waste Package and Surroundings**

Content: This figure depicts the temperature history of a typical reference spent fuel waste package, its components and the surrounding environment. The temperature will be plotted as a function of time for 10,000 years.



11

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title: 5.1 DESCRIPTION OF THE ENGINEERED BARRIER SYSTEMS

Lead Author & Phone No. Hugh Benton (702) 794-1891

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

1. Johnstone, J. K., R. R. Peters, and P. F. Gnirk, 1984. Unit Evaluation at Yucca Mountain, Nevada Test Site: Summary Report and Recommendation, SAND83-0372, Sandia National Laboratories, Albuquerque, N. Mexico.

2. Helgeson, H. C., J. M. Delany, H. W. Nesbitt, and D. K. Bird, 1978. "Summary and Critique of the Thermodynamic Properties of Rock-Forming Mineral," American Journal of Science, Vol. 278-A, Kline Geology Laboratory, Yale University, New Haven, Conn.

3. Wolfsberg, K., and D. T. Vaniman, (Comps.), 1984. Research and Development Related to the Nevada Nuclear Waste Storage Investigations, October 1 -- December 31, 1983, LA-10032-PR, Los Alamos National Laboratory, Los Alamos, N. Mex.

4. DePoorter, G. L., 1986. Letter from G. L. DePoorter (LANL) to M. D. Valentine (DOE/NV), TWS-ES-NP/01-86-28, January 17, 1986; regarding adjustment for correct mole fraction by dividing solute concentration by 55.5.

5. Montan, D. N., 1986. Memorandum from D. N. Montan (LLNL) to L. B. Ballou (LLNL), May 9, 1986; regarding the boiling point of water - theme and variations.

6. Van Konynenburg, R. A., 1984. Radiation Doses in Granite Around Emplacement Holes in the Spent Fuel Test -- Climax (Final Report), UCRL-53580, Lawrence Livermore National Laboratory, Livermore, Calif.

7. Durham, W. B., J. M. Beiriger, M. Axelrod, and S. Trettenero, 1985. The Effect of Gamma Irradiation on the Strength and Elasticity of Climax Stock and Westerly Granites, UCRL-92526, preprint, Lawrence Livermore National Laboratory, Livermore, Calif.

8. Montazer, P., and W. E. Wilson, 1984. Conceptual Hydrologic Model of Flow in the Unsaturated Zone, Yucca Mountain, Nevada, USGS-WRI-84-4345, Water-Resources Investigations Report, U.S. Geological Survey.

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: HB-1

2. Section no. & title: 5.1 DESCRIPTION OF THE ENGINEERED BARRIER SYSTEMS

3. Lead author & phone no: Hugh Benton (702) 794-1891

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Table summarizing the quantities of spent fuel to be received at the MGDS.

7. What is the information needed for?

   Preparation of quantity of HLW to be emplaced Section 5.1.2.2. This will be Table 5.1A.

8. What group is the probable information supplier?

   Systems Analysis Group.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    Oak Ridge is generally a good source of information on this. They have a data base and publications on this subject. ("Characteristics of Potential Repository Wastes," DOE/RW-0184-R1).

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **HB-2**

2. Section no. & title: **5.1 DESCRIPTION OF THE ENGINEERED BARRIER SYSTEMS**

3. Lead author & phone no: **Hugh Benton (702) 794-1891**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Table showing anticipated burn-up distribution/age at repository from 2010 to 2032.

7. What is the information needed for?

   Preparation of quantity of HLW to be emplaced Section 5.1.2.2. This will be Table 5.1B.

8. What group is the probable information supplier?

   Systems Analysis Group.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    Oak Ridge is a good source. ("Characteristics of Potential Repository Wastes," DOE/RW-0184-R1). LLNL has also generated a report ("Waste Forms Characteristics Report," to be issued).

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: HB-3
2. Section no. & title: 5.1 DESCRIPTION OF THE ENGINEERED BARRIER SYSTEMS
3. Lead author & phone no: Hugh Benton (702) 794-1891
4. Information request date: 2/21/92
5. Work location: M&O - Las Vegas
6. Type of information needed:

   Table showing a summary of the quantities of HLW glass expected to be received at the repository.

7. What is the information needed for?

   Preparation of quantity of HLW to be emplaced Section 5.1.2.2. This will be Table 5.1C.

8. What group is the probable information supplier?

   Systems Analysis Group.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    DWPF and WVDP have issued reports ("Waste Form Qualification Report" for DWPF and WVDP, respectively).

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11. Response by (name):
12. Response date:
13. Response:

Il

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: HB-4

2. Section no. & title: 5.1 DESCRIPTION OF THE ENGINEERED BARRIER SYSTEMS

3. Lead author & phone no: Hugh Benton (702) 794-1891

4. Information request date: 2/21/92

5. Work location: M&O - Las Vegas

6. Type of information needed:

   Table showing typical characteristics of 5, 10, 15 and 20 year old spent fuel to be received at the repository.

7. What is the information needed for?

   Preparation of Waste Form Characteristics, Section 5.1.2.3. This will be Figure 5.1D.

8. What group is the probable information supplier?

   Systems Analysis Group.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    Oak Ridge SF Data Base. ("Characteristics of Potential Repository Wastes," DOE/RW-0184-R1). LLNL has also generated a report ("Waste Forms Characteristics Report," to be issued).

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11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number: **HB-5**

2. Section no. & title: **5.1 DESCRIPTION OF THE ENGINEERED BARRIER SYSTEMS**

3. Lead author & phone no: **Hugh Benton (702) 794-1891**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Table showing variation between PWR/BWR fuel rod and assembly dimensions.

7. What is the information needed for?

   Preparation of Waste Form Characteristics, Section 5.1.2.3. This will be Figure 5.1E.

8. What group is the probable information supplier?

   Systems Analysis Group.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    Oak Ridge Data Base. ("Characteristics of Potential Repository Wastes," DOE/RW-0184-R1). LLNL has also generated a report ("Waste Forms Characteristics Report," to be issued).

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form A: Information Request

1. Log number: **HB-6**

2. Section no. & title: **5.1 DESCRIPTION OF THE ENGINEERED BARRIER SYSTEMS**

3. Lead author & phone no: **Hugh Benton (702) 794-1891**

4. Information request date: **2/21/92**

5. Work location: **M&O - Las Vegas**

6. Type of information needed:

   Table showing typical characteristics of DWPF HLW glass to be received at the repository.

7. What is the information needed for?

   Preparation of Waste Form Characteristics, Section 5.1.2.3. This will be Figure 5.1F.

8. What group is the probable information supplier?

   Systems Analysis Group.

9. When is the information needed?

   TBD.

10. What kind of related information is already available in references, etc.?

    DWPF Project. ("Characteristics of Potential Repository Wastes," DOE/RW-0184-R1). ("Waste Forms Characteristics Report," to be issued).

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form B: Information Response

1. Section No. & Title: **5.1 DESCRIPTION OF THE ENGINEERED BARRIER SYSTEMS**

2. Person Supplying Information: Hugh Benton (702) 794-1891

3. Phone No.:

4. Lead Author (Requester):

   Instructions: Information suppliers may use this form to communicate information which has been requested by lead authors via Information Request Forms. The Log Number on this form should be identical to the Log Number of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form C: Information Request Tracking Log

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received

MGDS Annotated Outline

Section 5.2 Engineered Barrier System Compliance with 10 CFR 60

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5.2.1.2 Waste Forms

5.2.1.3 Underground Facility Design Criteria

5.2.2 EBS Compliance with 10 CFR 60 Performance Objectives

Assuming anticipated processes and events, the two post-closure objectives in 10 CFR 60.113 require: 1) substantially complete containment within the waste packages for up to 1000 years (containment), and 2) following the containment period, control of the release of any radionuclide from the EBS to less than 1 part in 100,000 per year of its 1000 year inventory (controlled release). By reference, the period of controlled release is extended to 10,000 years via 40 CFR Part 191. Although the containment period "shall not be less than 300 nor more than 1000 years after permanent closure", as per 10 CFR 60.113, 1000 years has been chosen by DOE for design purposes. [The DOE will design the waste packages to provide total containment during the containment period under the full range of anticipated repository conditions, recognizing technological limitations and residual uncertainties. Use will be made of a robust, multi-barrier package that will be tolerant to the full range of repository conditions.]

Other regulatory requirements in addition to those in 10 CFR 60.113 affect the waste package design, including requirements for retrievability, criticality control, consideration of alternative designs, a performance confirmation program, and specific waste package design criteria. [Each of these requirements will be considered in the design and performance assessment (PA) activities.]

Compliance with the criteria for both the reference and alternative designs must be determined by PA. PA is defined as the analysis that predicts the behavior of a system or system component under a given set of conditions. [The assessment will compare the actual performance measures with those predicted by the subsystem level or total system level computational model. These performance measures will be based on the allocation of performance to each of the barriers and the performance parameter goals previously established. PA will provide suggested changes to these values and, therefore, interfaces with both the design and testing efforts. Both qualitative and quantitative sensitivity and uncertainty analyses must be performed to show that compliance has been achieved with sufficient margin.]

[If the design did not meet the regulatory requirements with sufficient margin, the available actions would be assessed. This would include modifying performance allocations, as well as re-examining those barriers for which no allocation was taken previously. For example:

- Internal canisters
- Modifying the design
- Considering the interpretation of regulatory terms and the regulations themselves.]

5.2.2.1 Containment Performance Objective

[Performance assessments will be performed by the PA staff to determine whether the reference and alternate designs meet the requirements of SCC as defined in 10 CFR 60.113 (a) (ii) (A). The parameter values given in the SCP will be compared with those generated as a result of the test program. Depending on the material, these tests will include general corrosion and low-temperature oxidation, mechanical degradation, mechanical toughness under repository conditions, metallurgical stability, galvanic effects, stress corrosion cracking, and localized corrosion. The fabrication history of the prototype containers and the various barriers will be reviewed to confirm that the specifications have been met. Particular attention will be paid to the non-destructive examination of closures.]

[The assessments will use individual mechanistic waste package degradation codes to be developed by the Waste Package Development staff that will be incorporated into an overall waste package performance code. The assessments will include a range of environmental scenarios. This will permit the calculation of the number of failures during the containment period, as well as the potential for early failures. Both qualitative and quantitative sensitivity, and uncertainty analyses will be performed to show whether compliance has been achieved with sufficient margin. The result will be compared to the performance objective for SCC to determine whether it has been met with sufficient confidence that the NRC will find that compliance has been achieved with reasonable assurance. The potential release of radionuclides as a result of the calculated failures will be evaluated using source terms developed for each scenario by the waste form performance activities.]

5.2.2.2 Release Rate Performance Objective

[Performance assessments will be performed to determine whether the reference and alternate designs meet the requirements of controlled release as defined in 10 CFR 60.113. The assessments will include a range of environmental scenarios. Release will be calculated based on waste package and waste form computational models. The potential release of radionuclides as a result of the calculated failures will be evaluated using source terms developed for each scenario using the waste form performance (source term) data. However, compliance focusses on the release from the EBS and not on the individual waste packages. The computational models will include the diffusional releases from the packages and the EBS based on the most likely groundwater migration processes. These will be integrated over all of the likely processes as a function of time to determine the release from the EBS.]

[The assessment will compare the actual performance measures with those predicted by the subsystem level computational model. These performance measures will be based on the allocation of performance to each of the barriers and the performance parameter goals previously established. Performance assessment will provide suggested changes to these values and therefore, interfaces with both the design and testing efforts. Both qualitative and quantitative sensitivity and uncertainty analyses will be performed to show that compliance has been achieved with sufficient margin. Analyses will also be performed with the alternative design to show whether it provides longer radionuclide isolation.]

5.2.3 Radiation Protection

Skeleton text has not been developed for this subsection.

5.2.X Waste Package/EBS Model Description

[The models to be developed will be placed in the context of an overall model hierarchy. This model hierarchy will provide the vehicle for the WP/EBS PA-determined resolution of SCP Issues 1.4 (Containment) and 1.5 (Release Control). At the base of the hierarchy, and providing the technical basis for the PA calculations, are the submodels which characterize quantitatively the performance parameters or responses of the WP/EBS materials/design in the repository environment. As the model hierarchy proceeds to higher level models the performance parameter submodels may be simplified, but must remain as defensible as at the deterministic/mechanistic submodel level. The test programs described in the SIPs will appear in the model hierarchy as they relate to performance parameter submodels. The testing and modeling activities that will be performed provide the basis for the use and defense of these submodels. In a similar manner, the higher level PA analyses provide feedback for the prioritization of test activities and sensitivity analyses (required for design and performance allocation activities).]

[Performance assessments will determine whether the candidate designs meet the requirements for "substantially complete containment" (SCC) and "controlled release" as defined in 10 CFR 60.113. The parameter values given in the SCP will be compared with those generated as a result of the test program.] The process of performance assessment is an interactive one which means that many loops through the process are performed until a design is achieved that will meet the requirements.

[The approach to model development will follow that given in ASTM C 1174-91 [Ref. 1]. The process calls for the development of mechanistic understanding. If complete mechanistic understanding cannot be obtained, then partial understanding will be sought. Lastly, if neither full nor partial mechanistic understanding is possible, then bounding models will be utilized. Whatever final model is developed, verification and validation will be performed. It is worth noting that total validation in the classic sense is not achievable given the time frame of repository performance. However, partial validation may be possible with the aid of natural analogues, both for the corrosion-allowance waste package materials and the waste forms. Long-term and in-situ testing can also add confidence that the degradation modes are understood.]

5.2.X.1 Container Materials Models

[The development of models for the degradation and breach of the container materials will follow the framework of the model hierarchy discussed above. The goal is to develop a model that incorporates the mechanistic understanding of the degradation and breach processes. The models will be supported by a parallel container materials testing effort. The result will be a mathematical expression that describes the process for each container material. The prediction of degradation will be deterministic and will include the variability of the process. However, the breach of the barrier(s) will be expressed probabilistically to provide the starting points for the initiation of degradation of the inner container and the initiation of the degradation of the waste form and the potential release of radionuclides.]

[If the outer barrier is made from a corrosion-allowance material, the dominant corrosion mode will be uniform oxidation/corrosion. (Localized attack, stress corrosion cracking, and mechanical failure are usually not important for this class of materials.) During the period when the containers are exposed to hot humid air oxidation can take place. The oxidation rate under these atmospheric conditions will be either linear (non-protecting) or parabolic (protecting). The goal of the materials development effort is to select a material for which a protective oxide film would develop and remain intact over time. If protecting, the degradation rate would then decrease with time and the total degradation would follow a power-law function, usually a square root dependence, with time. For linear (non-protecting) corrosion, the degradation rate is linear with time.]

[The inner barrier is likely to be one of the corrosion-resistant materials extensively studied by LLNL that had received high rankings as a result of the application of the selection criteria. These include Alloy 825, Alloy C-4, and titanium Grade 12. The dominant corrosion mechanisms for these materials are likely to be localized attack and stress corrosion cracking. (Mechanical failure and uniform oxidation/corrosion are not important degradation modes for these materials.) Expressions will be developed that describe the degradation of the container by each of the possible mechanisms. These will be combined to obtain the failure rate as a function of time. This will provide the starting point for the initiation of the degradation of the waste form and the potential release of radionuclides.]

[The HLW canister and the spent fuel cladding may also provide a redundant containment barrier. This will depend on ongoing research on these barrier materials, austenitic stainless steel AISI 304L and Zircaloy, respectively. These barriers could provide added confidence that the containment requirements will be met.]

5.2.X.2 Waste Form Models

Models have been developed that describe the long-term dissolution behavior of HLW glass over time. [To this, a model must be added that describes the potential pre-conditioning of the glass surface by hot humid air. The models can be partially validated through the use of natural analogues of other glasses, e.g., basaltic glasses.]

The modeling of spent fuel is much more complicated. Spent fuel is made up of, in addition to the cladding considered under the container materials section, the gap (between the pellet and the cladding), the grain boundary, and the matrix. The gap and grain boundary radionuclide inventory is considered to be readily available for dissolution when contacted by water. The inventory of radionuclides in the gap and grain boundaries, for low gas-release fuel, is about 2% of the total inventory of those species. Low gas-release fuel represents a major fraction of the present inventory. The inventory for higher release fuel is roughly proportional to release.

[The matrix dissolution appears to be congruent for a wide range of fuel types and burnups. The dissolution also appears to be correlated to available surface area. The surface area is a function of the state of oxidation, with greater areas associated with increases in the oxidation state. If the temperature is sufficiently low, the matrix remains in a low (O/M=2.4) state with a structure of U_4O_9. and the surface area does not change much with oxidation. At higher temperature, the oxidation state can increase to U_3O_8 or to UO_3, with a much larger surface area, created by the powdering of the material. Testing will be performed to further evaluate the effect of temperature and time on oxidation, surface area, and dissolution. A model can then be developed that describes the mechanism. The models can be partially validated through the use of natural analogues, e.g., of uraninite in natural reactor systems such as Oklo and Cigar Lake.]

5.2.X.3 Waste Package/EBS Model Descriptions

[The model describing the behavior of the WP/EBS over time makes use of the individual submodels that will be described in Section 5.2.X.2 and 5.2.X.3. To these must be added information about the thermal, mechanical, hydrologic, and geochemical environment of the waste packages as a function of time. The performance of the subsystem will be enhanced by the presence of an engineered backfill material, which is a part of the EBS. This subsystem model for the WP/EBS incorporates the major features of the component submodels noted above. They will then be able to provide distributions of the failure rates of the components and a range of releases form the WP/EBS that can be tested against the requirements of 10 CFR 60.113 for substantially complete containment and controlled release. The possible combination of processes and variables has been reduced to those specific to the Yucca Mountain Project that are described in the SCP.]

[These WP/EBS models will also be used as decision analysis tools for evaluating candidate conceptual designs, examining parametric sensitivity, and participating in evaluation of alternative site characterization strategies. The WP/EBS modules developed through an empirical/deterministic approach provide the basis for developing performance predictions of the WP/EBS in terms of probabilistic distribution functions.]

[The waste package and the waste package environment models will also be used to provide the source terms at the EBS/NBS interface for total system performance. The total system performance assessments will provide an evaluation of how the EBS/NBS performs as a combined system.]

[The verification and validation of the models is an ongoing process. The codes and models are documented in the literature with comparisons of independent modeling efforts. As test data become available and models are upgraded, the verification and validation process is augmented. Because of the complexity in the Yucca Mountain repository system, these models can only be partially validated in the true academic sense. However, long-term and in-situ testing can provide added confidence that the system is behaving as predicted.]

REFERENCES

5.2A "Standard Practice for Prediction of the Long-Term Behavior of Waste Package Materials Including Waste Forms Used in the Geologic Disposal of High-Level Nuclear Waste," American Society of Testing Materials Designation: C 1174-91.

5.2B R.B. Stout and H.R. Leider, Editors, "Preliminary Waste Form Characteristics Report," Version 1, October 1991, Lawrence Livermore National Laboratory.

1. Section No. & Title: 5.2 ENGINEERED BARRIER SYSTEM COMPLIANCE WITH 10 CFR 60

2. Lead Author & Phone No. Paul Childress (702) 794-18242.

3. First Phase Planning Package Due: 6/21/91

   Second Phase Planning Package Due: 10/18/91

   First Phase Skeleton Draft Due: 12/30/91

   Second Phase Skeleton Draft Due: 3/15/92

4. Plan Approved: W.R. Griffin 8/27/91
   (Licensing Mgr & Lead Author)

5. Section Summary (Approximately 100 Words):

   Section 5.2 will provide a description of the EBS design criteria and industry codes and standards used in the EBS design process. Design parameters and goals will be described in relation to the design criteria and how demonstration of satisfying these goals will show compliance with the applicable requirements of 10 CFR 60.

6. Opening Statement

   The purpose of this section is to determine whether the EBS has been designed in accordance with specific criteria, the satisfaction of which will allow the demonstration of compliance with all applicable requirements of 10 CFR 60.

7. Main Body Outline:

5.2 ENGINEERED BARRIER SYSTEM COMPLIANCE WITH 10 CFR 60

5.2.1 EBS Compliance with 10 CFR 60 Design Criteria

An introductory description and discussion of the design criteria for waste package, waste forms, and the underground facility are provided in this section in response to 10 CFR 60.135 and 10 CFR 60.133(h), respectively.

5.2.1.1 Waste Package Design Criteria

The design criteria of 10 CFR 60.135 are discussed in terms of specific requirements imposed on the waste package relative to:

7. Main Body Outline: (Continued)

- Preventing compromise of waste package functions
- Preventing compromise of underground facility performance
- Preventing compromise of geologic setting performance
- Consideration of factors such as radionuclide solubility, corrosion, gas generation, thermal effect, radiolysis, and mechanical strength of containment barriers
- Consideration of explosive, pyrophoric, and chemically reactive materials, free liquids handling and package identification.

Applicable industry codes and standards and design parameters and goals used to meet the design criteria are discussed. A discussion of how these codes, standards, and parameter goals result in compliance with the criteria is provided. To the extent applicable, a description of the modeling and analyses used to demonstrate that the design parameter goals are met is provided along with a thorough discussion of the bases for the models. The variability and uncertainties associated with the databases, models, and analysis results is also described.

5.2.1.2 Waste Forms

The design criteria of 10 CFR 60.135 related to the waste forms are discussed in terms of the specific requirements imposed. These relate to:

- Assurance that the waste form is in the solid form
- Particulate waste form consolidation to limit availability and generation of particulates
- Assurance that the waste will be non-combustible.

Applicable design parameters and goals used to meet the design criteria are discussed. A discussion of how these parameter goals result in compliance with the criteria is provided. To the extent applicable, models and analyses used to demonstrate that parameter goals are met and the bases for the models and analysis are described. The associated variabilities and uncertainties will also be discussed.

7. Main Body Outline: (Continued)

5.2.1.3 Underground Facility Design Criteria

The design criterion for the underground facility that is considered part of the EBS as defined in 10 CFR 60.133(h) is discussed in terms of specific requirements imposed to satisfy this criterion. The criterion is interpreted to apply only to the overall system performance objective after permanent closure (i.e., that the engineered barriers shall be designed to assist the geologic setting in ensuring that releases of radionuclides to the accessible environment following permanent closure conform to the standards established by the Environmental Protection Agency with respect to both anticipated and unanticipated processes and events).

Applicable industry codes and standards and design parameters and goals used to meet this criterion are discussed. A discussion of how these codes, standards, and parameter goals result in compliance with the criterion is provided.

5.2.1.3 Underground Facility Design Criteria (Continued)

To the extent applicable, a description of the models and analyses used to demonstrate that the design parameter goals are met is provided along with a thorough discussion of the bases for the models. Variabilities and uncertainties associated with the data bases, models and analysis results are described.

5.2.2 EBS Compliance with 10 CFR 60 Performance Objectives

An introductory discussion of the meaning and the interpretation of the HLW containment and release rate performance objectives of 10 CFR .113(c) is provided.

The computer codes used to assess EBS performance in terms of the containment and release rate performance objectives is described. The testing and model development efforts used to support the codes are discussed, including techniques used to extrapolate the short term test behavior.

Uncertainties in the test data, models, codes, and code predictions are discussed.

7. Main Body Outline: (Continued)

The allocation of performance functions and performance parameter goals is described. Assumptions of anticipated processes and events are described.

5.2.2.1 Containment Performance Objective

A description of the analyses, prediction, and evaluation of radionuclide containment in terms of the interpreted containment performance objective is provided. The sources of uncertainty in the prediction that apply specifically to containment of radionuclides are addressed. Considerations of the favorable and potentially adverse conditions described in 10 CFR 60.122 are discussed.

5.2.2.2 Release Rate Performance Objective

A description of the analyses, prediction, and evaluation of radionuclide release from the EBS is provided in terms of the interpreted release rate performance objective. The sources of uncertainty in the prediction that apply specifically to radionuclide release after the containment period are addressed.

5.2.2.2 Release Rate Performance Objective (Continued)

Considerations of the favorable and potentially adverse conditions described in 10 CFR 60.122 are discussed.

5.2.3 Radiation Protection

Descriptions are provided for the measures to be taken to maintain radiological safety of the workers in the underground facility during handling, storage, emplacement, potential retrieval and isolation of the waste packages under normal operating conditions, anticipated operational occurrences, and accident conditions. The projected radiation exposures to workers and to members of the public are tabulated for each of the operations and conditions described above until permanent closure.

5.2.X Waste Package/EBS Model Description

[Descriptions of EBS Models will be provided in a new section 5.2.X. It may be appropriate to consider further reorganization of Section 5.0 to Separate Description (5.1), Model Description (5.2), and Compliance (5.3).]

8. Conclusion:

[A statement similar to the following should be made in a potential license application: The engineered barrier system (EBS) has been developed to satisfy the design criteria of 10 CFR 60. Testing, modeling, code development, and performance assessment activities have been used to understand, describe, simulate, and predict the integrated behavior of the EBS. These activities demonstrate that the radionuclide containment and release performance objectives are met with high reliability and confidence.]

9. Support Authors & Their Assignments:

5.2.1.3 Underground Facility - Paul McKie

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 5.2 **EBS COMPLIANCE WITH 10 CFR 60**

Lead Author & Phone No. Paul Childress (702) 794-1824

A. Table No. **5.2A**

Title: **EBS Design Requirements, Parameters, and Goals**

Content: (Reference paragraph 5.2.1.1)

This table will correlate each of the design criteria from 10 CFR 60 with derived design requirements, design parameters, and parameter goals that, if satisfied, would ensure that the criteria are met.

B. Figure No. **5.2A**

Caption: **Evaluation of EBS to Contain Radionuclides**

Content: (Reference paragraph 5.2.2.1)

Plot of a measure of radionuclide containment (measure TBD) versus time.

C. Figure No. **5.2B**

Caption: **Evaluation of EBS to Limit Radionuclide Release**

Content: (Reference paragraph 5.2.2.2)

Plot of a measure of radionuclide release (measure TBD) versus time.

MGDS Annotated Outline Planning Package
Form 2: Figures & Tables

Date: 9/30/92

Section No. & Title: 5.2 EBS COMPLIANCE WITH 10 CFR 60

Lead Author & Phone No. Paul Childress (702) 794-1824

A. Table No. **5.2B**

Title: **Projected Radiation Exposure to Workers and Public**

Content: (Reference paragraph 5.2.3.1)

This table will tabulate the projected radiation exposure to both repository underground facility workers and the general public based on handling, storage, emplacement, potential retrieval, and isolation of waste packages under normal operating conditions, anticipated operational occurrences, and accident conditions.

| B. Table No. **5.2C**

| Title: **Results of Containment Performance Objective Evaluation**

Content:

| This table will compare the calculated containment failure rates with desired values.

| C. Table No. **5.2D**

| Title: **Results of Release Rate Performance Objective Evaluation**

Content:

| This table will compare the calculated release rates for each design option with the allowable
| release limits from 10 CFR 60.113.

MGDS Annotated Outline Planning Package
Form 3: References

Date: 9/30/92

Section No. & Title:

Lead Author & Phone No.

Instructions: List all books, articles, or other references that are expected to be used for the section. Indicate whether references are draft or final, and whether they are publicly available (i.e., published). Refer to the Writer's Guide, Appendix D of the Annotated Outline Management Plan for guidance on formatting reference information.

1.

2.

3.

4.

5.

6.

7.

8.

II

MGDS Annotated Outline Information Need Form
Form A: Information Request

Date: 9/30/92

1. Log number:

2. Section no. & title: **5.2 ENGINEERED BARRIER SYSTEM COMPLIANCE WITH 10 CFR 60**

3. Lead author & phone no: **Paul Childress (702) 794-1824**

4. Information request date:

5. Work location:

6. Type of information needed:

7. What is the information needed for?

8. What group is the probable information supplier?

9. When is the information needed?

10. What kind of related information is already available in references, etc.?

---

11. Response by (name):

12. Response date:

13. Response:

MGDS Annotated Outline Information Need Form
Form B: Information Response

Date: 9/30/92

1. Section No. & Title:
2. Person Supplying Information:
3. Phone No.:
4. Lead Author (Requester): Marshall Weaver (702) 794-1871

   Instructions: Information suppliers may use this form to communicate information that has been requested by lead authors via Information Request Forms. The Log No. on this form should be identical to the Log No. of the Information Request Form.

5. Response by Information Supplier:

Note: Attach additional sheets if necessary.

MGDS Annotated Outline Information Need Form Date: 9/30/92
Form C: Information Request Tracking Log

Note: This is a recommended format for a manual tracking system. Other tracking methods such as a simple computer data base are also acceptable.

Date:

Lead Author:

Log No.	Section	Date Issued	Date Response Received