QA: L

**Civilian Radioactive Waste Management System
Management & Operating Contractor**

Site Electrical System Technical Report

BCBC00000-01717-5705-00003, Rev 00

February 26, 1998

Prepared for:

U.S. Department of Energy
Yucca Mountain Site Characterization Office
P.O. Box 98608
Las Vegas, NV 89193-8608

Prepared by:

TRW Environmental Safety Systems, Inc.
1180 Town Center Drive
Las Vegas, NV 89134

Under Contract Number
DE-AC01-91RW00134

**Civilian Radioactive Waste Management System
Management & Operating Contractor**

**Site Electrical System Technical Report
DI: BCBC00000-01717-5705-00003, Rev 00**

February 26, 1998

Prepared by: R. E. Howell Date: 2/26/98
R. E. Howell
CRWMS M&O, Charlotte

Reviewed by: B. French Date: 02/26/98
B. French
Checker
CRWMS M&O, Las Vegas

J. Leak Date: 2/26/98
J. Leak
Discipline Checker
CRWMS M&O, Las Vegas

Approved by: S. J. Meyers Date: 2-26-98
S. J. Meyers
Department Manager
Repository Surface Design
CRWMS M&O, Las Vegas

CONTENTS

	<u>Page</u>
FIGURES	4
TABLES	5
ACRONYMS AND ABBREVIATIONS	6
1. PURPOSE	7
2. QUALITY ASSURANCE	7
3. METHOD	8
4. DESIGN INPUTS	9
4.1 DESIGN PARAMETERS	9
4.2 CRITERIA	10
4.3 ASSUMPTIONS	12
4.4 CODES AND STANDARDS	15
5. REFERENCES	17
6. USE OF COMPUTER SOFTWARE	18
7. DESIGN ANALYSIS	18
7.1 OVERVIEW	18
7.2 MGDS SITE ELECTRICAL POWER DELIVERY OVERVIEW	18
7.3 ON-SITE DELIVERY (DISTRIBUTION LINES)	26
7.4 MGDS MAIN SUBSTATION	26
7.5 NORTH PORTAL DISTRIBUTION	27
7.6 SHAFT EMPLACEMENT SUBSTATION	32
7.7 SOUTH PORTAL SUBSTATION	33
7.8 SHAFT DEVELOPMENT SUBSTATION	33
8. CONCLUSIONS	33
9. ATTACHMENTS	34

FIGURES

Figure 7-1. MGDS Site Overall Electrical Power Distribution Block Diagram	19
Figure 7-2. MGDS North Portal Electrical Distribution One-Line Diagram	20
Figure 7-3. MGDS Security System Electrical Distribution One-Line Diagram	21
Figure 7-4. MGDS Security Station 3 - Security Lighting One-Line Diagram	22
Figure 7-5. MGDS South Portal Electrical Distribution One-Line Diagram	23
Figure 7-6. MGDS Shaft Development Electrical Distribution One-Line Diagram	24
Figure 7-7. MGDS Shaft Emplacement Electrical Distribution One-Line Diagram	25

TABLES

Table 2-1. MGDS Electrical System Classification Assignment	8
Table 4-1. Class 1E IEEE Standards	13
Table 4-2. Industrial IEEE Standards	13
Table 4-3. WHB and CPB Crane Electrical Loads	14
Table 7-1. North Portal Electrical Loads	28
Table 7-2. Backup Power Sources	32

ACRONYMS AND ABBREVIATIONS

ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CDA	Controlled Design Assumptions Document
CFR	Code of Federal Regulations
CI	Configuration Item
CRWMS	Civilian Radioactive Waste Management System
DOE	U.S. Department of Energy
HLW	High-level (radioactive) Waste
hp	horsepower
IEEE	Institute of Electrical and Electronics Engineers
M & O	Management and Operating Contractor
MGDS	Mined Geologic Disposal System
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NRC	Nuclear Regulatory Commission
NUREG	Nuclear Regulatory Commission publication
OA/FA	oil emersed self cooled/oil emersed forced air cooled
OCRWM	Office of Civilian Radioactive Waste Management
pf	power factor
QA	Quality Assurance
QAP	Quality Assurance Procedure
QARD	Quality Assurance Requirements and Description
RDRD	Repository Design Requirements Document
RPC	Records Processing Center
SDD	System Description Document
SNF	Spent nuclear fuel
SSCs	Systems, Structures, and Components
TBD	To Be Determined
TBV	To Be Verified
VA	Viability Assessment
WHB	Waste Handling Building
wh	warehouse
WTB	Waste Treatment Building

1. PURPOSE

This study has been prepared to provide the initial conceptual design for those support systems and facilities which have not been addressed since the preparation of the Site Characterization Plan Conceptual Design Report (SCP-CDR) (Reference 5.1). The appropriate level of detail was included to provide a credible design concept and to support the preparation of a cost estimate for Viability Assessment (VA).

The purpose of this technical report is to provide the initial conceptual electrical design of the site systems and associated facilities. The objective of this technical report is to identify the design criteria and user needs for the MGDS site electrical power and outline the primary features and capacity of the system.

Site Electrical System will serve both surface and subsurface operations users needs which are used to determine approximate electrical loads for normal, emergency, security, and backup power (see Table 7-2). Facility electrical systems that interface with the site system will not be assessed, but the interfaces will be defined within the report. Single line electrical figures will be provided depicting the major electrical equipment, lighting, user and facility interfaces. Surface and subsurface electrical equipment and distribution will be identified in the design. Basic system features, user loads, and capacity will be summarized.

2. QUALITY ASSURANCE

An activity evaluation has been performed in accordance with QAP-2-0 and has determined that the QA program is applicable to this technical report. The classification of permanent items described in QAP-2-3, *Classification of Permanent Items* has been performed for the *Classification of Preliminary MGDS Repository Design* (Reference 5.2). Therefore, some items addressed in this technical report are to be considered "Q" items, and are subject to the requirements of the OCRWM *Quality Assurance Requirements and Description* (QARD) (Reference 5.3). Therefore, as specified in NLP-3-18, this technical report is documented as being subject to QA controls. Table 2-1 presents the QA classification assignment for the MGDS Site Electrical System. It should be noted that not all SSCs associated with these System Description Documents (SDD) are "Q" items.

Table 2-1. MGDS Electrical System Classification Assignment

SDD Number	System	QA Classification
SU44	Site Electrical Power System	QA-1, QA-5, QA-6
SS06	Subsurface Electrical Distribution System	QA-1, QA-5
SU18	Waste Handling Facility Electrical System	QA-1, QA-5
SU53	Offsite Utilities System	Non-Quality (NQ)

Although the results from this technical report will estimate load requirements and electrical equipment sizing for the Repository, they are considered conceptual level and will not be used directly for procurement, fabrication or construction. Therefore, the formal To Be Verified (TBV) and To Be Determined (TBD) tracking system, described in NLP-3-15 *To Be Verified and To Be Determined Monitoring System*, is not applicable. Any data from this technical report that is used as design input must be treated as unconfirmed (TBV) and tracked per NLP-3-15 prior to inclusion in documents supporting fabrication, procurement, or construction.

3. METHOD

This report was developed by first identifying the areas within the MGDS site that required electrical power and then establishing the electrical loads for each of these locations. The sizing of the transformers for the subsurface (the North Portal, the South Portal, the shaft development area and the shaft emplacement area) were obtained from preliminary electrical information from the subsurface group (Reference 5.4). The North Portal Pad surface electrical load requirements were established by calculations. The calculations used the building square footage, which was obtained from the Repository Surface Design Site Layout Analysis, Table 7-2 (Reference 5.5). The values (watts/square foot) for a similar type building were obtained from R. S. Means Electrical Cost Data (Reference 5.6). The calculated values shown in Table 7-1 North Portal Electrical Loads were used to size the building transformers.

The electrical loads that required QA1 power were identified from the Classification of Preliminary MGDS Repository Design (Reference 5.2) and from discussion with the responsible design group personnel. For the QA1 electrical loads, the IEEE standards for industrial facilities (Table 4-2) were used for developing the conceptual design.

The electrical loads established for all the areas within the MGDS site were used to determine the capacity of the interface with the offsite utility. A preliminary location for the main site substation was established and the connection to the offsite utility transmission identified. The power delivery from the site main substation to the areas requiring electrical power were then identified. The conceptual design is shown in Figures 7-1 through 7-7.

4. DESIGN INPUTS

This document provides a conceptual level of design for the site wide electrical power distribution. Most of the design inputs used in this document are the requirements set forth in the Repository Design Requirements Document (RDRD) (Reference 5.7) and from several other projects of the same complexity and technical requirements.

4.1 DESIGN PARAMETERS

This data is conceptual, consequently, the use of any data in this technical report for input into documents supporting procurement, fabrication, or construction is required to be controlled and tracked as TBV or TBD in accordance with NLP-3-15 or other appropriate procedures.

- 4.1.1** The watts per square foot for lighting, electrical devices, HVAC and miscellaneous electrical is taken from the R. S. Means Electrical Cost Data, Table 9.0-1151 (Reference 5.6) These values are shown in Table 7-1.
- 4.1.2** The North Portal Pad building square footage was taken from the Repository Surface Design Site Layout Analysis (Reference 5.5 - Table 7-2). The values shown in Table 7-1 are the electrical loads based on the building square footages.
- 4.1.3** The sizing of the subsurface substations transformers, North Portal Subsurface Transformer (non-critical load) 15/20 MVA, North Portal Subsurface Transformers (critical load) 5/6.25 MVA, South Portal Subsurface Transformers 20/26.7 MVA, South Portal Surface Transformers 4 x 1 MVA, Emplacement Shaft Transformers 3.75/4.7 MVA, Emplacement Surface Transformer 1/1.15 MVA, Development Shaft Transformers 3.75/4.7 MVA, and Development Surface Transformer 1/1.15 MVA, were obtained from preliminary electrical information from the subsurface group (Reference 5.4).

4.2 CRITERIA

The following design criteria were developed to respond to the Repository Design Requirements Document (RDRD) (Reference 5.7) to address the requirements that specifically apply to this document. The applicable RDRD requirements are cited for each criteria statement.

4.2.1 The Repository Segment interfaces with the commercial power grid at the MGDS Main Substation. The MGDS requires [RDRD 3.2.3.4.A]:

- A. *One 138 kV [TBV] feed.
- B. *66.7 [TBV] MVA.
- C. 60 hertz +/- [TBD] %.
- D. *Three phase connections.

*Above data is based on assumption provided in Section 4.3.4 (66.7 MVA is based on the nameplate rating of the three transformers supplied by the 138 kV line).

4.2.2 The MGDS Site Electrical System components that are important to safety shall be designed so that essential safety functions can be performed under both normal and accident conditions. [RDRD 3.2.5.1.4.A, RDRD 3.7.3]

4.2.3 The design of the MGDS site electrical systems that are important to safety shall include redundant systems to the extent necessary to maintain, with adequate capacity, the ability to perform safety functions. [RDRD 3.2.5.1.4.B]

4.2.4 Lighting levels shall comply with the requirements of NUREG 0700 Section 6.1.5.4.c and the recommended practices of the Illumination Engineering Society. [RDRD 3.3.6.7.C]

4.2.5 Provisions shall be made to make reliable and timely emergency power immediately available to instruments, utility service systems, central security systems and operating systems, including alarm systems important to safety, in the event of a loss of the primary electric power source or circuit. (Backup power requirements for items not identified as important to safety are treated by analysis during design development process). [RDRD 3.3.6.11.B, RDRD 3.7.3.2.A]

4.2.6 Lightning protection, including lightning arrestors, static wires, and grounding systems, shall be provided. Lightning protection shall be provided for all major buildings and surface facilities. A ground grid shall be provided around each surface facility and shall

be tied to a single point ground system. [RDRD 3.7.3.1]

- 4.2.7 All electrical wiring and fixtures shall be kept physically separate from data and communication wiring for safety and to prevent induced interference. [RDRD 3.7.3.4.A.3]
- 4.2.8 All communications equipment required for security, including off-site equipment, shall remain operable from independent power sources in the event of loss of primary power. [RDRD 3.7.3.4.F]
- 4.2.9 Equipment which could fail during an operation important to safety shall be designed to permit recovery of the operation without compromising the health and safety of the public or the repository employees. [RDRD 3.2.5.2.7]
- 4.2.10 All site survey, planning and design activities shall comply with NRC direction supplemented by the criteria of DOE Order 6430.1A to the extent there is no conflict. [RDRD 3.3.1.A]
- 4.2.11 Critical communications and data circuits shall be protected or shielded from electromagnetic interference from sources within the Repository Segment and from external sources to the extent specified by manufacturers of sensitive data processing and communications equipment used in the system. [RDRD 3.3.2.A]
- 4.2.12 The workmanship criteria shall reflect the currently applicable codes, standards, regulations, architectural, engineering principles and practices specified in DOE Order 6430.1A (General Design Criteria) - 0109 Reference Standards and Guides, including: [RDRD 3.3.4.B]

ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
IEEE	Institute of Electrical and Electronics Engineers
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association

- 4.2.13 The electric power system shall be designed in accordance with DOE Order 6430.1A, Division 16, "Electrical," ANSI C2, National Electrical Safety Code and applicable state laws. [RDRD 3.7.3.2.B]
- 4.2.14 An uninterruptible power supply system shall be provided and shall be designed in accordance with DOE Order 6430.1A, Division 16 Electrical. [RDRD 3.7.3.2.C]

4.2.15 The emergency electrical power supply system shall be provided and shall be designed in accordance with DOE Order 6430.1A, Division 16 Electrical and applicable state law. [RDRD 3.7.3.2.D]

4.2.16 Lighting shall be designed in accordance with DOE Order 6430.1A, Division 16, Electrical. [RDRD 3.7.3.5.A (1 & 2), as modified by the Controlled Design Assumptions Document (CDA) (Reference 5.8)]

1. General lighting for underground shall meet OSHA and MSHA codes.
2. General lighting for underground service facilities not related to waste handling or security shall meet OSHA and MSHA codes.

4.3 ASSUMPTIONS

4.3.1 It is assumed that the Main Substation is located near the North Portal Pad along the "H" road just west of the access road to the North Portal Pad. The basis of this assumption is the use of the existing 69kV power line access for the 138kV transmission line [TBV]. (Used in Section 7.4.1)

4.3.2 It is assumed that IEEE standards for commercial nuclear power plants, in accordance with 10 CFR 50, Criteria 17, as shown in Table 4-1, do not apply. The basis of this assumption is that the repository is not a reactor facility and that the requirements to protect against a loss of cooling accident (LOCA) are too stringent. Instead industrial IEEE standards will be applied to this technical report, as shown in Table 4-2. (Used in Section 3 and throughout Section 7)

4.3.3 It is assumed that there will be no QA-1 electrical loads at the South Portal [TBV]. The basis of this assumption is the Classification of Preliminary MGDS Repository Design (Reference 5.2). (Used in Section 7.7)

4.3.4 It is assumed that there will be a minimum of one 138 kV transmission line with capacity to meet peak power [TBV]. The basis of this assumption is that the safety or critical electrical loads will be backed up by the emergency diesel generators which satisfies the redundancy requirement. (Used in Section 4.2.1 and throughout Section 7)

4.3.5 It is assumed that 10 CFR 73 provides the security requirements for the MGDS. The basis of this assumption is 10 CFR 60.31b, which specifies that MGDS facilities will be designed using requirements of comparable DOE facilities, such as the Monitored Retrievable Storage (MRS). The MRS is governed by 10 CFR 72, which references 10 CFR 73 for security. (Used in Section 7.5.6)

Table 4-1. Class 1E IEEE Standards
(List of IEEE Standards that do not apply to the conceptual design of the site electrical system)

IEEE/NPE Standard	Scope of applicability to the MGDS Site Electrical System Design
IEEE 308	Requirements for electrical power distribution for Class 1E loads
IEEE 323	Requirements for procurement, testing & maintenance of Class 1E equipment
IEEE 384	Separation criteria for Class 1E to non-1E circuits, and 1E to 1E redundant circuits
IEEE 387	Requirements for diesels
IEEE 420	Criteria for design and qualification for control boards, panels, and racks for Class 1E circuits
IEEE 628	Criteria for design, installation, and qualification for raceways for Class 1E circuits
IEEE 650	Criteria for qualification of Class 1E static battery chargers and inverters
IEEE 741	Criteria for protective relay for Class 1E power systems and equipment
IEEE 765	Criteria for Preferred Power Source (PPS) (off-site power) interface with Class 1E power

Table 4-2. Industrial IEEE Standards

IEEE Standard	Scope of applicability to the MGDS Site Electrical System Design
IEEE 141	Recommended Practice for Electrical Power Distribution for Industrial Plants
IEEE 142	Recommended Practice for Grounding of Industrial and Commercial Power Systems
IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
IEEE 739	Recommended Practice for Energy Management in Industrial and Commercial Facilities

- 4.3.6** It is assumed that the subsurface electrical substations feeding subsurface loads will have a mine safety resistant ground. This assumption is based on the requirements of IEEE 142, Section 1.11. (Used in Section 7.4.4)
- 4.3.7** It is assumed that the factors for conservatism for North Portal electrical loads are as shown in Table 7-1. A conservatism factor of 2.4 is used for the Waste Handling Building (WHB) and the Waste Treatment Building (WTB) due to the application of nuclear HEPA filters in these buildings which require considerably more HVAC loads than any building type listed in the Means data (Reference 5.6). All other buildings use conservative factors ranging from 1 to 1.15 because the Means data does not give values for building descriptions which exactly match the buildings located at the North Portal (Used in Table 7-1)
- 4.3.8** It is assumed that the Waste Handling Building and Carrier Preparation Building crane electrical load is 770 kVA, as listed in Table 4-3. This assumption is based on an interoffice correspondence from Meyers to Howell (Reference 5.9) [TBV]. (Used in Table 7-1)

Table 4-3. WHB and CPB Crane Electrical Loads

Crane Description	Number	Tons	hp	kVA	Diversity Factor	Actual kVA
Carrier Prep Bridge (in CPB)	2	10	10	14.92	1	14.92
Carrier Bay Bridge	1	140	140	104.44	1	104.44
Cask Unloading Area Bridge	3	140	140	313.32	1	313.32
Assembly Handling Cell Bridge	3	15	15	33.57	0.5	16.79
Canister Transfer Cell Bridge	2	75	75	111.90	1	111.90
WPRC Bridge	1	20	20	14.92	0.5	7.46
DC Cell Bridge	2	110	110	164.12	1	164.12
Empty DC Preparation Bridge	1	50	50	37.3	1	37.30
Welder Maintenance Cell Bridge	1	20	20	14.92	0	0
Transfer Corridor Bridge	1	50	50	37.3	0	0
DC Cell Transfer Corridor Bridge	1	50	50	37.3	0	0
Total						770.25

- 4.3.9** It is assumed that 1 ton of crane capacity requires 1 horsepower (hp) or 746 watts of electrical power [TBV]. This assumption is based on information from a typical reactor building 100 ton crane, which requires 97.5 hp (60 hp for the main hoist; 50 hp for the aux hoist, which would never be run at the same time as the main hoist; 7.5 hp for the trolley motor; and 2 x 15 hp for the bridge). (Used in Table 4-3)
- 4.3.10** It is assumed that the QA classifications shown in Table 2-1 have been correctly assigned. This is based on the work performed in *Classification of the Preliminary MGDS Repository Design* (Reference 5.2), which carries a TBV for these classifications [TBV]. (Used in Table 2-1.)

4.4 CODES AND STANDARDS

The following codes and standards apply to this technical report:

4.4.1 American National Standards Institute (ANSI)

ANSI C2-1997 National Electrical Safety Code

4.4.2 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

ASHRAE 90.1-1989 Energy Efficient Design of New Buildings Except New Low-Rise Residential Buildings

4.4.3 Institute of Electrical and Electronics Engineers (IEEE)

IEEE 141-1993 IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants

IEEE 142-1991 IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems

IEEE 242-1986 IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

IEEE 308-1991 IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations

IEEE 323-1983	IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations
IEEE 384-1992	IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits
IEEE 387-1995	IEEE Standard Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations
IEEE 420-1982	IEEE Standard for the Design and Qualification of Class 1E Control Boards, Panels, and Racks Used in Nuclear Power Generating Stations
IEEE 628-1987	IEEE Standard Criteria for the Design, Installation, and Qualification of Raceway Systems for Class 1E Circuits for Nuclear Power Generating Stations
IEEE 650-1990	IEEE Standard for Qualification of Class 1E Static Battery Chargers and Inverters for Nuclear Power Generating Stations
IEEE 739-1995	IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities
IEEE 741-1990	IEEE Standard Criteria For Security Systems for Nuclear Power Generating Stations
IEEE 765-1995	IEEE Standard for Preferred Power Supply (PPS) for Nuclear Power Generating Stations

4.4.4 National Fire Protection Association (NFPA)

NFPA 20	Centrifugal Fire Pumps, 1996
NFPA 72	National Fire Alarm Code, 1996
NFPA 110	Emergency and Standby Power Systems, 1996

4.4.5 Code of Federal Regulations (CFR)

Title 10	Energy, Part 50 - Domestic Licensing of Production and Utilization Facilities
Title 10	Energy, Part 60 - Disposal of High-Level Radioactive Wastes in Geologic Repositories
Title 10	Energy, Part 72 - Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-level Radioactive Waste
Title 10	Energy, Part 73 - Physical Protection of Plants and Materials

4.4.6 Nuclear Regulatory Commission publications

NUREG 0700	Guidelines for Control Room Design Reviews
------------	--

4.4.7 U. S. Department of Energy (DOE) Orders

DOE Order 6430.1A	General Design Criteria, April 6, 1989
-------------------	--

5. REFERENCES

- 5.1** *Site Characterization Plan Conceptual Design Report (SCP-CDR)*, SAND84-2641, SNL 1987.
- 5.2** *Classification of Preliminary MGDS Repository Design*, M&O Document Identifier (DI) B000000000-01717-0200-00134 REV 00.
- 5.3** *Quality Assurance Requirements and Description (QARD)*, U. S. Department of Energy, DOE/RW-0333P, Rev 7.
- 5.4** Interoffice correspondence, J. M. Calle to Bob Howell, *Subsurface Transformer Size*, DI: LV.RSD.JMC.02/98.006, Civilian Radioactive Waste Management System, February 25, 1998.
- 5.5** *Repository Surface Design Site Layout Analysis*, DI: BCB000000-01717-0200-00007, REV 01.

- 5.6 *R. S. Means Electrical Cost Data, 1997*, 20th Annual Edition, R. S. Means Company, Inc., Construction Publishers & Consultants, 1996.
- 5.7 *Repository Design Requirements Document (RDRD)*, Yucca Mountain Site Characterization Project, YMP/CM-0023, REV 0, ICN 1.
- 5.8 *Controlled Design Assumptions Document (CDA)*, DI: B00000000-01717-4600-00032, REV 04, ICN 3.
- 5.9 Interoffice correspondence, S. J. Meyers to R. E. Howell, *Basis for Estimating Crane Electrical Loads for Site Electrical System Technical Report*, DI: LV.SD.SJM.2/98.030, Civilian Radioactive Waste Management System, February 23, 1998.

6. USE OF COMPUTER SOFTWARE

Not used.

7. DESIGN ANALYSIS

7.1 OVERVIEW

Figures are included for the MGDS Site Overall Electrical Power Distribution Block Diagram (Figure 7-1), MGDS North Portal Electrical Distribution One-Line Diagram (Figure 7-2), the MGDS Security System Electrical Distribution One-Line Diagram (Figure 7-3), the MGDS Security Station 3 - Security Lighting One-Line Diagram (Figure 7-4), the MGDS South Portal Electrical Distribution One-Line Diagram (Figure 7-5), the MGDS Shaft Development Electrical Distribution One-Line Diagram (Figure 7-6), and the MGDS Shaft Emplacement Electrical Distribution One-Line Diagram (Figure 7-7).

7.2 MGDS SITE ELECTRICAL POWER DELIVERY OVERVIEW

The electrical power delivery system transmits and distributes electrical power to the power distribution equipment located throughout the MGDS site. Power is transmitted to the MGDS site from an offsite utility. The 138 kV transmission line terminates in the MGDS Main Substation and is connected to the transformers through substation power circuit breakers and disconnect switches (Figure 7-2).

The electrical power delivery system and facility electrical distribution systems will be designed to meet the energy conservation requirements of ASHRAE 90.1 and IEEE 739.

FIGURE 7-1 MGDS SITE
OVERALL ELECTRICAL POWER
DISTRIBUTION BLOCK DIAGRAM

Title: SITE ELECTRICAL SYSTEM
TECHNICAL REPORT

DOCUMENT IDENTIFIER: BCBC00000-01717-5705-00003 Rev00 Page: 21

FIGURE 7-3 MGDS SECURITY
SYSTEM ELECTRICAL
DISTRIBUTION ONE-LINE DIAG

Title: SITE ELECTRICAL SYSTEM
TECHNICAL REPORT

DOCUMENT IDENTIFIER: BCBC00000-01717-5705-00003 Rev00 Page: 22

FIGURE 7-4 MGDS SECURITY
STATION 3 - SECURITY
LIGHTING ONE-LINE DIAG.

FIGURE 7-5 MGDS SOUTH PORTAL
 ELECTRICAL DISTRIBUTION
 ONE-LINE DIAGRAM

FIGURE 7-7 MGDS SHAFT
EMPLACEMENT ELECTRICAL
DISTRIBUTION ONE-LINE DIAGRAM

7.3 ON-SITE DELIVERY (DISTRIBUTION LINES)

The on-site power to the MGDS has five distribution points: Main Substation, North Portal Distribution, Shaft Emplacement Substation, South Portal Substation, and Shaft Development Substation. These five distribution points are described in Sections 7.4 through 7.8.

7.4 MGDS MAIN SUBSTATION

7.4.1 Main Substation Location

The Main Substation which is anticipated to be constructed, operated, and maintained by the MGDS is located near the North Portal pad along the "H" road, just west of the access road.

7.4.2 Main Substation Structural Steel and Concrete

The transmission line terminates on a structural steel tower in the MGDS Main Substation. The substation contains both structural steel and concrete. Structural steel is used as the material for disconnect switch mounts, breaker mounts, and any other equipment mounts. The disconnect switches, breakers, and other equipment are mounted on concrete pads.

7.4.3 Main Substation Circuit Breakers and Disconnect Switches

The transmission line connects to each transformer through a 138 kV power circuit breaker. Disconnect switches, located on both sides of the breakers, isolate the circuit breaker for maintenance.

7.4.4 Main Substation Transformers

Each of the main transformers are rated to provide the load requirements of the entire attached load. The transformers are also sized to supply power to future additions. The transformer ratings are in MVA, oil emersed self cooled/oil emersed forced air cooled (OA/FA). The voltages are in kV, with the primary windings connected in delta and the secondary windings in solidly grounded or mine safety grounded wye. They are oil filled and will have load tap changers if required by load conditions [TBV].

The transformers step the voltage down to 12.47 kV for distribution to the North Portal. The secondary of each transformer is connected to a dedicated 12.47 kV circuit breaker located in the Main Substation. The load side of the 12.47 kV breakers feed 12.47 kV distribution lines. Two of the 12.47 kV distribution lines are connected to the North Portal surface switchgear groups (switchgear "A" and switchgear "B") located in the North Portal Switchgear Building and the third 12.47 kV distribution line is connected to the North Portal subsurface non-QA-1

switchgear. The South Portal substation is fed by a 138 kV transmission line.

Electrical power delivery also includes the grounding system which consists of 1) a grounding grid for the surface substation, 2) a grounding grid located beneath each building, and 3) a separate subsurface grounding grid. The main surface substation grounding grid is connected to the buildings ground grids. The subsurface ground grid is isolated from the surface ground grid. Electrical equipment as well as building structural steel is connected to each grid in accordance with applicable IEEE requirements.

Each of the oil filled transformers will have containment dikes, and a fire wall will be provided between each of the transformers to prevent mitigation of a fire [TBV].

7.4.5 Transformer Bus

The secondary windings of each transformer is connected to a circuit breaker located in the Main Substation.

7.5 NORTH PORTAL DISTRIBUTION

7.5.1 Power Delivery Switchgear

Two 12.47 kV switchgear buses are located in a switchgear building in the North Portal Surface Substation. One is fed by each 15/20 MVA OA/FA transformer through a 12.47 kV distribution line to an incoming breaker located in the switchgear. Each switchgear (A and B) bus provides power to approximately half of the North Portal Surface Loads through a number of feeder breakers and transformers. A normally open tie breaker allows one of the buses (and therefore one main transformer) to serve the entire facility in the event of a transformer, substation circuit breaker, or 12.47 kV distribution line failure. The Waste Handling Building (WHB) and Waste Treatment Building (WTB) are fed radially from Switchgear "A" and "B" (Figure 7-2). All other surface buildings are fed by a loop arrangement from either Switchgear "A" or "B" (Figure 7-2). The building loads are listed in Table 7-1. The switchgear is sized to serve future loads as described above for the main transformers. The main switchgear bus "B" also provides power to the Shaft Emplacement Substation (Figure 7-2).

A 12.47 kV switchgear bus is located at the North Portal entrance for supplying electrical power to the subsurface. It is fed by a 15/20 MVA OA/FA transformer through a 12.47 kV distribution line and an incoming breaker located in the switchgear. The switchgear bus provides power to the North Portal subsurface loads through a number of feeder breakers.

Table 7-1. North Portal Electrical Loads

Radiologically Controlled Area Facilities												
				(Units = Watt/sq ft - based on Means Electrical Cost Data, 1997)								Electrical Load (kVA)
Building	Bldg No.	Sq. Ft.	Bldg Type	Lighting	Devices	HVAC	Misc	Other	Total	pf	Conserv.	
Airlock Bldg (AB)	210	7500	wh+HVAC+misc	1	0.6	4.5	1.5		7.6	0.85	1.1	74
Waste Handling Bldg (WHB)	211	7500	office, low rise	3	2	4.3	1.2		10.5	0.85	1	93
		1500	college science	3	3	5.3	1.3		12.6	0.85	1	22
		4500	gar, com+HVAC	0.5	0.5	4	0.5		5.5	0.85	1.1	32
		366500	manufac, tools	4	1		1.1		6.1	0.85	1.1	2893
		366500	HVAC			4.5			4.5	0.85	2.4	4657
Waste Handling Bldg cranes												755
Waste Treatment Bldg (WTB)	215-1	2000	office, low rise	3	2	4.3	1.2		10.5	0.85	1	25
		63400	manufac, tools	4	1		1.1		6.1	0.85	1.1	500
		63400	HVAC			4.5			4.5	0.85	2.4	806
Carrier Prep Bldg (CPB)	215-2	1500	office, low rise	3	2	4.3	1.2		10.5	0.85	1	19
		18100	manufac, tools	4	1	4.5	1.1		10.6	0.85	1.1	248
Carrier Prep Bldg crane												15
Carrier Washdown Bldg	215-3A,B	2100	gar+misc	0.5	0.5	0	2.5		3.5	0.85	1.1	9.5
Transporter Maint. Bldg	220-4C	1500	office, low rise	3	2	4.3	1.2		10.5	0.85	1	19
		6000	manufac, tools	4	1	4.5	1.1		10.6	0.85	1.15	86
Change House (existing)	5008	13970	telephone exc.	1	0.6	4.5	1.1		7.2	0.85	1.1	130
Switchgear Bldg (existing)	5010	8400	telephone exc.	1	0.6	4.5	1.1		7.2	0.85	1.1	78
Shop Bldg	N/A	800	office, low rise	3	2	4.3	1.2		10.5	0.85	1	10
		13600	manufac, tools	4	1	4.5	1.1		10.6	0.85	1.1	187
Modular Office Complex	N/A	24500	office, low rise	3	2	4.3	1.2		10.5	0.85	1	303

Table 7-1. North Portal Electrical Loads, continued

Balance of Plant Area Facilities												
				(Units = Watt/sq ft - based on Means Electrical Cost Data, 1997)								Electrical Load (kVA)
Building	Bldg No.	Sq. Ft.	Bldg Type	Lighting	Devices	HVAC	Misc	Other	Total	pf	Conserv.	
Security Station 1 (Main BOP portal)	220-3A	8000	office, low rise	3	2	4.3	1.2		10.5	0.85	1.05	104
Sec Station 2 (RCA/BOP portal)	220-3B	3000	office, low rise	3	2	4.3	1.2		10.5	0.85	1.05	39
Sec Station 3 (RCA tr/rail portal)	220-3C	2800	office, low rise	3	2	4.3	1.2		10.5	0.85	1.05	36
Administration Bldg	220-5A	44000	office, low rise	3	2	4.3	1.2		10.5	0.85	1	544
Food Service Facility	220-5B	11000	restaurant	2.5	2	6.8	1.7		13	0.85	1	168
Training Auditorium	220-5C	1000	auditorium	2.5	1	3.3	0.8		7.6	0.85	1	9
Medical Center	220-1B	8200	medical clinic	2.5	1.5	3.2	1		8.2	0.85	1	79
Fire Station	220-2	1520	office, low rise	3	2	4.3	1.2		10.5	0.85	1	19
		6080	gar+HVAC+misc	0.5	0.5	3	0.5		4.5	0.85	1.1	35
Computer Center	220-22	4000	off+dev+HVAC	3	3	4.8	1.2		12	0.85	1.1	62
Central Warehouse	220-7	51300	wh,groc+HVAC	1	0.6	3	0.5		5.1	0.85	1	308
		5700	office, low rise	3	2	4.3	1.2		10.5	0.85	1	70
Central Shops	220-4A	57000	manuf,tool+misc	4	1	4.5	2.1		11.6	0.85	1.05	817
Motor Pool and Facility Service Station	220-4B	120	office, low rise	3	2	4.3	1.2		10.5	0.85	1	1
		1080	gar,com+HVAC	0.5	1	2	0.5		4	0.85	1.1	6
Mockup Building	220-6	1728	office, low rise	3	2	4.3	1.2		10.5	0.85	1	21
		6912	manufac, tools	4	1	4.5	1.1		10.6	0.85	1	86
Utility Building	N221-2	5500	telephone exc.	1	0.6	4.5	1.1		7.2	0.85	1.1	51

Table 7-1. North Portal Electrical Loads, continued

Site Service Facilities												
				(Units = Watt/sq ft - based on Means Electrical Cost Data, 1997)								Electrical Load (kVA)
Building	Bldg No.	Sq. Ft.	Bldg Type	Lighting	Devices	HVAC	Misc	Other	Total	pf	Conserv.	
Visitor Center	N221-3	14300	office, low rise	3	2	4.3	1.2		10.5	0.85	1	177
Lighting												
Area	Bldg No.	Illum/sf										Electrical Load (kVA)
General Parking	N120-1C	1 fc										2
Loaded Truck Carrier Parking	N120-1B	1 fc										1
Waste Trans. Rail Car Parking	N120-1A	2 fc										59
RCA Security Area (minus 3 above)	N/A	2 fc										65
Balance of Plant area	N/A	1 fc										29
TOTAL LOAD (kVA) =												13748

The electrical load in kVA for each building was developed by adding the watts/square foot for lighting, electrical devices, HVAC and miscellaneous electrical equipment taken from the R. S. Means Electrical Cost Data, 1997 and then multiplying this sum by the building square footage.

Note: There are applications throughout the MGDS site where renewable energy sources (solar, fuel cell, etc.) could be utilized. The use of renewable energy sources would reduce the total electrical offsite source requirements and should be looked at in future, more detailed, studies.

7.5.2 Switchgear Building

The switchgear groups "A" and "B" are located in the existing switchgear building on the North Portal Pad [TBV]. This building houses major switchgear, the associated equipment, and a local control panel for control of the substation breakers and transformer fans. The equipment is accessed for installation, removal, or maintenance through double swinging doors.

7.5.3 Power Distribution Cable

Power is distributed to secondary substations consisting of pad mounted transformers and disconnect switches throughout the MGDS by 15 kV class cables of appropriate ampacity. These cables terminate in secondary substation transformers disconnect switches. These switches allow the removal of a secondary substation without affecting the continued operation of the remaining secondary substations. Cables which penetrate the protected area will be routed through conduit banks in order to meet applicable security requirements. Conduit banks are also provided under roads and railroad tracks for physical protection of the cables. Power is distributed from the secondary substations to the buildings designated on Figure 7-2.

7.5.4 Emergency Diesels

Emergency power will be provided by a diesel generator located at each distribution location which has QA-1 electrical loads (North Portal, Shaft Emplacement, and Shaft Development). Emergency power is defined as an independent reserve source of electric energy that, upon failure or outage of the normal source, provides reliable electric power to critical devices and equipment whose failure to operate satisfactorily would jeopardize the health and safety of personnel or result in damage to property. This backup power source is provided to ensure the continued operation of equipment/systems designed to prevent radiological releases to the environment in the event of a loss of normal power. Only loads meeting this definition will be tied to these emergency diesels.

7.5.5 Security Diesel

The security system at the MGDS facilities will be designed using the requirements of comparable DOE surface facilities (10 CFR 60.31b), such as the Monitored Retrievable Storage (MRS) facility which is governed by 10 CFR 72 which references 10 CFR 73 for security. 10 CFR 73 requirements will be applied to the surface facilities which will likely be removed once the repository is closed. 10 CFR 73.50e(4) states that "All communication equipment, including offsite equipment, shall remain operable from independent power sources in the event of a loss of primary power." 10 CFR 73.46e(6) states that "All alarms required by this section shall remain operable from independent power sources in the event of the loss of normal power. Switchover to standby power shall be automatic and shall not cause false alarms on annunciator modules."

Intrusion detection equipment, alarm annunciation equipment, security lighting, equipment to provide assessment of alarms, and communication equipment will be provided with independent power sources, in order to meet these requirements. A diesel generator and Uninterruptible Power Supply (UPS) equipment will be provided for this purpose. See Figures 7-3 and 7-4 for one line diagrams for the MGDS Security System Electrical and MGDS Security Station 3 - Security Lighting.

7.5.6 Subsurface Personnel Safety Diesel

A backup diesel will be provided at the entrance to the subsurface to provide backup power for ventilation, lighting, etc. upon a loss of normal power for evacuation of personnel who may be underground during the loss of offsite power.

7.5.7 Backup Sources of Power

In the event of a loss of normal power from the grid, several sources of power are provided for the MGDS based on the classification of each area/component. Table 7-2 outlines the appropriate uses of each of the types of backup power available at the MGDS.

Table 7-2. Backup Power Sources

Type of Backup Power Source	Description	Source	Key Consideration
Emergency Power	Emergency	10 CFR 60 & IEEE standards	Diesels for critical power to supply electrical loads to prevent release of radiological material
Security Power	Security	10 CFR 73	Security loads only from separate diesel for security
Fire Protection Power	Fire Protection	NFPA 20 NFPA 72 NFPA 110	Fire Detection - Battery (UPS) Fire Pump - Backup Diesel Pump
Subsurface Personnel Safety Power	Backup Power for Ventilation, Lighting, etc.	National Electrical Safety Code	Diesel for ventilation, lighting, etc. for personnel in subsurface

7.6 SHAFT EMPLACEMENT SUBSTATION

The Shaft Emplacement Power Delivery system distributes power for surface and subsurface

electrical equipment. This system has a 12.47kV power distribution line which terminates at the substation (Figure 7-7). It has three transformers with isolation breakers for performing maintenance.

Two transformers and switchgear groups are provided for QA-1 power to the ventilation fans and other QA-1 electrical loads. One diesel generator is provided for emergency power to QA-1 loads.

One transformer and switchgear group will supply power to surface non-QA-1 loads.

7.7 SOUTH PORTAL SUBSTATION

The South Portal and Shaft Development areas are primarily involved in construction activities and with non-QA-1 operational activities. The South Portal Power Delivery system has a 138kV power transmission line which terminates at the substation (Figure 7-5). Two transformers with isolation breakers are provided for performing maintenance.

Two transformers and switchgear groups are provided for power to the subsurface electrical loads. A diesel generator provides for standby power to subsurface loads.

One transformer and switchgear group will supply power to surface loads.

7.8 SHAFT DEVELOPMENT SUBSTATION

The Shaft Development Power Delivery system has a 12.47kV power distribution line which terminates at the substation (Figure 7-6). Two transformers with isolation breakers are provided for performing maintenance.

Two transformers and switchgear groups are provided for QA-1 power to the ventilation fans and other QA-1 electrical loads. A diesel generator is provided for emergency power to QA-1 loads.

One transformer and switchgear group will supply power to surface non-QA-1 loads.

8. CONCLUSIONS

These conclusions are intended to support the Viability Assessment (VA) design. The conclusion of this report provides an initial conceptual electrical scheme for supporting the site systems and associated facilities as shown in Figures 7-1 through 7-7.

Due to the unqualified/unconfirmed input data used in this report, the output/conclusions from

this report cannot be used as input into documents supporting procurement, fabrication, or construction unless they are controlled and tracked as TBV or TBD in accordance with NLP-3-15.

9. ATTACHMENTS

Attachment I Listing of key words for the Records Processing Center (RPC)

Attachment I

Key Words (to accompany the document upon submittal to the RPC) for:

Site Electrical System Technical Report, DI: BCBC00000-01717-5705-00003 REV 00

electrical

MGDS utilities

power distribution

one-line diagrams

MGDS electrical loads

backup power

emergency power

security power

offsite power source

lighting

QA-1 electrical loads

uninterruptible power supply (UPS)