Rec'd with letter dtd. 7/25/94

PACKAGE 1D

M&O Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR

ANALYSES

90% DESIGN REVIEW

JULY 11, 1994

40

CRWMS/M&O

Design Analysis Cover Sheet

Complete only applicable items.

(1.)

WBS: 1.2.6
QA: QA

1. DESIGN ANALYSIS TITLE MUCK STORAGE PAD ANALYSIS			
3. DOCUMENT IDENTIFIER BABCC0000-01717-0200-00001		4. REV. NO. ~~0A~~ 0B [initials] 7/1/94	5. TOTAL PAGES 9
6. TOTAL ATTACHMENTS/NO. OF PAGES IN EACH 1 (20 PAGES)		7. SYSTEM ELEMENT ESF	

	Print Name	Signature	Date
8. Originator	H. A. Asgarian	[signature]	06-15-94
9. Checker	R. D. Clark	Roy D. Clark	6/15/94
10. Lead Discipline Engineer	H. R. Montalvo	[signature]	6/15/94
11. Department Manager			

12. REMARKS

QAP-3-9

0492 (Rev. 03/14/94)

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

CRWMS/M&O

Design Analysis Revision Record

Complete only applicable items.

(1.)

WBS: 1.2.6
QA: QA

2. DESIGN ANALYSIS TITLE

MUCK STORAGE PAD ANALYSIS

3. DOCUMENT IDENTIFIER	4. REVISION NO.
BABCC0000-01717-0200-00001	~~0A~~ 0B [initials] 7/7/94

5. Revision No.	6. Pages Added	7. Pages Deleted	8. Description of Revision
0A	9 (20 ATT. PGS.)		ISSUED FOR INTERDISCIPLINE REVIEW
0B	0	0	ISSUED FOR 90% REVIEW

1. PURPOSE

The purpose of this analysis is to define the spatial requirements of the area (pad) for storage of muck removed from the tunnel area during the construction of the Exploratory Studies Facility (ESF). This analysis uses the estimate for the amount of material to be removed and determines the required area of the storage pad.

2. QUALITY ASSURANCE

Work performed under this analysis is considered not important to waste isolation or radiological safety.

3. METHOD

The method used in this analysis is a combination of descriptive narrative analysis and calculations.

4. CODES AND STANDARDS

4.1 YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT (YMP):

YMP Baseline Document No YMP/CM-0019, July 1993	Exploratory Studies Facility Design Requirements (ESFDR), Rev. 0

4.2 U.S. DEPARTMENT OF ENERGY (DOE):

DOE Order 6430.1A, April 6, 1989	General Design Criteria for DOE Facilities

5. DESIGN INPUTS

It is estimated that 1,087,000 cubic yards (829,768 cubic meters) of material is to be removed from the tunnel (Reference Section 8.5).

6. CRITERIA

6.1 ESFDR REQUIREMENTS

6.1.1 3.1.3.1.A.2 Auxiliary site - consists of the areas prepared for ESF purposes not fulfilled by the main site. Examples of the possible use of auxiliary sites include:

- laydown area

- explosives magazine
- muck and rock storage
- topsoil storage
- batch plant
- water tank
- substation with standby generators
- compressors
- warehouse

and other areas defined as the design progresses.

6.1.2 3.1.3.1.A.3 Access roads - all features needed to provide vehicular access, as required, to all surface areas designated to support the ESF.

6.1.3 3.1.3.1.A.4 Site drainage system - items and measures utilized to control drainage and runoff water to preclude damage by erosion or flooding.

6.1.4 3.2.1.L Applicability of state and local regulations shall be determined by DOE, with the exception of environmental requirements which are addressed in 3.2.1.24.A.

6.1.5 3.2.1.Q Unless specifically waived in writing by OCWRM [Office of Civilian Radioactive Waste Management] design and construction of all ESF facilities and equipment shall be accomplished using the criteria specified in the appropriate section of DOE Order 6430.1A. For facilities over which the NRC [Nuclear Regulatory Commission] has regulatory authority, NRC requirements shall be the only controlling nuclear safety requirements. The following components are addressed in DOE Order 6430.1A:

1. General Requirements
2. Site and Civil Engineering
3. Concrete
4. Masonry
5. Metals
6. Woods and Plastics
7. Thermal and Moisture Protection
8. Doors and Windows
9. Finishes
10. Specialties
11. Equipment
12. Furnishings
13. Special Facilities
14. Conveying Systems
15. Mechanical
16. Electrical

6.1.6 3.2.2.1.D Roads, building sites, utility corridors, and storage areas for excavated rock shall be cleared, graded, and stabilized. Topsoil shall be stored in an environmentally acceptable manner.

6.1.7 3.2.2.1.F All storm water runoff shall be controlled in an environmentally acceptable manner.

6.1.8 3.2.2.1.K Site preparation activities shall disturb only the amount of land necessary to support construction and operation.

6.1.9 3.2.2.1.M Runoff and erosion during construction and operation and after decommissioning shall be controlled in accordance with applicable State of Nevada and local regulations.

6.1.10 3.2.2.1.Q Rock excavated from the underground facilities shall be deposited at a location on the surface that is not visible from U.S. Highway 95.

6.1.11 3.2.2.1.2.B All auxiliary sites shall be protected against the flood caused by a 100-year storm except as specified below:

1. Batch plant site, 10-year storm,
2. Booster pump building site, 50-year storm,
3. Compressor site, 50-year storm.

6.1.12 3.2.2.1.2.F The capacity of surface rock storage areas shall include allowance for overbreak and swell.

6.1.13 3.2.2.1.2.G The muck storage site must provide equipment or facilities for dust control when muck storage begins.

6.1.14 3.2.2.1.3.F Muck haulage in the vicinity of the main site shall be separated from personnel access for safety considerations.

6.2 DOE ORDER 6430.1A REQUIREMENTS

6.2.1 Section 0250-3 - Roads

Geometric design of all roads, streets, access drives, and parking areas shall comply with AASHTO [American Association of State Highway and Transportation Officials] GDHS [Geometric Design of Highways and Streets]-84.

Gradients for roads, streets, and access drives shall comply with AASHTO GDHS-84. Road and street grade changes in excess of 1 percent shall be accomplished by means of vertical curves. The length of vertical curves shall be determined in accordance with AASHTO GDHS-84. Roadway centerline gradient profiles shall be shown for vertical control.

6.2.2 Section 0270-2.1 - Stormwater Management Systems, General

Stormwater management systems shall be cost effective and shall provide flood protection commensurate with the value and operational requirements of the facilities to be protected.

The following conditions and requirements shall be considered prior to stormwater management system design:

- Local regulations
- Site topography
- Ultimate development within the drainage area
- Requirements for future expansion
- Outfall locations
- Existing drainage systems
- Location of other utilities
- Security boundary and safeguard requirements

In accordance with the CWA [Clean Water Act], as amended by the WQA [Water Quality Act] of 1987, the NPDES [National Pollutant Discharge Elimination System] Permit Regulations require control of point source stormwater discharge.

Stormwater management systems shall be designed for not less than the 25-year, 6-hour storm. The potential effect of larger storms (up to the 100-year, 6-hour storm) shall also be considered. With the approval of the cognizant DOE authority, lesser design storms may be used where a large expenditure for flood protection cannot be economically justified.

7. ASSUMPTIONS

A bulking factor of 50 percent is assumed for the muck. No verification is required.

8. REFERENCES

8.1 Surveying, Moffit/Bouchard, Sixth Edition.

8.2 "Flood Potential of Fortymile Wash and its Principal Southwestern Tributaries, Nevada Test Site, Southern Nevada," by U.S. Geological Survey, Water Resources Investigation Report 83-400,1984.

8.3 "Handbook of Applied Hydrology, A Compendium of Water-Resources Technology," Ven Te Chow, Editor-in-Chief, McGraw-Hill, 1964.

8.4 Not used.

8.5 Design Analysis No. B00000000-01717-0200-00089 Rev. 00, "Description and Rationale for Enhancement to the Baseline ESF Configuration."

9. COMPUTER PROGRAMS

Not used.

10. DESIGN ANALYSIS

10.1 DESCRIPTIVE NARRATIVE ANALYSIS

10.1.1 Storage Area Requirements

Under Title I design, a storage area adjacent to the Topsoil and Rock Storage areas was selected. During Title II design it was decided that this area was not the most suitable storage area and a pad closer to the tunnel was needed. This would lower the cost of conveyor construction by shortening the distance between the tunnel and the pad, and would result in lower maintenance costs in the future. Two areas close to the ESF Pad were selected and studied to determine the most suitable alternative. Both areas were selected outside the probable maximum flood (PMF) zone (reference Page 10 of 20, Attachment I, and reference Section 8.2). Alternative 1 is a triangular shaped area, bounded by the access road to the North Portal Pad on the west, an existing power line and its service road on the south, and the limits of PMF on the northeast side. Alternative 2 is a rectangular shaped area, bounded by the access road to the North Portal Pad on the east, an existing power line and its associated service road on the south, another existing power line and access road on the west, and with the northern boundary close to the culvert crossing on the access road to the North Portal Pad. Several meetings and discussions were conducted to select the best alternative. Area 1 was slightly farther away and the conveyor alignment had to cross the access road to the North Portal Pad. Area 2 was closer to the tunnel, but was bounded by the access road, the power lines, and the site of the proposed potential repository facilities, with no potential for future expansion.

Factoring in the above criteria for both areas, Area 1 was selected as a more attractive choice, having long-term economic advantage over Area 2 and also having future expansion potential.

10.1.2 Drainage Requirements

Both Area 1 and Area 2 are on relatively high ground and outside the PMF and 100-year flood zones. Both areas are also protected from local flooding by the adjacent access roads. Minimal flood protection in the form of drainage ditches around the pads is sufficient to protect them from any local flooding. Area 1, the selected storage pad, must be protected from a 100-year flood (reference Section 6.1.11). The access road to the North Portal Pad is designed to handle the 100-year stormwater on its west side, from H-Road to the culvert crossing. At the culvert crossing the stormwater will flow to the east side of the access road and to the northeast side of the proposed storage pad. This is effectively protects the west and northeast sides of the pad. The south side of the pad is protected from 100-year flooding by the H-Road and the existing service road for the power line. Therefore, Area 1 has existing 100-year flood protection and only needs a perimeter drainage ditch system to protect it against local flooding.

10.1.3 Access Road Requirements

A conveyor system is proposed to be built from the tunnel to the muck storage area. An access road is to be constructed along the alignment of the conveyor during the construction of the conveyor system. This access road will be sufficient as an access road to the pad and is presently planned as a dirt road. The conveyor alignment to Area 1 crosses the access road to the North Portal Pad. Access to the muck storage pad will be provided from this intersection or from the North Portal Pad. An access road is also planned along the perimeter of the muck storage pad.

10.2 CALCULATIONS

Area 1 is a triangular shaped area with approximate dimensions of 2,440 ft x 1,150 ft (reference Page 11 of 20, Attachment I). Area 2 is a rectangular shaped area with approximate dimensions of 1,500 ft x 500 ft (reference Page 12 of 20, Attachment I). Detailed area and volume calculations, using the average-end-area method, were performed for each area (for Area 1 calculations reference Pages 7-9 of 20, and for Area 2 calculations reference Pages 2-7 of 20, Attachment I). These calculations show a height of 20 feet for Area 1 and 80 feet for Area 2. The lower height of the pile for Area 1 is another factor in its advantage over Area 2. This shows that in addition to the potential area expansion, Area 1 has height expansion potential. Combining these two factors shows that potential volume expansion is a better possibility at Area 1. Additional storage volume would be provided at Areas 1 and 2 due to removal of topsoil. Alternate 1 has a larger area and will provide more storage capacity than Alternate 2.

11. CONCLUSIONS

Based upon the calculations, analysis, and discussions with other participant organizations, Area 1 is the selected area for the muck storage pad. This area is in close proximity to the North Portal Pad, is outside 100-year flood zone, has the capacity for the present requirements, and has the capacity for any future expansion. It also has economic advantage over the area selected under Title I design.

12. ATTACHMENTS

ATTACHMENT	TITLE
I	Determining Volume of Muck That Can Be Stored in Area 2

Design Analysis Cover Sheet

CRWMS/M&O

Complete only applicable items.

(1.)

WBS: 1.2.6
QA: QA

2. DESIGN ANALYSIS TITLE COMPRESSED AIR SYSTEM/CONDENSATE RECEIVER TANK FOUNDATIONS			
3. DOCUMENT IDENTIFIER BABBDF000-01717-0200-00001		4. REV. NO. 0A	5. TOTAL PAGES 10
6. TOTAL ATTACHMENTS/NO. OF PAGES IN EACH NONE	7. SYSTEM ELEMENT ESF		

	Print Name	Signature	Date
8. Originator	M. Gomez	[signature]	7/7/94
9. Checker	J. SALCHAK	[signature]	7·7·94
10. Lead Discipline Engineer	M. GOMEZ	[signature]	7/7/94
11. Department Manager			

12. REMARKS

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

CRWMS/M&O

Design Analysis Revision Record

Complete only applicable items.

(1.)

WBS: 1.2.6

QA: QA

2. DESIGN ANALYSIS TITLE

COMPRESSED AIR SYSTEM/CONDENSATE RECEIVER TANK FOUNDATIONS

3. DOCUMENT IDENTIFIER

BABBDF000-01717-0200-00001

4. REVISION NO.

0A

5. Revision No.	6. Pages Added	7. Pages Deleted	8. Description of Revision
0A	10	0	

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

1. PURPOSE

The purpose of this analysis is to design structural foundations for the Compressed Air System (CAS), and the Condensate Receiver Tank. This analysis is in support of design drawing BABBDF00-01717-2100-23017.

2. QUALITY ASSURANCE

The items considered within this analysis relate to temporary equipment foundations not included on the Q-list. There are no Q-Controls associated with this analysis.

3. METHOD

The equipment foundation shall be designed in Section 10 using standard foundation design hand calculations. The vertical loads will reflect Mechanical requirements. Lateral loads will be calculated using applicable codes. The soil bearing and foundation stresses will be analyzed using accepted engineering mechanics. The foundation will be designed using the Strength Design Method.

4. CODES AND STANDARDS

4.1 U.S. DEPARTMENT OF ENERGY (DOE):

DOE 6430.1A, dated April 6, 1989	General Design Criteria

4.2 AMERICAN CONCRETE INSTITUTE (ACI):

ACI 318-89	Building Code Requirements for Reinforced Concrete

4.3 AMERICAN NATIONAL STANDARDS INSTITUTE, INC./AMERICAN SOCIETY OF CIVIL ENGINEERS (ANSI/ASCE):

ANSI/ASCE 7-88	Minimum Design Loads for Buildings and Other Structures

4.4 UNIFORM BUILDING CODE (UBC):

UBC, 1991

4.5 AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC):

AISC, 9th Edition	Manual of Steel Construction, Allowable Stress Design

4.6 AMERICAN WELDING SOCIETY (AWS)

AWS D1.1

5. DESIGN INPUTS

5.1 Basis for Design (BFD) Document, Package 1D, Section 7.2.4.6 Surface Compressed Air System (BAB000000-01717-6300-00002, Rev.05)

6. CRITERIA

6.1 The Exploratory Studies Facility Design Requirements

6.2 BFD Document, Package 1D (BAB000000-01717-6300-00002, Rev 5)

6.3 Determination of Importance Evaluation for Package 1D (BAB000000-01717-0200-0000

7. ASSUMPTIONS

7.1 Allowable Soil Pressure = 2,000 psf

7.2 Passive Soil Pressure = 350 pcf

7.3 Concrete Properties

A. Compressive Strength (f'c) = 4,000 psi
B. Concrete weight = 150 pcf

7.4 Reinforcing Yield Strength (fy) = 60 ksi

8. REFERENCES

None used.

9. COMPUTER PROGRAMS

None used.

10. DESIGN ANALYSIS

(Reference page 6, 7, 8, and 9 for hand calculations)

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134
SUBJECT: COMPRESSED AIR SYSTEM/CONDENSATE RECEIVING TANK FDN.

WBS NO: 1.2.6.
DATE: 7-6-94 RE. NO:
CALC NO: BABBCF000-01717-0200-00
ORIGINATOR: M. GOMEZ
CHECKED BY:
CHECKED DATE:

10.0 BODY OF CALCULATION:

10.1 COMPRESSED AIR PAD

- WEIGHTS

EQUIPMENT TYPE		WT
AFTER COOLER	(AX)	1600#
MOISTURE SEPERATOR	(MS)	200#
RECEIVER	(VE)	6,000#
FILTER	(FL)	500#
AIR COMPRESSOR	(CM)	10,000#
		20,300#

* WEIGHTS ARE RELATIVELY UNIFORM ACCROSS PAD. INCREASE 50% FOR ECCENTRICITY & PIPING

WT = 20.3K(1.5) = 30.5K

- LATERAL FORCES: $F = q_z G_h C_f A_f$ (ASCE 7-88)

$q_z = .00256(K_z)(IV)^2$
$= 15 psf$

$K_z = 0.8$ 0-15'
$I = 1.07$ (CAT. III)
$V = 80 mph$
$G_h = 1.32$ <15'
$C_f = 1.4$ *

$F = 15(1.32)(1.4)(A_f)$
$= 27.7 A_f$

* $A_f = 8'(50') = 400$#

$F = 27.7(400) = 11.1^K$

* ASSUME EQUIVALENT FLAT PROJECTED AREA

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134
SUBJECT: COMPRESSED AIR SYSTEM/CONDENSATE RECEIVING TANK FDNS

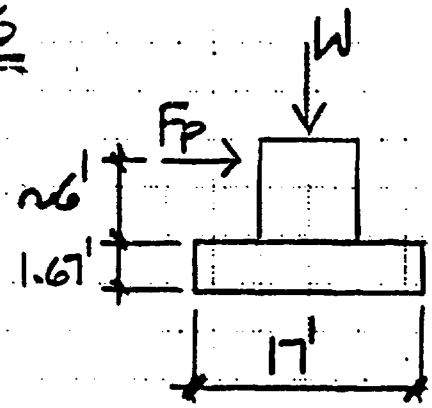
WBS NO: 1.2.6.
DATE: 7-6-94 REV NO:
CALC NO: BABBDF000-01717-0200-00001
ORIGINATOR: M. GOMEZ
CHECKED BY:
CHECKED DATE:

3.) SEISMIC: $F_p = Z I C_p W_p$
$= .45 W_p$

Z = .4 ZONE 4
I = 1.5
C_p = .75 TABLE 23P III.1

$F_p = .45(30.5) = 13.7^k$

∴ SEISMIC GOVERNS



- OVERTURNING:

ASSUME Fp ACTS AT 2/3h

FOUNDATION SIZE = 17' × 55' × 1'-8"

$F_p = 13.7^k$

$W_T = 30.5^k + 17'(55')(1.67')(.15)$
$= 265^k$

* DESIGN MAT FOR TRIBUTARY WIDTH (CONSERVATIVE)

$M_{OT} = 13.7^k(8') = 110^{k'}$
$M_R = 265^k(17'/2) = 2255^{k'}$
STABILITY RATIO = 2255/110 = 20.5 OK

- SOIL BEARING

$e = M/P = 110/265 = .42' < L/6 = 17'/6 = 2.83'$

$$S.B. = \frac{P}{A}\left[1 \pm \frac{6e}{L}\right] = \frac{265}{17'(55')}\left[1 \pm \frac{6(.42)}{17'}\right]$$

S.B. = 400 psf MAX < 1.33(2000) = 2667 psf OK

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134
SUBJECT: COMPRESSED AIR SYSTEM/CONDENSATE RECEIVING TANK FDNS

WBS NO: 1.2.6.
DATE: 7-6-94 REV NO.
CALC NO: BABEDF000-01717-0200-0001
ORIGINATOR: M. GOMEZ
CHECKED BY:
CHECKED DATE:

- REINFORCING: MAXIMUM CANTILEVER = 6'

$w_{u\,max} = 1.1(1.7)(.75)(500) = 700\,psf$

$d = 20" - 3" - .5" = 16.5"$

$M_u = .7(6)^2/2 = 12.6^{k'}$

$K_u = \frac{12.6^{k'}(12000)}{12(16.5)^2} = 46$

$\rho = 1.33(.0013) = .0017$ ← GOVERNS

(OR) $\rho = .0033$

$A_s = .0017(12)(16.5) = .34\,in^2/'$

USE #7 @ 12" o/c E.W.

$A_s = 0.6\,in^2/'$

10.2 CONDENSATE RECEIVING UNIT FDN:

- WEIGHT EMPTY = 4200#
  FULL = 12500#

- SIZE 4'-6" ϕ x 13'-0" LONG

- LATERAL FORCES

A) WIND: SIMILAR TO 10.1 EXCEPT $C_f = 0.6$ TAB. 2

$q_z = 15\,psf$

$h/D = 13/4.5 = 2.9$

$D\sqrt{q_z} = 17.4 > 2.5$

$F = 15(1.32)(.6)A_f$
$= 11.9A_f = 11.9(58.5)$
$F = 700\#$

$A_f = 4.5'(13') = 58.5\,ft^2$

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

Civilian Radioactive Waste Management System

Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134

SUBJECT: COMPRESSED AIR SYSTEM/CONDENSATE RECEIVING TANK FDNS

WBS NO: 1.2.6.

DATE: ___-___-___ REV NO:

CALC NO: BABBDF000-01717-0200-00001

ORIGINATOR: M. GOMEZ

CHECKED BY:

CHECKED DATE:

B) SEISMIC: SIMILAR TO SECTION 10.1

$F_p = .45(12.5^k) = 5{,}625^{\#}$

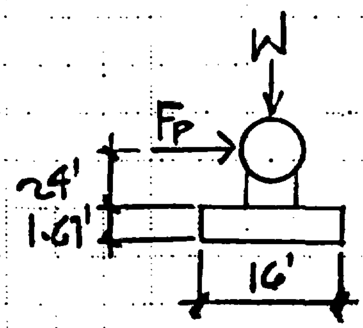
∴ SEISMIC GOVERNS

• OVERTURNING:

FOUNDATION SIZE = 16' × 21' × 1'-8"

$F_p = 5.63^k$

$W_T = 12.5^k + 16'(21')(1.67')(.15) = 97^k$



$M_{OT} = 5.63^k(6') = 33.8^{k'}$

$M_R = 97^k(16'/2) = 776^{k'}$

STABILITY RATIO: 776/34 = 22.8 OK

- SOIL BEARING

$e = M/P = 33.8/97 = .35' < L/6 = 16/6 = 2.67'$

$S.B = \frac{P}{A}\left[1 \pm \frac{6e}{L}\right] = \frac{97^k}{16'(21')}\left[1 \pm \frac{6(.35)}{16}\right]$

≈ 300 psf MAX < 1.33(2000) = 2660 psf OK

• REINFORCING:

$W_{U\,MAX} = 1.4(300) = 420$ psf

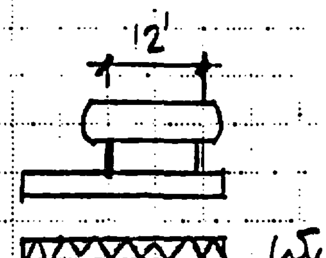
$M_U = .42(9)^2/2 = 17$ k' ; $K_U = \frac{17(12000)}{12(16.5)^2} = 63$

$\rho = 1.33(.0013) = .0018$ ← GOV

(OR) $\rho = .0053$

$A_s = .0018(12)(16.5) = .36$ in²/'

USE #7 @ 12" o/c E.W (As = .60 in²/')



d = 20" − 3" − .5" = 16.5"

11. CONCLUSIONS

11.1 The design shows that a concrete foundation that has minimum dimensions of 17' x 55' x 1'-8" thick, reinforced with #7 bars @ 12" o/c each way, is adequate to support the CAS equipment.

11.2 The design shows that a concrete foundation that has minimum dimensions of 12' x 20' x 1'-8" thick, reinforced with #7 bars @ 12" o/c each way, is adequate to support the Condensate Collection Tank.

12. ATTACHMENTS

None

CRWMS/M&O

Design Analysis Cover Sheet

Complete only applicable items.

1.

WBS: 1.2.6
QA: QA

2. DESIGN ANALYSIS TITLE		
GENERATOR PAD FOUNDATIONS		
3. DOCUMENT IDENTIFIER BABBDA000-01717-0200-00005	4. REV. NO. 0A	5. TOTAL PAGES 9
6. TOTAL ATTACHMENTS/NO. OF PAGES IN EACH NONE	7. SYSTEM ELEMENT ESF	

	Print Name	Signature	Date
8. Originator	M. Gomez	[signature]	7/7/94
9. Checker	J. SALCHAK	[signature]	7.7.94
10. Lead Discipline Engineer	M. GOMEZ	[signature]	7/7/94
11. Department Manager			

12. REMARKS

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

CRWMS/M&O

Design Analysis Revision Record

Complete only applicable items.

(1.)

WBS: 1.2.6
QA: QA

2. DESIGN ANALYSIS TITLE
GENERATOR PAD FOUNDATIONS

3. DOCUMENT IDENTIFIER	4. REVISION NO.
BABBDA000-01717-0200-00005	0A

5. Revision No.	6. Pages Added	7. Pages Deleted	8. Description of Revision
0A	9	0	

1. PURPOSE

The purpose of this analysis is to design structural foundations for the Generator Pad. This analysis is in support of design drawing BABBDF000-01717-2100-23010.

2. QUALITY ASSURANCE

The items considered within this analysis relate to temporary equipment foundations not included on the Q-list. There are no Q-Controls associated with this analysis.

3. METHOD

The equipment foundation shall be designed in Section 10 using standard foundation design hand calculations. The vertical loads will reflect Mechanical/Electrical requirements. Lateral loads will be calculated using applicable codes. The soil bearing and foundation stresses will be analyzed using accepted engineering mechanics. The foundation will be designed using the Strength Design Method.

4. CODES AND STANDARDS

4.1 U.S. DEPARTMENT OF ENERGY (DOE):

DOE 6430.1A, dated April 6, 1989	General Design Criteria

4.2 AMERICAN CONCRETE INSTITUTE (ACI):

ACI 318-89	Building Code Requirements for Reinforced Concrete

4.3 AMERICAN NATIONAL STANDARDS INSTITUTE, INC./AMERICAN SOCIETY OF CIVIL ENGINEERS (ANSI/ASCE):

ANSI/ASCE 7-88	Minimum Design Loads for Buildings and Other Structures

4.4 UNIFORM BUILDING CODE (UBC):

UBC, 1991

4.5 AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC):

AISC, 9th Edition	Manual of Steel Construction, Allowable Stress Design

4.6 AMERICAN WELDING SOCIETY (AWS):

AWS D1.1

5. DESIGN INPUTS

5.1 Basis for Design (BFD) Document, Package 1D, Section 7.2.4.1 Power System (BAB000000-01717-6300-00002, Rev.05)

6. CRITERIA

6.1 The Exploratory Studies Facility Design Requirements

6.2 BFD Document, Package 1D (BAB000000-01717-6300-00002, Rev 5)

6.3 Determination of Importance Evaluation for Package 1D (BAB000000-01717-0200-0000

7. ASSUMPTIONS

7.1 Allowable Soil Pressure = 2,000 psf

7.2 Passive Soil Pressure = 350 pcf

7.3 Concrete Properties

A. Compressive Strength (f'c) = 4,000 psi
B. Concrete weight = 150 pcf

7.4 Reinforcing Yield Strength (fy) = 60 ksi

8. REFERENCES

8.1

9. COMPUTER PROGRAMS

None used.

10. DESIGN ANALYSIS

(Reference page 6, 7, and 8 for hand calculations)

10.0 BODY OF CALCULATIONS

10.1 GENERATOR FOUNDATION

- WEIGHT = 29,740# SAY 30K
- SIZE = 6' x 20' x 9'-0" HIGH (ENCLOSURE)
- LATERAL FORCES

A) WIND: $F = q_z G_h C_f A_f$ (ASCE 7-88)

$q_z = .00256(K_z)(IV)^2$
$= 15psf$

$K_z = 0.8$ 0-15'
$I = 1.07$ (CAT. III)
$V = 80mph$
$G_h = 1.32$ <15'
$C_f = 1.4$

$F = 15(1.32)(1.4)A_f$
$= 27.7A_f$

$A_f = 9'(20) = 180^{\square}$ (TRANSVERSE WORST CASE)
$F = 27.7(180) = 4990\#$

B) SEISMIC: $F_p = Z I C_p W_p$
$= .45W_p$

$Z = .4$ ZONE 4
$I = 1.5$
$C_p = .75$ TABLE 23-P
III.1

$F_p = .45(30^K) = 13.5^K$

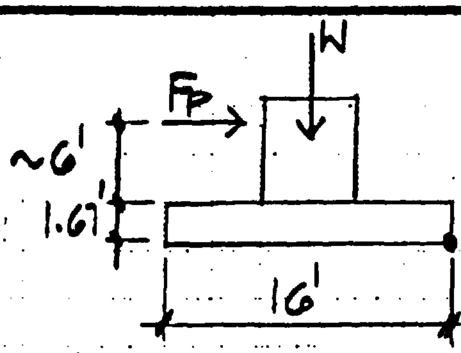
∴ SEISMIC GOVERNS

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134
SUBJECT: GENERATOR FDNS

WBS NO. 1.2.6.
DATE: 7-6-94 REV NO.
CALC NO: BABBDA000-01717-0200-00005
ORIGINATOR: M GOMEZ
CHECKED BY:
CHECKED DATE:

- OVERTURNING:



ASSUME F_p ACTS AT 2/3 h

FOUNDATION SIZE = 16' x 30' x 1'-8"

$F_p = 13.5^k$

$W_T = 30^k + 16'(30')(1.67')(.15)$
$= 150^k$

*DESIGN MAT FOR TRIBUTARY WIDTH (CONSERVATIVE)

$M_{OT} = 13.5^k(8') = 110^{k'}$

$M_R = 150^k(16'/2) = 1200^{k'}$

STABILITY RATIO = 1200/110 = 10.9 OK

- SOIL BEARING

$e = M/P = 110/150 = .733' < L/6 = 16'/6 = 2.67'$

$SB = \frac{P}{A}\left[1 \pm \frac{6e}{L}\right] = \frac{150}{16(30)}\left[1 \pm \frac{6(.733)}{16'}\right]$

$S.B._{MAX} = 400$ psf $< 1.33(2000) = 2667$ psf OK

- REINFORCING: MAXIMUM CANTILEVER = 6'

$W_{u\,max} = 1.1(1.7)(.75)(500) = 700$ psf

$d = 20" - 3" - .5"$
$= 16.5"$

$M_U = .7(6)^2/2 = 12.6^{k'}$

$K_U = \frac{12.6^{k'}(1200)}{(12)(16.5)^2} = .46$

$\rho = 1.33(.0013) = .0017 \leftarrow$ GOVERNS

(OR) $\rho = .0033$

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134
SUBJECT: GENERATOR FDNS

WBS NO: 1.2.6.
DATE: 7-6-94 REV NO:
CALC NO: BABEDA000-01717-020 000
ORIGINATOR: M. GOMEZ
CHECKED BY:
CHECKED DATE:

$A_s = .0017(12)(16.5) = .34\ in^2/_{1}$

USE #7 @ 12" O/C E.W.

$A_s = .60\ in^2/_{1}$

11. CONCLUSIONS

The design shows that a concrete foundation that has minimum dimensions of 16' x 30' x 1'-8" thick, reinforced with #7 @ 12" o/c each way, is adequate to support the proposed Generator Pad.

12. ATTACHMENTS

None

CRWMS/M&O

Design Analysis Cover Sheet

Complete only applicable items.

(1.)

WBS: 1.2.6
QA: QA
Page: 1 Of: 10

2. DESIGN ANALYSIS TITLE			
SITE LIGHTING FOUNDATIONS			
3. DOCUMENT IDENTIFIER BABBDA000-01717-0200-00006		4. REV. NO. 0A	5. TOTAL PAGES 10
6. TOTAL ATTACHMENTS/NO. OF PAGES IN EACH NONE		7. SYSTEM ELEMENT ESF	

	Print Name	Signature	Date
8. Originator	M. Gomez	[signature]	7/7/94
9. Checker	J. SALCIIAK	[signature]	7.7.94
10. Lead Discipline Engineer	M. GOMEZ	[signature]	7/7/94
11. Department Manager			

12. REMARKS

QAP-3-9 0492 (Rev. 03/14/94)

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

CRWMS/M&O

Design Analysis Revision Record

Complete only applicable items.

(1.)

WBS: 1.2.6
QA: QA

2. DESIGN ANALYSIS TITLE	
SITE LIGHTING FOUNDATIONS	
3. DOCUMENT IDENTIFIER	**4. REVISION NO.**
BABBDA000-01717-0200-00006	0A

5. Revision No.	6. Pages Added	7. Pages Deleted	8. Description of Revision
0A	10	0	

1. PURPOSE

The purpose of this analysis is to design structural foundations for the Site Lighting. This analysis is in support of design drawing BABBDF000-01717-2100-23016.

2. QUALITY ASSURANCE

The items considered within this analysis relate to temporary equipment foundations not included on the Q-list. There are no Q-Controls associated with this analysis.

3. METHOD

The equipment foundation shall be designed in Section 10 using standard foundation design hand calculations. The vertical loads will reflect Electrical requirements. Lateral loads will be calculated using applicable codes. The soil bearing and foundation stresses will be analyzed using accepted engineering mechanics. The foundation will be designed using the Strength Design Method.

4. CODES AND STANDARDS

4.1 U.S. DEPARTMENT OF ENERGY (DOE):

DOE 6430.1A, dated April 6, 1989	General Design Criteria

4.2 AMERICAN CONCRETE INSTITUTE (ACI):

ACI 318-89	Building Code Requirements for Reinforced Concrete

4.3 AMERICAN NATIONAL STANDARDS INSTITUTE, INC./AMERICAN SOCIETY OF CIVIL ENGINEERS (ANSI/ASCE):

ANSI/ASCE 7-88	Minimum Design Loads for Buildings and Other Structures

4.4 UNIFORM BUILDING CODE (UBC):

UBC, 1991

4.5 AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC):

AISC, 9th Edition	Manual of Steel Construction, Allowable Stress Design

4.6 AMERICAN WELDING SOCIETY (AWS):

AWS D1.1

5. DESIGN INPUTS

5.1 Basis for Design (BFD) Document, Package 1D, Section 7.2.4.1 Power System (BAB000000-01717-6300-00002, Rev.05)

6. CRITERIA

6.1 The Exploratory Studies Facility Design Requirements

6.2 BFD Document, Package 1D (BAB000000-01717-6300-00002, Rev 5)

6.3 Determination of Importance Evaluation for Package 1D (BAB000000-01717-0200-0000

7. ASSUMPTIONS

7.1 Allowable Soil Pressure = 2,000 psf

7.2 Passive Soil Pressure = 350 pcf

7.3 Concrete Properties

A. Compressive Strength (f'c) = 4,000 psi
B. Concrete weight = 150 pcf

7.4 Reinforcing Yield Strength (fy) = 60 ksi

8. REFERENCES

Concrete Reinforcing Steel Institute, Handbook

9. COMPUTER PROGRAMS

None used.

10. DESIGN ANALYSIS

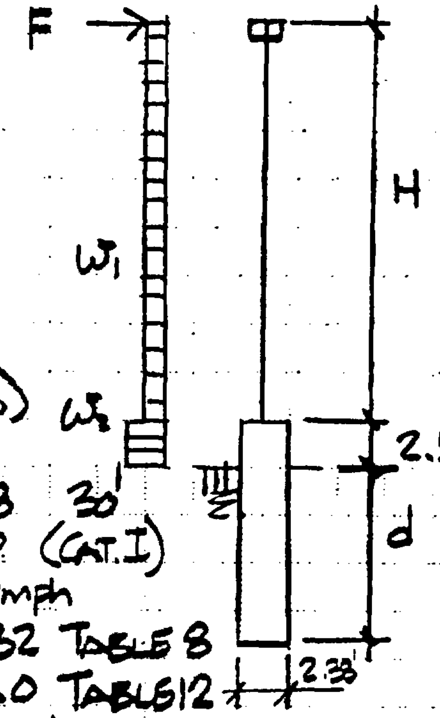
(Reference page 6,7, 8, and 9 for hand calculations)

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134
SUBJECT: SITE LIGHTING FNDS

WBS NO: 1.2.6.
DATE: 7-6-94 REV NO.
CALC NO: BABBAA000-01717-0200-20...
ORIGINATOR: M. GOMEZ
CHECKED BY:
CHECKED DATE:

10.0 BODY OF CALCULATION



10.1 30' POLE FDN: H=30'

- LATERAL FORCES (WIND)

$F = q_z G_h C_f A_f$ (ASCE 7-88)

$q_z = .00256 (K_z)(IV)^2$ $K_z = .98$ 30'
$= 16.1$ psf $I = 1.0$ (CAT. I)
$V = 80$ mph
$F = 16.1(1.32)(2)(A_f)$ $G_h = 1.32$ TABLE 8
$= 42.5 A_f$ $C_f = 2.0$ TABLE 12
$h/D = 30/.75 = 40 > 25$

$W_1 = .75'(42.5) = 32^{\#}/'$
$W_2 = 2.33'(42.5) = 100^{\#}/'$
$F = 5(1')(42.5) = 250^{\#}$

$M_{OT} = 250^{\#}(32.5') + \frac{32(32.5)^2}{2} + \frac{68(2.5)^2}{2} = 25{,}250^{\#'}$

$F_{EQUIV} = \frac{25{,}250^{\#'}}{32.5'} = 777^{\#}$

- FOOTING DEPTH (d)

FROM UBC SECTION 2907 (g) 2
ASSUME TOP TO BE UNRESTRAINED (CONSERVATIVE)

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

Civilian Radioactive Waste Management System

Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134

SUBJECT: SITE LIGHTING FDNS

WBS NO: 1.2.6.

DATE: 1-6-94 REV NO:

CALC NO BABBPA000-01717-0200-00006

ORIGINATOR: M. GOMEZ

CHECKED BY:

CHECKED DATE:

$$d = \frac{A}{2}\left[1 + \sqrt{1 + \frac{4.36h}{A}}\right]$$

$P = 771^{\#}$

$b = 2.33'$

$h = 32.5'$

$S_1 = 350 psf\ d/3$

$$A = \frac{2.34P}{S_1 b}$$

S_1 = ALLOWABLE SOIL BEARING PRESSURE @ d/3

d ASSUMED	S_1	A	d REQ'D	OK?
8'	933	.836	5.2'	Y
7'	817	.956	6.3'	Y
6'	700	1.115	6.9'	N

∴ USE 2'-4" φ × 7'-0" LONG

-REINFORCING

$M_U = 1.4(25.3^{k'}) = 35.4^{k'}$; $P_U = 10$ (ASSUMED)

FROM CRSI MANUAL W/5-#10 $M_U = 320^{k'}$ @ $P_U = 369^{k'}$ OK

USE 2'-4" φ × 7'-0" LONG W/ 5-#10

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134
SUBJECT: SITE LIGHTING FDNS

WBS NO: 1.2.8.
DATE: 7-6-94 REV NO:
CALC NO: BABBDA000-01717-0200-X
ORIGINATOR: M. GAMEZ
CHECKED BY:
CHECKED DATE:

10.2 40' POLE FDN H = 40'

- LATERAL FORCES: SIMILAR TO 10.1 EXCEPT $K_Z = 1.06$

$q_z = 16.1 \frac{(1.06)}{.98} = 17.4$

$F: 42.5 \frac{17.4}{16.1} = 46 \text{ psf } A_f$

$W_1 = .75'(46) = 34.5 \#/'$

$W_2 = 2.33'(46) = 110 \#/'$

$F = 5'(1')(46) = 250\#$

$M_{OT} = 250(42.5) + \frac{34.5(42.5)^2}{2} + \frac{75.5(2.5)^2}{2} = 42{,}020 \#'$

$F_{EQUIV} = \frac{42{,}020}{42.5} = 1000\#$

- FOOTING DEPTH (d)

SIMILAR TO SECTION 10.1

$d_{ASSUMED}$	S_1	A	d_{REQ}	OK?
10'	1167	.860	6.8	Y
9'	1050	.956	7.15	Y
8'	933	1.076	7.62	Y
7'	817	1.250	8.19	N

USE 2'-4" ϕ × 8'-0" LONG

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134
SUBJECT: SITE LIGHTING FDNS

WBS NO: 1.2.6.
DATE: 7-6-94 REV NO:
CALC NO: BABBDA000-01717-0200-00006
ORIGINATOR: M. GOMEZ
CHECKED BY:
CHECKED DATE:

- REINFORCING

$M_U = 1.4(42) = 59^{K'}$

BY INSPECTION W/ SECTION 10.1, REINFORCING OK

USE 2'-4"ϕ × 8'-0" LONG
W/ 5-#10

11. CONCLUSIONS

11.1 The design shows tha a concrete foundation that has minimum dimensions of 2'-6" diameter x 7'-0" long, reinforced with 5- #10's, is adequate to support a Site Lighting Standard with a nominal pole length of 30'.

11.2 The design shows that a concrete foundation that has minimum dimensions of 2'-6" diameter x 8'-0" long, reinforced with 5- #10's, is adequate to support a Site Lighting Standard with a nominal pole length of 40'.

12. ATTACHMENTS

None

CRWMS/M&O

Design Analysis Cover Sheet

Complete only applicable items.

(1.)

WBS: 1.2.6
QA: QA
Page: 1 Of: 9

2. DESIGN ANALYSIS TITLE			
DIESEL FUEL TANK FOUNDATIONS			
3. DOCUMENT IDENTIFIER: BABBDA000-01717-0200-00007	4. REV. NO.: 0A	5. TOTAL PAGES: 9	
6. TOTAL ATTACHMENTS/NO. OF PAGES IN EACH: NONE	7. SYSTEM ELEMENT: ESF		

	Print Name	Signature	Date
8. Originator	M. Gomez	[signature]	7/7/94
9. Checker	J. SALCHAK	J Salchak	7.7.94
10. Lead Discipline Engineer	M. GOMEZ	[signature]	7/7/94
11. Department Manager			

12. REMARKS

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

CRWMS/M&O

Design Analysis Revision Record

Complete only applicable items.

(1.)

WBS: 1.2.6
QA: QA

2. DESIGN ANALYSIS TITLE			
DIESEL FUEL TANK FOUNDATIONS			
3. DOCUMENT IDENTIFIER			4. REVISION NO.
BABBDA000-01717-0200-00007			0A

5. Revision No.	6. Pages Added	7. Pages Deleted	8. Description of Revision
0A	9	0	

1. PURPOSE

The purpose of this analysis is to design structural foundations for the Diesel Fuel Tank. This analysis is in support of design drawing BABBDF000-01717-2100-23082.

2. QUALITY ASSURANCE

The items considered within this analysis relate to temporary equipment foundations not included on the Q-list. There are no Q-Controls associated with this analysis.

3. METHOD

The equipment foundation shall be designed in Section 10 using standard foundation design hand calculations. The vertical loads will reflect Mechanical requirements. Lateral loads will be calculated using applicable codes. The soil bearing and foundation stresses will be analyzed using accepted engineering mechanics. The foundation will be designed using the Strength Design Method.

4. CODES AND STANDARDS

4.1 U.S. DEPARTMENT OF ENERGY (DOE):

DOE 6430.1A, dated April 6, 1989 — General Design Criteria

4.2 AMERICAN CONCRETE INSTITUTE (ACI):

ACI 318-89 — Building Code Requirements for Reinforced Concrete

4.3 AMERICAN NATIONAL STANDARDS INSTITUTE, INC./AMERICAN SOCIETY OF CIVIL ENGINEERS (ANSI/ASCE):

ANSI/ASCE 7-88 — Minimum Design Loads for Buildings and Other Structures

4.4 UNIFORM BUILDING CODE (UBC):

UBC, 1991

4.5 AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC):

AISC, 9th Edition — Manual of Steel Construction, Allowable Stress Design

4.6 AMERICAN WELDING SOCIETY (AWS):

AWS D1.1

5. DESIGN INPUTS

5.1 Basis for Design (BFD) Document, Package 1D, Section 7.2.4.1 Power System (BAB000000-01717-6300-00002, Rev.05).

6. CRITERIA

6.1 The Exploratory Studies Facility Design Requirements

6.2 BFD Document, Package 1D (BAB000000-01717-6300-00002, Rev 5)

6.3 Determination of Importance Evaluation for Package 1D (BAB000000-01717-0200-0000.

7. ASSUMPTIONS

7.1 Allowable Soil Pressure = 2,000 psf

7.2 Passive Soil Pressure = 350 pcf

7.3 Concrete Properties

A. Compressive Strength (f'c) = 4,000 psi
B. Concrete weight = 150 pcf

7.4 Reinforcing Yield Strength (fy) = 60 ksi

8. REFERENCES

None used.

9. COMPUTER PROGRAMS

None used.

10. DESIGN ANALYSIS

(Reference page 6, 7, and 8 for hand calculations)

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

WBS NO: 1.2.6.
CONTRACT NO. DE-AC01-91RW00134
DATE: 7-6-94 REV NO:
SUBJECT: DIESEL FUEL TANK FDN
CALC NO: BABEDA000-01717-0200-0
ORIGINATOR: M. GOMEZ
CHECKED BY:
CHECKED DATE:

10.0 BODY OF CALCULATIONS:

10.1 DIESEL FUEL TANK FDN

- WEIGHT: EMPTY = 22.5K; FULL = 85.0K

- SIZE: 9'-0" ϕ × 20'-0" LONG

- LATERAL FORCES

A) WIND: $F = q_{z} G_h C_f A_f$ (ASCE 7-88)

$q_{z} = .00256 (K_z)(IV)^2$
$= 15 \text{ psf}$

$K_z = 0.8$ 0-15'
$I = 1.07$ (CAT. III)
$V = 80 \text{ mph}$
$G_h = 1.32$ <15'
$C_f = 0.6$ TABLE 12
$L/D = 20/9 = 2.22$
$D\sqrt{q_z} = 3572.5$

$F = 15(1.32)(.6)(A_f)$
$F = 11.9 A_f$

$A_f = 9'(22') = 198^{\square}$ (TRANSVERSE WORST CASE)

$F = 11.9(198) = 2360^{\#}$

B) SEISMIC: $F_p = Z I C_p W_p$
$= .4(1.5)(.75) W_p$
$F_p = .45 W_p$

$Z = .4$ ZONE 4
$I = 1.5$
$C_p = .75$ Table 23-P III.1

$F_p = .45(85^k) = 38.3^k$

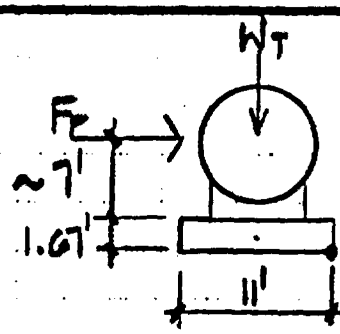
$\therefore$ **SEISMIC GOVERNS**

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134
SUBJECT: DIESEL FUEL TANK FDN

WBS NO: 1.2.6.
DATE: 7-6-94 REV NO:
CALC NO: BABBDA000-01717-0200-00007
ORIGINATOR: M. GOMEZ
CHECKED BY:
CHECKED DATE:

- OVERTURNING:



FOUNDATION SIZE = 11' × 22' × 1'-8"

$F_P = 38.3^k$

$W_T = 85^k + 11'(22')(1.67')(.15)$
$= 145^k$

$M_{OT} = 38.3^k(9') = 345^{k'}$

$M_R = 145^k(11'/2) = 798^{k'}$

STABILITY RATIO = 798/345 = 2.3 **OK**

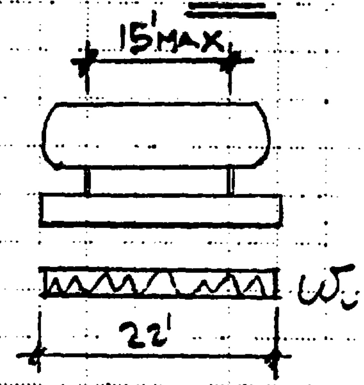
- SOIL BEARING:

$e = M/P = 345/145 = 2.38'$ $\geq L/6 = 11'/6 = 1.83'$

$S.B. = \frac{P}{A}\left[\frac{4L}{3L - 6e}\right] = \frac{145^k}{11'(22')}\left[\frac{4(11)}{3(11) - 6(2.38)}\right]$

S.B. = 1.41 KSF < 1.33(2) = 2.67 KSF **OK**

- REINFORCING: DESIGN FOR MAXIMUM SUPPORT WIDTH



$W_{u_{max}} = 1.1(1.7)(.75)(1.41) = 2$ KSF

$M_U = 2\left[\frac{15^2}{8} - \frac{3.5^2}{2}(2)\right] = 32^{k'}/'$

$K_U = \frac{32^{k'}(12{,}000)}{(12")(16.5")^2} = 118$

d: 20" − 3" − .5 = 16.5"

$\rho = 1.33(.0023) = .003$ ← GOVERNS

(OR) $\rho = .0033$

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134
SUBJECT: DIESEL FUEL TANK FDN

WBS NO: 1.2.6.
DATE: 7-6-94 REV NO:
CALC NO: BABBDA000-01717-0200-00006
ORIGINATOR: M.GOMEZ
CHECKED BY:
CHECKED DATE:

$A_s = .003(12)(16.5) = .59\ in^2/_1$

USE #7 @ 12" O/C E.W.

$A_s = .60\ in^2/_1$

11. CONCLUSIONS

The design shows that a concrete foundation that has minimum dimensions of 11' x 22' x 1'-8" thick, reinforced with #7 @ 12" o/c each way, is adequate to support the proposed Fuel Storage Tank.

12. ATTACHMENTS

None

CRWMS/M&O

Design Analysis Cover Sheet

Complete only applicable items.

(1.)

WBS: 1.2.6
QA: QA
Page: 1 Of: ~~4~~ 5 YS 6/16/94

2. DESIGN ANALYSIS TITLE BUILDINGS GROUND GRID CALCULATIONS			
3. DOCUMENT IDENTIFIER BABBA0000-01717-0200-00001		4. REV. NO. ~~00~~ 0A REH 7/7/94	5. TOTAL PAGES ~~4~~ 5 REH 7/7/94
6. TOTAL ATTACHMENTS/NO. OF PAGES IN EACH 1 attachment/~~12~~ 10 pages YS 6/16/94	7. SYSTEM ELEMENT ESF		

	Print Name	Signature	Date
8. Originator	B. Majmudar	Bharat H. Majmudar	6/3/94
9. Checker	Y. Shane	Yun H. Shane	6/16/94
10. Lead Discipline Engineer	R. Howell	R. E. Howell	7/7/94
11. Department Manager	P. Pimental		

12. REMARKS

QAP-3-9

0492 (Rev. 03/14/94)

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

CRWMS/M&O

Design Analysis Revision Record

Complete only applicable items.

(1.)

WBS: 1.2.6
QA: QA
Page: 2 Of:

2. DESIGN ANALYSIS TITLE
BUILDING GROUND GRID CALCULATIONS

3. DOCUMENT IDENTIFIER
BABBA0000-01717-0200-00001

4. REVISION NO.
~~00~~ 0A RSH 7/7/94

5. Revision No.	6. Pages Added	7. Pages Deleted	8. Description of Revision

QAP-3-9

0487 (Rev. 03/10/94)

1. PURPOSE

The purpose of this calculation is to determine the ground resistance of the ground grid for Switchgear Building, Change House, Shop Building, and Booster Pump Building.

2. QUALITY ASSURANCE

The items discussed in this document at this time are considered not important to waste isolation or radiological safety.

3. METHOD

Institute of Electrical and Electronic Engineers (IEEE) 80 method was used for this calculation.

4. CODES AND STANDARDS

4.1 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA):

NFPA 70 - 93 (Article 250) National Electrical Code

4.2 INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE):

IEEE 142 - 91 Recommended Practice for Grounding of Industrial and Commercial Power Systems.

IEEE 80 - 86 Guide for Safety in AC Substation Grounding.

5. DESIGN INPUTS

- Ambient Temperature - (-14°F to 108°F)
- Surface Material Resistivity - Variable (from Electrical Resistivity Survey of September 1993)
- Ground Cable - Copper, 4/0 AWG (212.00 kcmil)
- Ground Rod - Copper, 3/4" dia. x 10' long.

6. CRITERIA

None used.

7. ASSUMPTIONS

Uniform soil resistivity for the length of the ground rods were assumed.

8. REFERENCES

- Electrical Resistivity Survey of September 14, 1993.
- IEEE 80 - 1986.

9. COMPUTER PROGRAMS

None used.

10. DESIGN ANALYSIS

Grounding grid calculations were done to determine the resistance of the grounding system. Earth Resistivity data was received from the survey conducted on September 14, 1993. Ambient temperature was assumed as close as possible to the actual environmental conditions. The IEEE 80 method for the calculations was used.

11. CONCLUSION

The following ground grid calculations were performed:

1. Switchgear Building
2. Change House
3. Shop Building
4. Booster Pump Building.

The ground loop around the building is mainly provided for the equipment grounding and personnel safety. Its purpose is to reduce shock hazard to personnel, and provide low impedance return path for ground fault current.

In all cases, resistance to ground was found to be less than 5 ohms. Even though NFPA 70, Article 250-84, allow resistance to be within 25 ohms, IEEE 142 recommends it to be no greater than 5 ohms.

12. ATTACHMENTS

ATTACHMENT	TITLE
1	Building Ground Grid Calculations. (10 pages)

ATTACHMENT 1

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134

SUBJECT: BUILDING GROUND GRID CALCS.

WBS NO: 1.2.8.

DATE: 6-2-94 REV NO: OA

CALC NO: BABBA0000-01717-0200-00001

ORIGINATOR: B. MAJMUDAR

CHECKED BY: Y. D. SHANE RZH

CHECKED DATE: 6-16-94 7/7/94

IEEE 80

SCHWARZ'S FORMULA:

$$R_g = \frac{R_1 R_2 - R_{12}^2}{R_1 + R_2 - 2R_{12}} \qquad (1)$$

WHERE, R_1 = RESISTANCE OF GRID CONDUCTORS
R_2 = RESISTANCE OF GROUND RODS
R_{12} = MUTUAL RESISTANCE BETWEEN GRID CONDUCTORS AND GROUND RODS.
R_g = GROUND RESISTANCE

$$R_1 = (\rho_1/\pi l_1)(\ln(2l_1/h') + k_1(l_1/\sqrt{A}) - k_2) \qquad (2)$$

$$R_2 = (\rho_a/2n\pi l_2)[\ln(8l_2/d_2) - 1 + 2k_1(l_2/\sqrt{A})(\sqrt{n}-1)^2] \qquad (3)$$

$$R_{12} = (\rho_a/\pi l_1)[\ln(2l_1/l_2) + k_1(l_1/\sqrt{A}) - k_2 + 1] \qquad (4)$$

WHERE,
ρ_1 = SOIL RESISTIVITY IN Ω-m (FROM DEPTH h)
ρ_a = APPARENT SOIL RESISTIVITY IN Ω-m

l_1 = TOTAL LENGTH OF GRID CONDUCTORS IN m
l_2 = AVERAGE LENGTH OF GROUND ROD IN m
h = DEPTH OF GRID BURIAL IN m
$h' = \sqrt{d_1 h}$
A = AREA COVERED BY GRID IN m^2
n = NUMBER OF GROUND RODS

ATTACHMENT 1

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

WBS NO: 1.2.4.

CONTRACT NO. DE-AC01-91RW00134

DATE: 6-2-94 REV NO: 0A

SUBJECT: BUILDING GROUND GRID CALCS.

CALC NO: BABBA0000-01717-0200-~~00001~~ 0001

ORIGINATOR: B. MAJMUDAR

CHECKED BY: Y.D. SHANE RZH

CHECKED DATE: 6-16-94 7/7/94

k_1, & k_2 = CONSTANTS

d_1 = DIA. OF GRID CONDUCTORS IN m

d_2 = DIA. OF GROUND RODS IN m

a = SHORT-SIDE GRID LENGTH IN m

b = LONG SIDE LENGTH IN m

$\rho_1 = \rho_a$ FOR UNIFORM SOIL

ATTACHMENT 1

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134

SUBJECT: BUILDING GROUND GRID CALCS.

WBS NO: 1.2.8.
DATE: 6-2-94 REV NO: 0A
CALC NO: BABBA0000-01717-0200-001
ORIGINATOR: B. MAJMUDAR
CHECKED BY: Y. D. SHANE
CHECKED DATE: 6-16-94

SWITCHGEAR BLDG

$\rho_1 = 131 \ \Omega\text{-}m$

$\rho_2 = 131 \ \Omega\text{-}m$ (ASSUME UNIFORM SOIL)

$l_1 = 420 \text{ ft} \times 0.3048 = 128.02 \ m$

$l_2 = 10 \text{ ft} \times 0.3048 = 3.048 \ m$

$h = 2.5 \text{ ft} \times 0.3048 = 0.76 \ m$

$h' = \sqrt{0.0117 \times 0.76} = 0.0943 \ m$

$A = (145 \times 0.3048) \times (65 \times 0.3048) \ m^2$

$= 875.61 \ m^2$

$n = 18$

$K_1 = 1.261$ (FROM IEEE 80-86, PAGE 86)

$K_2 = 5.595$ (FROM IEEE 80-86, PAGE 87)

$d_1 = 0.0117 \ m$

$d_2 = 0.75 \text{ in} \times 0.0254$

$= 0.0191 \ m$

USING FORMULA (2), (3) & (4)

$$R_1 = \left(\frac{131}{\pi \times 128.02}\right)\left(\ln\left(\frac{2 \times 128.02}{0.0943}\right) + 1.261\left(\frac{128.02}{\sqrt{875.61}}\right) - 5.595\right)$$

$= 2.4359$

$$R_2 = \left(\frac{131}{2 \times 18 \times \pi \times 3.048}\right)\left[\ln\left(\frac{8 \times 3.048}{0.0191}\right) - 1 + (2 \times 1.261)\left(\frac{3.048}{\sqrt{875.61}}\right)\left(\sqrt{18} - 1\right)^2\right]$$

$= 3.3759$

ATTACHMENT 1

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134

SUBJECT: BUILDING GROUND GRID CALCS.

WBS NO: 1.2.6.
DATE: 6-2-94 REV NO: 0A
CALC NO: BABBA0000-01717-0200-00001
ORIGINATOR: B. MAJMUDAR
CHECKED BY: Y. D. SHANE
CHECKED DATE: 6-16-94

$$R_{12} = \left(131/\pi \times 128.02\right)\left[\ln\left(\frac{2\times 128.02}{3.048}\right) + 1.261\left(128.02/\sqrt{875.61}\right) - 5.595 + 1\right]$$

$$= 1.7235$$

USING FORMULA (1),

$$R_g = \frac{(2.5299 \times 3.3759) - (1.7235)^2}{2.5299 + 3.3759 - (2 \times 1.7235)}$$

$$= 2.2654\ \Omega$$

ATTACHMENT 1

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

WBS NO: 1.2.8.

CONTRACT NO. DE-AC01-91RW00134

DATE: 6-2-94 REV NO: 0A

SUBJECT: BUILDING GROUND GRID CALCS.

CALC NO: BABBA0000-01717-020X 0001

ORIGINATOR: B. MAJMUDAR

CHECKED BY: Y. D. SHANE

CHECKED DATE: 6-16-94

CHANGE HOUSE

$\rho_1 = 140\ \Omega\text{-}m$

$\rho_2 = 140\ \Omega\text{-}m$

$l_1 = 560\ ft \times 0.3048 = 170.688\ m$

$l_2 = 3.048\ m$

$h = 0.76\ m$

$h' = 0.0943\ m$

$A = (145 \times 0.3048) \times (135 \times 0.3048)$

$= 1818.577\ m^2$

$n = 24$

$k_1 = 1.328$

$k_2 = 5.505$

$d_1 = 0.0117\ m$

$d_2 = 0.0191\ m$

USING FORMULA (2), (3) & (4)

$$R_1 = \left(\frac{140}{\pi \times 170.688}\right)\left(\ln\left(\frac{2 \times 170.688}{0.0943}\right) + 1.328\left(\frac{170.688}{\sqrt{1818.577}}\right) - 5.505\right)$$

$= 2.0898$

$$R_2 = \left(\frac{140}{2 \times 24 \times \pi \times 3.048}\right)\left[\ln\left(\frac{8 \times 3.048}{0.0191}\right) - 1 + (2 \times 1.328)\left(\frac{3.048}{\sqrt{1818.577}}\right)\left(\sqrt{24} - 1\right)^2\right]$$

$= 2.7529$

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134

SUBJECT: BUILDING GROUND GRID CALCS

WBS NO: 1.2.6.

DATE: 6-2-94 REV NO: 0A

CALC NO: BABBA0000-01717-02000-00001

ORIGINATOR: B. MAJMUDAR

CHECKED BY: Y. D. SHANE

CHECKED DATE: 6-16-94

$$R_{12} = \left(140 / \pi \times 170.688\right)\left[\ln\left(\frac{2 \times 170.688}{3.048}\right) + 1.328\left(\frac{170.688}{\sqrt{1818.577}}\right) - 5.505 + 1\right]$$

$$= 1.4435$$

USING FORMULA (1),

$$R_g = \frac{(2.0898 \times 2.7529) - (1.4435)^2}{2.0898 + 2.7529 - (2 \times 1.4435)}$$

$$= 1.8762\ \Omega$$

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134

SUBJECT: BUILDING GROUND GRID CALCS.

WBS NO: 1.2.8.
DATE: 6-2-94 REV NO: 0A
CALC NO: BABBA0000-01717-02000-
ORIGINATOR: B. MAJMUDAR
CHECKED BY: Y. D. SHANE
CHECKED DATE: 6-16-94

SHOP BLDG

$\rho_1 = 62\ \Omega\text{-}m$

$\rho_2 = 62\ \Omega\text{-}m$

$l_1 = 500\,ft \times 0.3048 = 152.40\ m$

$l_2 = 3.048\ m$

$h = 0.76\ m$

$h' = 0.0943\ m$

$A = (205 \times 0.3048) \times (45 \times 0.3048) = 857.031\ m^2$

$n = 22$

$K1 = 1.161$

$K2 = 5.911$

$d_1 = 0.0117\ m$

$d_2 = 0.0191\ m$

USING FORMULA (2), (3) & (4).

$$R1 = \left(\frac{62}{\pi \times 152.40}\right)\left(\ln\frac{2 \times 152.40}{0.0943} + 1.161\left(\frac{152.40}{\sqrt{857.031}}\right) - 5.911\right)$$

$$= 1.0637$$

$$R_2 = \left(\frac{62}{2 \times 22 \times \pi \times 3.048}\right)\left[\ln\left(\frac{8 \times 3.048}{0.0191}\right) - 1 + (2 \times 1.161) \times \left(\frac{3.048}{\sqrt{857.031}}\right)\left(\sqrt{22} - 1\right)^2\right]$$

$$= 1.3898$$

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134

SUBJECT: BUILDING GROUND GRID CALCS.

WBS NO: 1.2.6.

DATE: 6-2-94 REV NO: 0A

CALC NO: BABBA0000-01717-02000-00001

ORIGINATOR: B. MAJMUDAR

CHECKED BY: Y. D. SHANE

CHECKED DATE: 6-16-94

$$R_{12} = \left(62 / \pi \times 152.40\right)\left[\ln\left(\frac{2 \times 152.40}{3.048}\right) + 1.61\left(152.40 / \sqrt{857.031}\right) - 5.911 + 1\right]$$

$$= 1.0457$$

USING FORMULA (1),

$$R_g = \frac{(1.0637 \times 1.3898) - (1.0457)^2}{1.0637 + 1.3898 - (2 \times 1.0457)}$$

$$= 1.0628\ \Omega$$

ATTACHMENT 1

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134

SUBJECT: BUILDING GROUND GRID CALCS.

WBS NO: 1.2.8.

DATE: 6 - 2 - 94 REV NO: 0A

CALC NO: BABBA0000-01717-0200-0

ORIGINATOR: B. MAJMUDAR

CHECKED BY: Y. D. SHANE

CHECKED DATE: 6-16-94

BOOSTER PUMP STATION

$\rho_1 = 140 \ \Omega\text{-}m$

$\rho_2 = 140 \ \Omega\text{-}m$

$l_1 = 158 \text{ ft} \times 0.3048 = 48.158 \ m$

$l_2 = 3.048 \ m$

$h = 0.76 \ m$

$h' = 0.0943$

$A = (53 \times 0.3048) \times (26 \times 0.3048) = 128.020 \ m^2$

$n = 22$

$K_1 = 1.173$

$K_2 = 5.185$

$d_1 = 0.0117 \ m$

$d_2 = 0.0191 \ m$

USING FORMULA (2), (3) & (4)

$$R_1 = \left(\frac{140}{\pi \times 48.158}\right)\left(\ln \frac{(2 \times 48.158)}{0.0943} + 1.173 \left(\frac{48.158}{\sqrt{128.020}}\right) - 5.185\right)$$

$$= 6.2334$$

$$R_2 = \left(\frac{140}{2 \times 22 \times \pi \times 3.048}\right)\left[\ln \left(\frac{8 \times 3.048}{0.0191}\right) - 1 + (2 \times 1.173) \times \left(\frac{3.048}{\sqrt{128.020}}\right) \times \left(\sqrt{22} - 1\right)^2\right]$$

$$= 4.9042$$

ATTACHMENT 1

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
Civilian Radioactive Waste Management System
Management & Operating Contractor

CONTRACT NO. DE-AC01-91RW00134
SUBJECT: BUILDING GROUND GRID CALCS.

WBS NO: 1.2.6.
DATE: 6-2-94 REV NO: 0A
CALC NO: BABBA0000-01717-0200-00001
ORIGINATOR: B. MAJMUDAR
CHECKED BY: Y. P. SHANE
CHECKED DATE: 6-16-94

$$R_{12} = \left(\frac{140}{\pi \times 48.158}\right)\left[\ln\left(\frac{2\times 48.158}{3.048}\right) + 1.173\left(\frac{48.158}{\sqrt{128.020}}\right) - 5.185 + 1\right]$$

$$= 3.9428$$

USING FORMULA (1)

$$R_g = \frac{(6.2334 \times 4.9042) - (3.9428)^2}{6.2334 + 4.9042 - (2\times 3.9428)}$$

$$= 4.62\ \Omega$$

CRWMS/M&O

Design Analysis Cover Sheet

Complete only applicable items.

(1.)

WBS: 1.2.6
QA: QA

2. DESIGN ANALYSIS TITLE STANDBY GENERATOR FUEL SYSTEM ANALYSIS			
3. DOCUMENT IDENTIFIER BABBDA000-01717-0200-00002		4. REV. NO. 0F	5. TOTAL PAGES 9
6. TOTAL ATTACHMENTS/NO. OF PAGES IN EACH (1-4pg)(2-1pg)(3-1pg)(4-5pg)(5-2pg)		7. SYSTEM ELEMENT ESF	

	Print Name	Signature	Date
8. Originator	C. Mellen	R. E. Flye FOR C. L. MELLEN	7-7-94
9. Checker	R. E. FLYE	R. E. Flye	7-7-94
10. Lead Discipline Engineer	R. E. FLYE	R. E. Flye	7-7-94
11. Department Manager			

12. REMARKS

CRWMS/M&O

Design Analysis Revision Record

Complete only applicable items.

(1.)

WBS: 1.2.6
QA: QA

2. DESIGN ANALYSIS TITLE
STANDBY GENERATOR FUEL SYSTEM ANALYSIS

3. DOCUMENT IDENTIFIER	4. REVISION NO.
BABBDA000-01717-0200-00002	0F

5. Revision No.	6. Pages Added	7. Pages Deleted	8. Description of Revision
0F			ISSUED FOR PACKAGE 1D DESIGN REVIEW

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

1. PURPOSE

The purpose of this analysis is to capture the design requirements and analyze equipment performance relevant to the Standby Generator Fuel System design at the Yucca Mountain Site Characterization Project (YMP) Exploratory Studies Facility (ESF).

2. QUALITY ASSURANCE

The work developed within this analysis relates to temporary equipment not included on the Q-list.

2.1 The quality assurance classification of this analysis is Q-None.

2.2 This analysis recognizes the controls established by the Determination of Importance Evaluation (DIE) for ESF Surface Compressed Air and Standby Power Systems (Reference 5.3). These controls will be included in the design of the Standby Generator Fuel System. DIE controls affecting this analysis include the following:

2.2.1 Minimize the potential for waste isolation and/or test interference impacts from hydrocarbon or water penetration into the soil. Periodic inspections shall be conducted to assure compliance. Leaks and spills are to be repaired, cleaned up, and reported upon discovery.

2.2.2 All tracers, fluids, and materials (TFM) used in the construction or operation of the Standby Generator Fuel System shall be monitored and handled in accordance with the TFM Management Plan.

3. METHOD

The method used in this design analysis involves capturing data and requirements, modifying or developing conceptual design criteria (Title I), then developing final design criteria (Title II). New data may have evolved since initial compilation began. Significant and major changes have occurred late in the working design. Design data and requirements are captured from the following sources:

3.1 Local Records Center (LRC), search for records associated with work previously done on the ESF Standby Generator Fuel System.

3.2 The Title I Design Summary Report (DSR) for the ESF provides a preliminary conceptual design basis for the Standby Generator Fuel System.

3.3 The Exploratory Studies Facility Design Requirements (ESFDR) document provides criteria and requirements compiled from upper tier documents.

3.4 Meetings with project participants involved with the design, construction, and testing of the YMP ESF.

3.5 Discussions with equipment vendors to evaluate available equipment and suitability for incorporation in the design.

3.6 ESF project status meetings, establishing constraints on construction and budgeting of the ESF.

3.7 Design reviews of the Standby Generator Fuel System, generating a wide variety of requirements and constraints.

4. CODES AND STANDARDS

4.1 U.S. DEPARTMENT OF ENERGY (DOE):

DOE 6430.1A	General Design Criteria, April 6, 1989

4.2 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA):

NFPA 30-93	Flammable and Combustible Liquids Code, August 20, 1993

4.3 UNDERWRITERS LABORATORIES, INC. (UL):

UL 142	Standard for Steel Aboveground Tanks for Flammmable and Combustible Liquids, April 1, 1993

4.4 AMERICAN PETROLEUM INSTITUTE (API):

API Recommended Practice 2350	Overfill Protection for Petroleum Storage Tanks, March 1997

5. DESIGN INPUTS

5.1 Title I DSR for the ESF, Rev. 1, May 6, 1992. Criteria for providing standby power generation.

5.2 ESFDR, YMP/CM-0019 Rev. 0, July 1993. Criteria for providing standby power generation.

5.3 DIE for ESF Surface Compressed Air and Standby Power Systems, BABBD0000-01717-2200-00022, Rev. 00. TFM controls for fuel storage.

5.4 Basis for Design (BFD) Document, BAB000000-01717-6300-00002, Rev. 05 Draft, June 6, 1994.

5.5 Design Analysis ST-ME-011, Underground Support Systems, D.A. Veronica, Raytheon Services Nevada (RSN), July 18, 1991. Surface requirements for supporting subsurface activities.

5.6 Letter from R. Sandifer to: J. Replogle, #LV.MG.RMS.12/93.191, Re: NTS Surplus Equipment, December 1, 1993. Criteria for using excessed equipment.

5.7 Interoffice Correspondence (IOC) from: C. Mellen to: R. E. Howell, #LV.ESS D.CM.5/94.583, Re: Standby Generator Fuel System Requirements, May 24, 1994. Design requirements for the Standby Generator Fuel System.

5.8 IOC from: F. A. Lane to: R. Flye, #LV.ESSD.FAL.6/94.590, Re: Standby Generator Fuel System control logic, June 1, 1994. Operation of the Standby Generator Fuel System.

5.9 Refuge Chambers- Subsurface Analysis.

5.10 Subsurface Specification Section 13046, Refuge Chamber; BABEC0000-01717-6300-13046 Rev. 0B.

5.11 Electrical Load Study: Canyon Substation Feed to North Portal, BAB000000-01717-6700-0001, Rev. 0A.

5.12 ESF Analysis of Standby Power Requirements, BABBDA000-01717-6700-00001, Rev. 00.

6. CRITERIA

6.1 FROM THE DSR (REFERENCE 5.1)

6.1.1 Section 3.4.1 Surface Utilities, Power Distribution

"The surface electrical power transmission and distribution system provides sufficient electrical power to meet construction and operational requirements for the surface and subsurface. Standby and uninterruptible power supply (UPS) systems are available for equipment required during any utility power outage. The main power source for the ESF site is a 69 kV transmission line fed from the existing Canyon Substation. (See Drawings No. YMP-025-1-ELEC-EL101 and YMP-025-1-ELEC-EL102.)

The design requires rerouting the existing 69 kV transmission line to the Topopah Spring (TS) North Portal and TS South Portal substations where the 69 kV transmission voltage is stepped down to 12,470 V, the primary distribution voltage. The 15 kV-rated power cables are routed in concrete-encased duct banks to various surface facilities, including site lighting, and supply subsurface power to the TS North Portal, TS South Portal, and optional shaft collar sites. Grounding provisions will be determined during Title II design.

Standby power is provided by diesel engine generators. During utility power outages, power is supplied to the ventilation fans; the optional shaft hoist (if required); subsurface facilities; communications and security equipment; UPS; security lighting; life safety; and other required equipment.

The UPS power is used for communications, security, life safety, Integrated Data System (IDS) equipment, and Principal Investigator-supplied site characterization test equipment that must operate during any utility or standby power outage. Each UPS time duration requirement will be determined during Title II Design."

6.2 FROM THE ESFDR (REFERENCE 5.2)

6.2.1 Section 3.1.3.2 A.1. Requirements, Surface Utilities

"Power system - systems, subsystems, components and structures that supply electrical power to the ESF site. These systems include, but are not limited to: ESF site substation(s); distribution systems; extension and upgrading of the existing 69-kV overhead power line to 138-kV; secondary power lines to the muck conveying system and booster pump station; surface lighting; a standby power generation system; power distribution to the facilities; and a UPS."

7. ASSUMPTIONS

It is assumed that the ambient temperature data source (Attachment 1) citing a maximum of 108 degrees F and minimum of -14 degrees F will not be exceeded for the life of the ESF North Portal Pad utilities. If actual temperature exceeds this range, the time spent outside the range is expected to be minimal with nominal effects on the operation of the Standby Generator Fuel System (Reference 8.1). No verification required.

8. REFERENCES

8.1 17-year Climatological Summary for Yucca Flat, NV. January 1962-April 1978. Provided to the M&O by B. Anzai of RSN.

8.2 Mechanical Engineering Reference Manual, eighth edition, Michael Lindeburg, P.E.

8.3 Cameron Hydraulic Data, 17th Edition, Ingersoll-Rand, 1992.

8.4 Mark's Standard Handbook for Mechanical Engineers, 9th Edition, Eugene A. Avallone to Theodore Baumeister III, McGraw-Hill, Inc., 1987.

9. COMPUTER PROGRAMS

No computer programs were used for this analysis.

10. DESIGN ANALYSIS

The body of this analysis is divided into three sections consisting of Standby Generator Fuel System requirements, Standby Generator Fuel System design, and Standby Generator Fuel System equipment analysis.

10.1 STANDBY GENERATOR FUEL SYSTEM REQUIREMENTS

10.1.1 DSR Requirements (See 6.1)

10.1.2 ESFDR Requirements (See 6.2)

10.1.3 BFD Requirements (See 6.3)

10.1.4 Standby Generator Fuel System Fuel Storage Requirements

10.1.4.1 The Standby Generator Fuel System main storage tank shall be designed to hold 7500 gallons of fuel. (Reference 5.7)

10.1.4.2 The Standby Generator Fuel System main storage tank shall be designed and constructed to UL 142. (Reference 4.3)

10.1.4.3 The Standby Generator Fuel System main storage tank shall have secondary containment. (Reference 5.3)

10.1.4.4 Provide for overfill protection of storage tanks. (Reference 4.4).

10.1.4.5 Provide for the transfer of 47 gph of fuel to each of the standby generators GN-401, 402, 403, and 404. Ensure that these standby generators can operate for at least 16 hours by transferring fuel from the main storage tank. (Reference 5.12)

10.1.4.6 Provide for the transfer of 51 gph of fuel for each of the supplemental power generators GN-405, 406, 407, and 408. Ensure that these generators can operate for at least 24 hours continuously by transferring fuel from the main storage tank. (Reference 5.11)

10.1.5 Equipment and Piping Requirements

The Standby Generator Fuel System transfer pumps shall have provisions for secondary containment of fuel. (Reference 5.3)

10.1.6 Standby Generator Fuel System Interfacing Requirements

Programmable controllers shall provide for interfacing with the IDS system. (Reference 5.8)

10.2 STANDBY GENERATOR FUEL SYSTEM DESIGN

10.2.1 Storage Tank Sizing

10.2.1.1 The main storage tank volume must be 9000 gallons. To satisfy the concurrent operation of both the standby and supplemental generators. Reference Attachment II for operation scenario.

10.2.1.2 The volume of the daytanks serving the standby generators is a minimum of 347 gallons.

10.2.1.3 The volume of the daytanks serving the supplemental power generators is a minimum of 500 gallons. (TBD-XXX)

10.2.2 Transfer Pump Sizing

10.2.2.1 Provide two transfer pumps sized at 10 gph each to satisfy transfer requirements shown in Attachment II.

10.2.2.2 Provide for a standby transfer pump to allow maintenance and assure reliability. Total number of transfer pumps is to be three identical units.

10.2.2.3 Estimated piping pressure drop including valves and fittings account for 40 feet of loss. Reference Attachment IV for calculations.

10.3 EQUIPMENT ANALYSIS

10.3.1 Transfer Pump Selection and Details

Provide three Viking number GG-4195D-F - reference Attachment IV for cut sheets.

10.3.2 Storage Tank Selection and Connections

Reference Attachment V for diagram.

11. CONCLUSIONS

The main fuel storage tank for the Standby Generator Fuel System will utilize secondary containment and be sized to store 9000 gallons of fuel.

12. ATTACHMENTS

ATTACHMENT	TITLE
I	17-Year Climatological Summary
II	Standby Generator Fuel System Operation Simulation
III	Standby Generator Fuel System Pressure Drop Calculation
IV	Viking Pump Cut Sheets
V	Storage Tank Diagrams

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

Latitude 36°57'N
Longitude 116°03'W
Elevation 3924 Feet
(1196 Meters)

17-YEAR CLIMATOLOGICAL SUMMARY
(JANUARY 1962 - APRIL 1978)
YUCCA FLAT, NEVADA - NEVADA TEST SITE
WEATHER SERVICE NUCLEAR SUPPORT OFFICE

Received April 1991
Nevada Coordinate System (Central)
E680,875
N803,600

MONTH			JAN	FEB	MAR	APR	MAY	JUN		JUL	AUG	SEP	OCT	NOV	DEC		ANN
TEMPERATURE	AVERAGES	DAILY MAXIMUM	51.1	56.9	60.9	67.7	79.2	88.9		96.3	94.3	96.3	76.1	61.6	51.8		72.5
		DAILY MINIMUM	20.7	26.8	28.3	34.0	43.3	50.4		57.2	56.6	47.1	36.7	26.9	20.1		37.1
		MONTHLY	35.9	41.3	44.6	50.9	61.3	69.6		76.8	75.4	66.7	56.9	44.3	36.9		54.9
	EXTREMES	HIGHEST	73	77	87	89	98	107		108	108	105	94	83	71		108
		YEAR	1971/766	1963	1966	1962	1974	1970		1972	1972	1971	1963/64	1976	1975		7-8/72
		LOWEST	0.10	5	9	13	26	29		40	38	26	12	5	14		14
		YEAR	1973	1965/71	1969/77	1906	1962	1967/71		1962/64	1968/75	1971	1971	1975	1967		12/1967
DEGREE DAYS (Base 65°)		HEATING	893	704	664	422	156	27		0	1	46	284	616	894		4658
		COOLING	0	0	0	1	39	170		371	332	104	8	11	0		1023

* One or more occurrences during the period of record but average less than 0.5 day.
# Most recent of multiple occurrences.
† Data period from January 1962 to December 1971.

(a) Sky cover is expressed in the range from 0 for no clouds to 10 when the sky is completely covered with clouds. Clear, partly cloudy and cloudy are defined as average daytime cloudiness of 0-3, 4-7 and 8-10 tenths, respectively.

MONTH			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
PRECIPITATION (Inches)		AVERAGE	0.87	1.05	0.65	0.41	0.33	0.31	0.53	0.45	0.81	0.40	0.59	0.68	6.88
		GREATEST MONTHLY	4.02	3.60	3.50	2.57	1.62	2.66	1.87	2.52	2.38	1.69	3.02	2.06	4.02
		YEAR	1969	1978	1978	1965	1971	1972	1976	1977	1969	1978	1965	1965	1/69
		LEAST MONTHLY	0	0	0	T	0	0	0	0	0	0	0	T	0
		YEAR	1972/76	1972/77	1972	1962/77	1976	1974/76	1963	1962	1968	1967	1962/76	1969/72	2/77
		GREATEST DAILY	1.25	1.51	0.99	1.08	0.86	1.03	1.10	2.18	2.13	1.65	1.10	1.31	2.18
		YEAR	1969	1976	1978	1965	1971	1972	1976	1977	1969	1976	1970	1965	8/77
	SNOW	AVERAGE	2.9	1.3	1.9	0.4	*	0	0	0	0	*	0.7	2.1	9.3
		GREATEST MONTHLY	29.1	17.4	9.0	3.0	0.2	0	0	0	0	T	6.6	9.9	29.1
		YEAR	1974	1969	1969	1964	1975					1971	1972	1971	1/74
		GREATEST DAILY	10.0	6.2	7.5	3.0	0.2	0	0	0	0	T	6.6	7.4	10.0
		YEAR	1974	1969	1969	1964	1975					1971	1972	1971	1/74
RELATIVE HUMIDITY (%)	HOUR (PST)	04	71	69	61	53	48	39	39	43	45	52	62	68	54
		10	63	45	34	27	22	18	19	22	22	27	39	48	31
		16	39	32	25	19	15	13	14	16	18	21	30	39	23
		22	65	57	47	38	32	25	27	29	33	41	53	63	42

* One or more occurrences during the period of record but average less than 0.5 day.
# Most recent of multiple occurrences.
↑ Data period from January 1962 to December 1971.

(a) Sky cover is expressed in the range from 0 for no clouds to 10 when the sky is completely covered with clouds. Clear, partly cloudy and cloudy are defined as average daytime cloudiness of 0-3, 4-7 and 8-10 tenths, respectively.

Title: Standby Generator Fuel System Analysis - DRAFT
Originator: C. Mellen

MONTH			JAN	FEB	MAR	APR	MAY	JUN		JUL	AUG	SEP	OCT	NOV	DEC		ANN
WIND (Speeds in MPH)		AVERAGE SPEED	6.0	6.8	8.6	9.1	8.0	7.9		7.5	6. 8	6.7	6.5	6.0	6.2		7.2
		PEAK SPEED	58	60+	56+	60+	80+	60		55	80+	80	80	60+	53		60+
		YEAR	1965	1976	1975	1967/70	1967	1967		1971	1968	1976	1971	1973	1970		2/76
	VECTOR WIND (Dir/ Spd)	23-02 (PST)	233/01	275/01	240/02	250/02	280/02	272/02		278/01	222/02	281/01	286/01	234/01	288/02		281/01
		11-14 (PST)	135/03	118/03	186/05	198/05	179/07	185/08		185/12	182/12	183/06	138/04	152/04	109/01		174/06
STATION PRESSURE (Inches)		AVERAGES	26.09	26.06	25.98	25.95	25.93	25.93		26.00	26.00	26.00	26.05	26.08	26.08		26.01
		HIGHEST	26.54	26.47	26.43	26.39	26.39	26.26		26.22	26.22	26.36	26.40	26.58	26.59		26.59
		LOWEST	25.42	25.31	25.47	25.50	25.42	25.42		25.67	25.71	25.56	25.52	26.31	25.49		25.31
(a) AVERAGE SKY COVER SUNRISE TO SUNSET			4.9	5.2	5.1	4.4	4.2	3.0		2.7	2.7	2.3	3.1	4.7	4.5		3.9

* One or more occurrences during the period of record but average less than 0.5 day.
\# Most recent of multiple occurrences.
† Data period from January 1962 to December 1971.

(a) Sky cover is expressed in the range from 0 for no clouds to 10 when the sky is completely covered with clouds. Clear, partly cloudy and cloudy are defined as average daytime cloudiness of 0-3, 4-7 and 8-10 tenths, respectively.

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

Title: Standby Generator Fuel System Analysis - DRAFT
Originator: C. Mellen

MONTH			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
AVERAGE NUMBER OF DAYS	SUNRISE TO SUNSET	CLEAR	13	11	12	13	16	18	20	21	21	20	13	15	192
		PARTLY CLOUDY	8	7	8	9	9	8	8	7	8	7	8	7	92
		CLOUDY	10	10	11	8	7	4	3	3	3	4	9	9	81
	PRECIPITATION	.01 INCH OR MORE	3	4	4	3	2	2	3	3	2	2	3	3	34
		.10 INCH OR MORE	2	2	2	1	1	1	1	1	1	1	2	1	16
		.50 INCH OR MORE	1	1	*	*	*	*	*	*	*	*	*	1	3
		1.00 INCH OR MORE	*	*	0	*	0	*	*	*	*	*	*	*	1
	1.0 INCH OR MORE OF SNOW		1	1	1	*	0	0	0	0	0	0	*	1	4
	THUNDERSTORMS		*	0	1	1	2	2	3	3	2	1	*	*	15
	TEMPERATURE MAXIMUM	90° F OR MORE	0	0	0	0	4	15	29	26	11	1	0	0	86
		32° F OR LESS	1	0	0	0	0	0	0	0	0	0	0	1	2
	TEMPERATURE MINIMUM	32°F OR LESS	29	24	23	13	2	0	0	0	1	9	24	30	166
		0° F OR LESS	1	0	0	0	0	0	0	0	0	0	0	0	1

* One or more occurrences during the period of record but average less than 0.5 day.
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† Data period from January 1962 to December 1971.

(a) Sky cover is expressed in the range from 0 for no clouds to 10 when the sky is completely covered with clouds. Clear, partly cloudy and cloudy are defined as average daytime cloudiness of 0-3, 4-7 and 8-10 tenths, respectively.

STANDBY GENERATOR FUEL SYSTEM OPERATION SIMULATION

FUEL STORAGE OPERATION SIMULATION

BY: C. MELLEN
DATE: 06/21
FN: FUELSTR5.WK3

DT-001 thru -0 8 hr stor cap. ea.
DG-001 thru -0 47 gph demand ea.
DT-001 thru -004 Fill Set 40% (ON)
DT-001 thru -004 high level setp 80% (OFF)

DT-005 2.206 hr stor cap. tot
DG-00 204 gph demand to
DT-005 Fill Setpoint =
80% high level (off)
40% low level (on)

P-1 = 10 gpm
P-2 = 10 gpm

HR	Main Fuel Tank volume	Main Fuel Tank %	Pump 1	Pump 2	Gross Supply	Net Return	Net Supply	Transfe Demand	diff.
0	9000	100.0%	0	0	0	0	0	0	0
1	9000	100.0%	600	0	600	600	0	0	0
2	8860	98.4%	600	0	600	460	140	140	0
3	8480	94.2%	600	0	600	220	380	380	0
4	8456	94.0%	600	0	600	576	24	24	0
5	8032	89.2%	600	0	600	176	424	424	0
6	7228	80.3%	600	600	1200	396	804	804	0
7	6844	76.0%	600	0	600	216	384	384	0
8	6820	75.8%	600	0	600	576	24	24	0
9	6436	71.5%	600	0	600	216	384	384	0
10	6252	69.5%	600	0	600	416	184	184	0
11	5088	56.5%	600	600	1200	36	1164	1164	0
12	5064	56.3%	600	0	600	576	24	24	0
13	4680	52.0%	600	0	600	216	384	384	0
14	4656	51.7%	600	0	600	576	24	24	0
15	4112	45.7%	600	0	600	56	544	544	0
16	3308	36.8%	600	600	1200	396	804	804	0
17	2924	32.5%	600	0	600	216	384	384	0
18	2900	32.2%	600	0	600	576	24	24	0
19	2516	28.0%	600	0	600	216	384	384	0
20	2492	27.7%	600	0	600	576	24	24	0
21	2108	23.4%	600	0	600	216	384	384	0
22	2084	23.2%	600	0	600	576	24	24	0
23	1700	18.9%	600	0	600	216	384	384	0
24	1676	18.6%	600	0	600	576	24	24	0
25	1676	18.6%	600	0	600	600	0	0	0
26	1676	18.6%	600	0	600	600	0	0	0
27	1676	18.6%	600	0	600	600	0	0	0
28	1676	18.6%	600	0	600	600	0	0	0
29	1676	18.6%	600	0	600	600	0	0	0
Totals							7324	7324	0

HR	DT-001 vol	DT-001 %		DT-001 fill	D.G. deman	DT-002 vol	DT-002 %		DT-002 fill	D.G. deman
0	376	100%	0	0	0	376	100%	0	0	0
1	329	88%	0	0	47	329	88%	0	0	47
2	282	75%	0	0	47	282	75%	0	0	47
3	235	63%	0	0	47	235	63%	0	0	47
4	188	50%	0	0	47	188	50%	0	0	47
5	151	40%	0	10	47	151	40%	0	10	47
6	299	80%	0	195	47	299	80%	0	195	47
7	252	67%	0	0	47	252	67%	0	0	47
8	205	55%	0	0	47	205	55%	0	0	47
9	158	42%	0	0	47	158	42%	0	0	47
10	151	40%	0	40	47	151	40%	0	40	47
11	299	80%	0	195	47	299	80%	0	195	47
12	252	67%	0	0	47	252	67%	0	0	47
13	205	55%	0	0	47	205	55%	0	0	47
14	158	42%	0	0	47	158	42%	0	0	47
15	151	40%	0	40	47	151	40%	0	40	47
16	299	80%	0	195	47	299	80%	0	195	47
Totals				675	752				675	752

HR	DT-003 vol	DT-003 %		DT-003 fill	D.G. deman	DT-004 vol	DT-004 %		DT-004 fill	D.G. demand
0	376	100%	0	0	0	376	100%	0	0	0
1	329	88%	0	0	47	329	88%	0	0	47
2	282	75%	0	0	47	282	75%	0	0	47
3	235	63%	0	0	47	235	63%	0	0	47
4	188	50%	0	0	47	188	50%	0	0	47
5	151	40%	0	10	47	151	40%	0	10	47
6	299	80%	0	195	47	299	80%	0	195	47
7	252	67%	0	0	47	252	67%	0	0	47
8	205	55%	0	0	47	205	55%	0	0	47
9	158	42%	0	0	47	158	42%	0	0	47
10	151	40%	0	40	47	151	40%	0	40	47
11	299	80%	0	195	47	299	80%	0	195	47
12	252	67%	0	0	47	252	67%	0	0	47
13	205	55%	0	0	47	205	55%	0	0	47
14	158	42%	0	0	47	158	42%	0	0	47
15	151	40%	0	40	47	151	40%	0	40	47
16	299	80%	0	195	47	299	80%	0	195	47
Totals				675	752				675	752

HR	DT-005	DT-005 fill	D.G. deman	vol	%
0	0	0	0	450	100%
1	0	0	204	246	55%
2	0	140	204	182	40%
3	0	380	204	358	80%
4	0	24	204	178	40%
5	1	384	204	358	80%
6	0	24	204	178	40%
7	1	384	204	358	80%
8	0	24	204	178	40%
9	1	384	204	358	80%
10	0	24	204	178	40%
11	1	384	204	358	80%
12	0	24	204	178	40%
13	1	384	204	358	80%
14	0	24	204	178	40%
15	1	384	204	358	80%
16	0	24	204	178	40%
17	1	384	204	358	80%
18	0	24	204	178	40%
19	1	384	204	358	80%
20	0	24	204	178	40%
21	1	384	204	358	80%
22	0	24	204	178	40%
23	1	384	204	358	80%
24	0	24	204	178	40%
Totals		4624	4896		

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

Title: Standby Generator Fuel System Analysis - DRAFT
Originator: C. Mellen

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

STANDBY GENERATOR FUEL SYSTEM PRESSURE DROP CALCULATION

FUEL SYSTEM PRESSURE DROP CALCULATION

07-Jul-94

Calc #: BABBDAOOO-01717-0200-00002
Operation: Full loading fuel transfer to generators
Project: MDGS - YUCCA MOUNTAIN
Site: ESF-NORTH PORTAL PAD
Job #: DE-AC01-91RW00134
Service: DIESEL FUEL TRANSFER
Author: C. Mellen
Client: DOE-YMPO
Fluid: DIESEL NO.2
Spec gravity 0.9 Viscocity: 10.2 (centpse.)
Density (p): 56.07 (lbm/ft3) Viscocity: 0.000213 (lbf/ft-s)
Roughness: 0.00015 (ft) Kinematic viscosity (v)= 1.22E-04 (ft2/s) 60 (SSU)

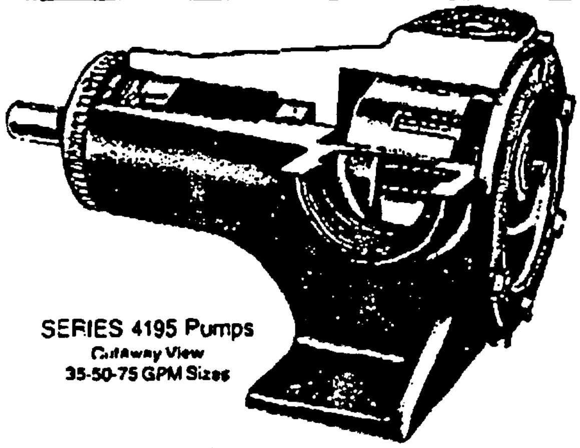
NODE	GPM	DIA. (FT)	VEL. (FPS)	LENGTH (FT)	Re	FRICTION (f)	FITTINGS	#	FRICTION (k)	VALVE TYPE	FRICTION (Cv)	PIPE dH (ft)	FITTING dH (ft)	VALVE dH (ft)	SUBTOT dH (ft)	SUM dH (ft)
a-b	20	0.134167	3.14	50	1.11E+05	0.1420	90-ell	7	0.57	GATE	329.8	8.12	0.551	0.008	8.679	8.679
	20	0.134167	3.14	0	1.11E+05	0.1420		0	0	STRAINER	40	0.00	0.000	0.520	0.520	9.198
	20	0.134167	3.14	0	1.11E+05	0.1420		0	0	CHECK	93	0.00	0.000	0.096	0.096	9.295
	10	0.087417	3.70	0	8.52E+04	0.0185	90-ell	2	0.69	GATE	329.8	0.00	0.264	0.002	0.266	9.561
	10	0.087417	3.70	0	8.52E+04	0.0185	90-ell	2	0.69	CHECK	93	0.00	0.264	0.024	0.288	9.849
b-c	20	0.134167	3.14	100	1.11E+05	0.1420	t-thru	1	0.38	GATE	329.8	16.24	0.052	0.008	16.300	25.861
	20	0.134167	3.14	0	1.11E+05	0.1420	90-ell	6	0.57		1000000	0.00	0.472	0.000	0.472	26.333
c-d	16.75	0.134167	2.63	25	9.30E+04	0.0181	t-thru	1	0.38		1000000	0.36	0.037	0.000	0.400	26.733
d-e	13.5	0.134167	2.12	25	7.49E+04	0.0191	t-thru	1	0.38		1000000	0.25	0.024	0.000	0.273	27.006
e-f	10.25	0.134167	1.61	25	5.69E+04	0.0205	t-thru	1	0.38		1000000	0.15	0.014	0.000	0.168	27.174
f-g	7	0.134167	1.10	25	3.89E+04	0.0225	t-thru	1	0.38		1000000	0.08	0.006	0.000	0.085	27.259
g-h	7	0.134167	1.10	0	3.89E+04	0.0225	90-ell	6	0.69		1000000	0.00	0.070	0.000	0.070	27.330
h-i	0.6	0.0625	0.43	200	7.15E+03	0.0344	90-ell	12	0.69	BPR	0.25	0.32	0.022	11.975	12.320	39.649
i-j																
k-l																
l-m																
m-n																
	1	10							0		TOTAL:	25.53	1.778	12.632	39.938	

VIKING PUMP CUT SHEETS

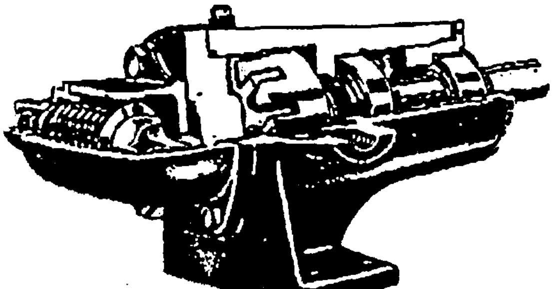
VIKING* HEAVY-DUTY PUMPS
SERIES 4195
STANDARD CONSTRUCTION

SECTION 144
PAGE 144.3
ISSUE A

FEATURES



SERIES 4195 Pumps
Cutaway View
35-50-75 GPM Sizes



SERIES 4195 Pumps
Cutaway View
10-20-30 GPM Sizes

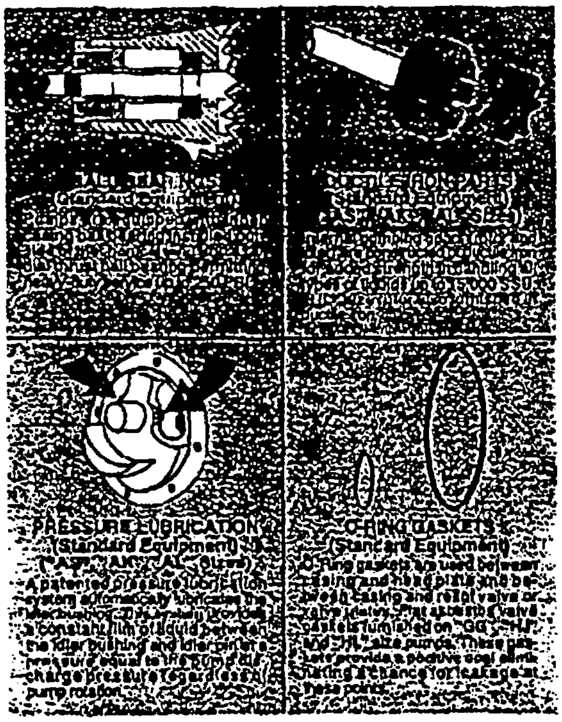
①Pressure Range	250 PSI for 100 SSU and above 150 PSI for 38 to 100 SSU 100 PSI for below 38 SSU
①Temperature Range	−40° F. to +350° F.
①Viscosity Range	0.1 cP to 15,000 SSU

GPM 10-20-30-35-50-75
②(Nominal Rating)

Viking's high-speed, heavy-duty Series 4195 pumps are available in capacities of 10, 20, 30, 35, 50 and 75 GPM. The three smaller size pumps can be furnished directly connected to either 1800 or 1200 RPM motors. The three larger sizes directly connected to 1200 RPM motors. (See Series 4195D units shown on page 144.5.) All six sizes of Viking Series 4195 pumps are furnished with Roto-Ring mechanical seals. This seal is a simple self-adjusting, non-leak method of shaft sealing located ahead of the casing ball bearing. The Series 4195 pumps are built for continuous or intermittent duty for such applications as filtering, circulating, transferring, or booster service in general industrial, petroleum and marine uses. NOTE: "UL" listed pumps for handling flammable liquids require special construction. (Ductile Iron Casing on "AS", "AK" and "AL" sizes). See Catalog Section 440 for details and pricing information. Model numbers for these pumps must be designated by a suffix -F, eg. GG4195-F or when used with a "D" drive, GG4195D-F. "UL" listed models must be equipped with either an internal or return-to-tank safety relief valve. Maximum discharge pressure for "UL" listed models is 125 PSIG.

① Values shown represent minimums or maximums. Some special construction or consideration may be required before a catalogued pump can be applied to an application involving maximum pressure or minimum or maximum temperature and/or viscosity. Certain models have restrictions in pressures and/or viscosities. See specifications, page 144.4, and performance curves.

② Nominal capacities based on handling thin liquids at 1800 RPM on three small sizes, 1200 RPM on three large sizes.



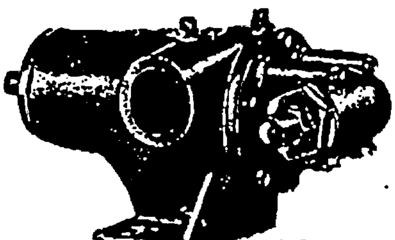
SECTION 144
PAGE 144.4
ISSUE A

UNMOUNTED PUMPS

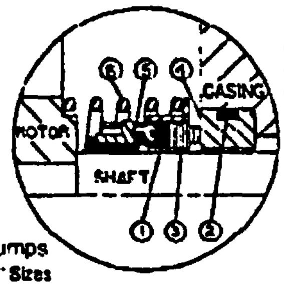
VIKING® HEAVY-DUTY PUMPS

SERIES 4195

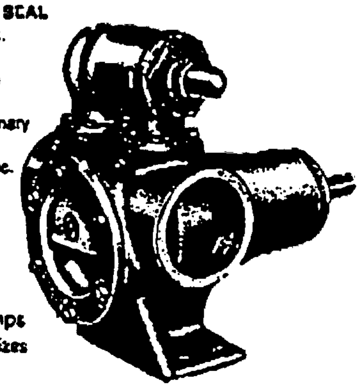
STANDARD CONSTRUCTION



SERIES 4195 Pumps
"GG", "HJ" and "HL" Sizes



MECHANICAL SEAL
① Buna-N bellows.
② Buna-N O-ring.
③ Carbon rotating face (washer)
④ Ni-Resist stationary seal.
⑤ Steel metal parts.
⑥ Stainless steel spring.



SERIES 4195 Pumps
"AS", "AK" and "AL" Sizes

In addition to the famous features listed on the previous page, Series 4195 heavy-duty pumps are furnished with an integral relief valve as shown in the pump photos above. Return-to-tank valves are also available on all models on request. Note: On the "GG", "HJ" and "HL" sizes, the valve mounts on the pump head. The "AS", "AK" and "AL" size valve mounts on top of the pump casing. All sizes equipped with Buna-N mechanical seal with carbon rotating and Ni-Resist stationary faces.

For Optional Seal Construction—See Section 630.
Dimensions for Unmounted Pumps—See Page 144.8.
Performance Data for Unmounted Pumps—See Pages 144.13 through 144.26

CONSTRUCTION—SERIES ①4195 ("GG" THROUGH "AL" SIZES)

Standard Construction Models	Casing	Head	Rotor	Idler	Rotor Shaft and Idler Pin	Idler Bushing	Internal Safety Relief Valve
GG4195 HJ4195	Iron	Iron	②Iron	③Iron	Steel	Carbon Graphite	Iron
HL4195	Iron	Iron	Ductile Iron	Iron	Steel	Carbon Graphite	Iron
AS4195 AK4195 AL4195	Iron	Iron	Ductile Iron	Ductile Iron	Steel	Carbon Graphite	Iron

SPECIFICATIONS—UNMOUNTED PUMPS

Model Numbers Unmounted Pump	Port Size Inches	④ Nominal Pump Rating GPM	RPM	Motor Horsepower Required At Rated Speed Pumping 100 SSU Liquid: 250 PSI	100 PSI	Maximum Hydrostatic Pressure PSIG	Maximum Pump Discharge Pressure PSIG	① Maximum Temperature Degrees F	② Steel Fitted Construction Recommended Above This Viscosity SSU	⑦ Approximate Shipping Weight With Valve (Less Power) Pounds
GG4195	1	10 7	1800 1200	¾ ½	1 ¾	400	100—below 38 SSU 150—38 to 100 SSU 250—above 100 SSU	225	7500	30
HJ4195	1½	20 13	1800 1200	1½ 1	2 1½	400	100—below 38 SSU 150—38 to 100 SSU 250—above 100 SSU	?25	7500	44
HL4195	1½	30 20	1800 1200	2 1½	3 2	400	100—below 38 SSU 150—38 to 100 SSU 250—above 100 SSU	225	⑥	44
AS4195	2½	35	1200	2	3	400	100—below 38 SSU 150—38 to 100 SSU 250—above 100 SSU	225	⑥	65
AK4195	2½	50	1200	3	5	400	100—below 38 SSU 150—38 to 100 SSU 250 above 100 SSU	225	⑥	85
AL4195	3	75	1200	5	7½	400	100—below 38 SSU 150—38 to 100 SSU 250—above 100 SSU	225	⑥	88

① Standard Buna-N seal from —20°F. to +225°F. With special construction, temperatures from -40°F. to +350°F can be handled with this series.
② When steel fitted construction is required, "GG" will have steel rotor, "HJ" will have ductile iron rotor.
③ "GG" size has steel idler
④ Nominal capacities based on handling thin liquids at 1800 RPM on three small sizes, 1200 RPM on three large sizes
⑤ For viscosities above 15,000 SSU, provide details for recommendations
⑥ These models have ductile iron rotors; steel fitted rotors not necessary
⑦ If suction pressure exceeds 100 PSIG, consult factory

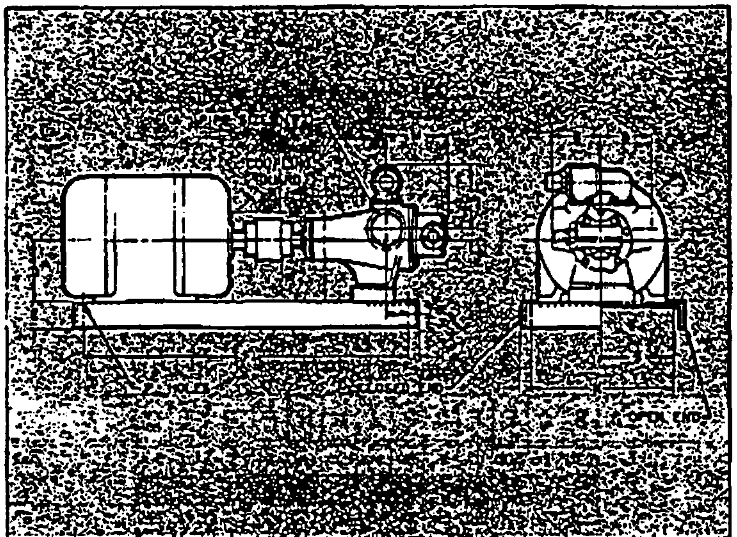
PRELIMINARY PREDECISIONAL DRAFT MATERIAL

VIKING® HEAVY-DUTY PUMPS
SERIES 4195
STANDARD CONSTRUCTION

SECTION 144
PAGE 144.9
ISSUE A

DIMENSIONS

These dimensions are average and not for construction purposes. Certified prints on request.



For specifications, see page 144.5.

DIMENSIONS— SERIES 4195 ("D" DRIVE) "GG"—"HJ"—"HL"— "AS"—"AK"—"AL" SIZES

MODEL NO.	A	D	O	C	F	H	J	K	L	M	M_1	N	P	S	[illegible]
GG41950	1	2.75	①3.50	1.30	17.50	.75	.75	8.50	.38	3.75		.62	.30	4.25	3-018-036
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
	1	2.75	②3.50	1.50	20.50	.75	.75	8.50	.38	3.75		.62	.30	4.25	3-016-018
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
HJ41950 HL41950	1½	2.75	③3.50	③2.12	20.50	.75	.75	8.50	0	4.75		.62	.30	4.25	3-016-019
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
	1½	3.75	④3.50	2.94	25.00	1.00	1.50	9.00	.25	4.75		.62	.56	4.50	3-016-008
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
	1½	3.75	⑤3.25	2.94	25.00	1.00	1.50	9.00	.25	4.75		.62	.56	4.50	3-016-009
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
AS41950	2½	5.00	④3.50	④3.00	28.00	1.00	1.50	9.00	0		7.00	1.12	.56	4.50	3-017-060
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AK41950	2½	5.00	⑤3.25	2.94	28.00	1.00	1.50	9.00	0		7.00	1.12	.56	4.50	3-017-008
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AL41950	3	5.00	⑥3.25	4.00	38.00	1.38	1.38	16.00	3.75		7.00	1.12	.62	5.00	3-017-001
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

① 56 frame motors (short base) (Available with "GG" size pump.)
② 143T and 145T frame motors (long base) (Available with "GG" size pump.)
③ 56, 143T and 145T frame motors (Available with "HJ" or "HL" size pumps.)
④ 182, 182T, 184, 184T frame motors. (Available with "HJ" through "AL" size pumps.)
⑤ 213, 213T, 215, 215T frame motors. (Available with "HJ" through "AL" size pumps.)
⑥ 254U, 254T, 256U, 256T frame motors (Available with "AK" through "AL" size pumps.)
⑦ Dimensions include motor block, base height is 1½".
⑧ Dimension includes motor block, base height is [illegible].

NOTE: All "AS", "AK", "AL" pump sizes are usable with any of the three motors shown in columns

NOTE: Dimensions shown in gray areas are millimeters; others are inches

VIKING HEAVY-DUTY PUMPS
SERIES 495
STANDARD CONSTRUCTION

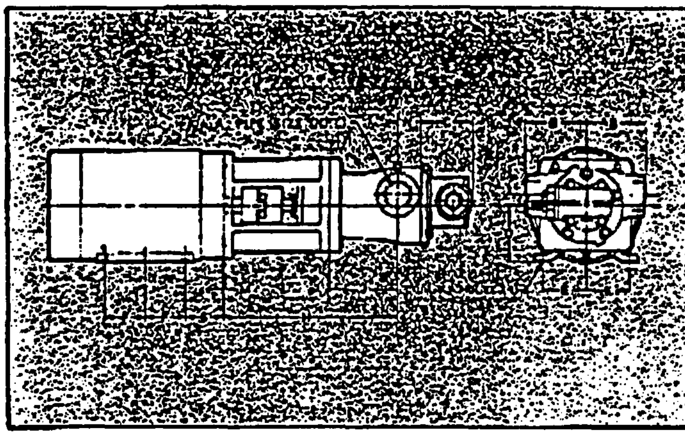
SECTION	144
PAGE	144.11
ISSUE	A

DIMENSIONS

These dimensions are average and not for construction purposes. Certified prints on request

For specifications, see page 144.7

DIMENSIONS—SERIES 495 ("M" DRIVE) "GG"—"HJ"—"HL" SIZES



MODEL NO.	A	B	C	J	L	M	N	MOTOR FRAME	D	E	F	G	H	K
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	56C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
								143TC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
								145TC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
								182TC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
								184TC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	56C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
								143TC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
								145TC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
								182TC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
								184TC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
								213TC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
								215TC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

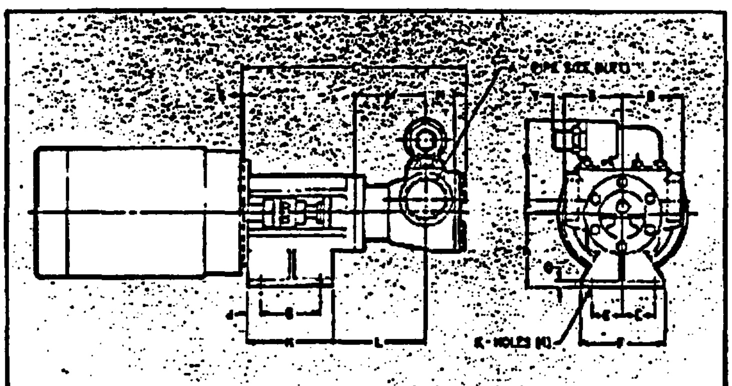
NOTE: Dimensions shown in gray area are millimeters, others are inches

NOTE: Jaw type coupling with straight jaws recommended to facilitate assembly of motor and pump to bracket.

COUPLING IS GUARDED WITH PLATES OVER SIDE OPENINGS ON MOUNTING BRACKET.

For specifications, see page 144.7.

DIMENSIONS—SERIES 495 ("M" DRIVE) "AS"—"AK"—"AL" SIZES



MODEL NO	A	B	C ①	D	E	F	G	H	J	K	L ①	M	N	O	P	R	S	Y
AS495M	2½	5.00	19.06	6.25	2.75	7.00	5.00	7.00	1.00	.56	8.44	6.38	2.00	.50	1.12	7.00	.19	1.00
AK495M			[illegible]										[illegible]					
AL495M	3	[illegible]	19.56	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

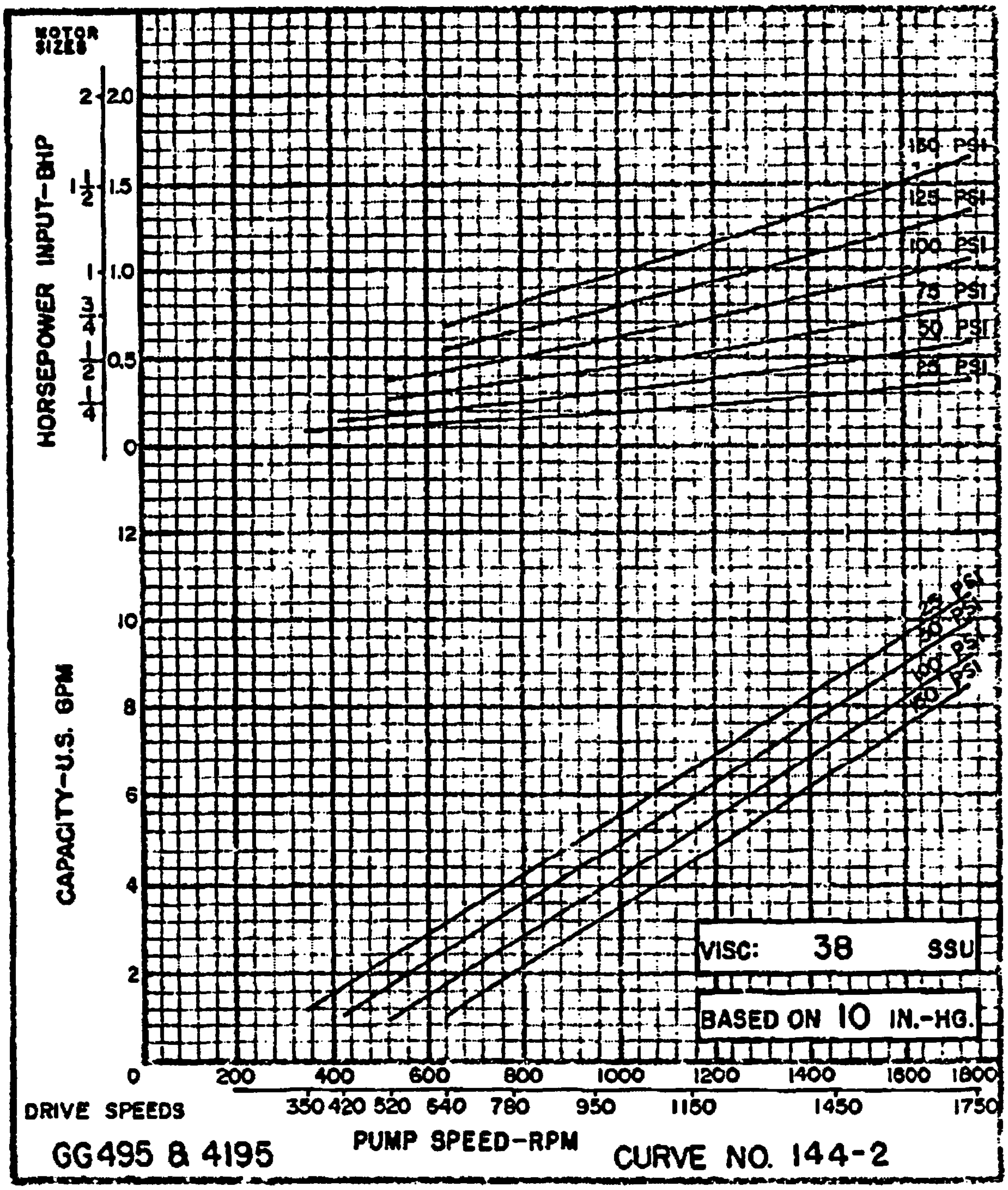
① Dimensions are correct for 182TC through 215TC motors. For 254TC, 256TC motors, add .88" to the dimensions shown.

NOTE: Dimensions shown in gray area are millimeters, others are inches.

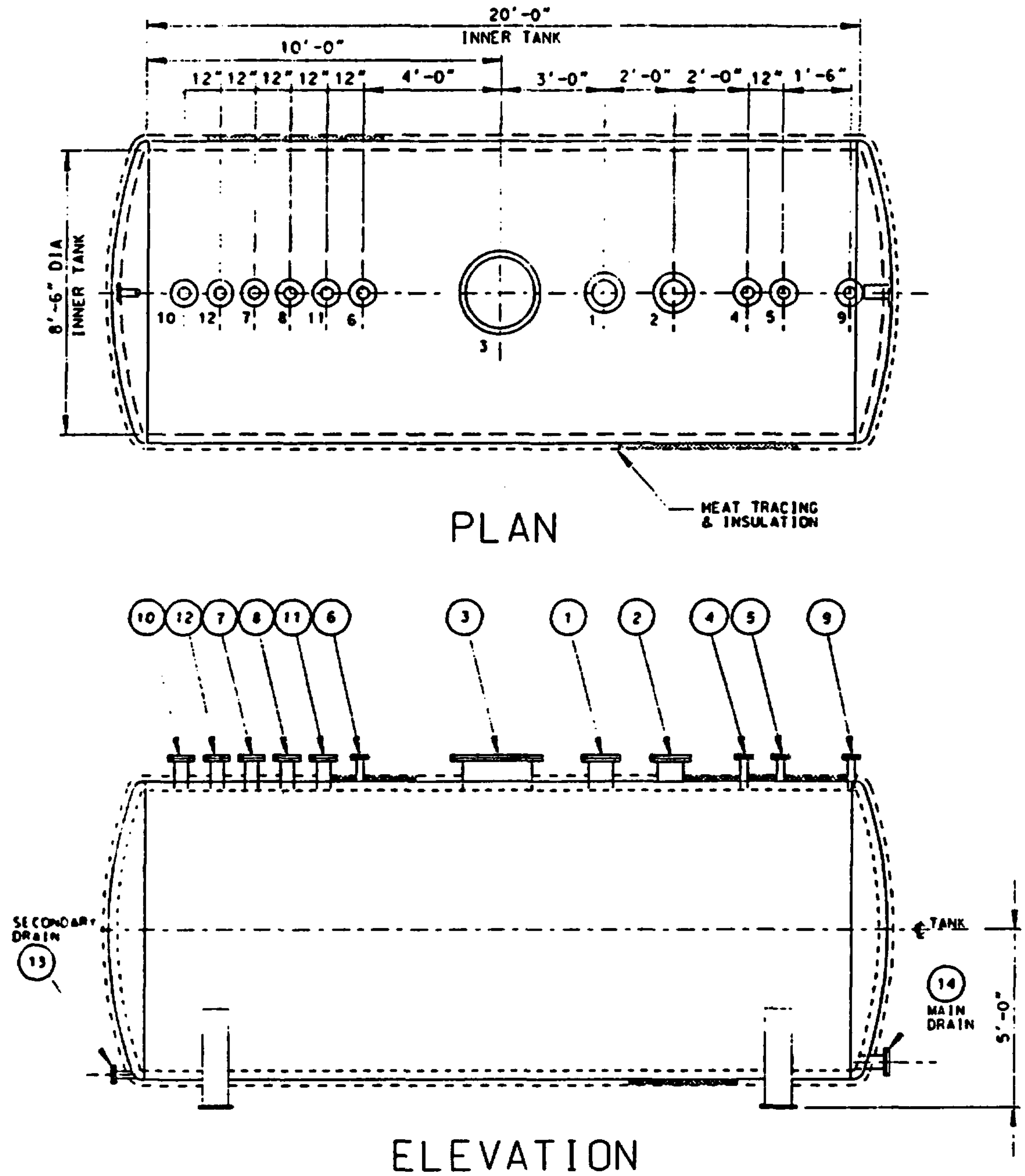
NOTE: Jaw type coupling with straight jaws recommended to facilitate assembly of motor and pump to bracket.

COUPLING IS GUARDED WITH PLATES OVER SIDE OPENINGS ON MOUNTING BRACKET.

PRELIMINARY PREDECISIONAL DRAFT MATERIAL


MOTOR SIZES
HORSEPOWER INPUT-BHP
2
1½
1
¾
½
¼
2.0
1.5
1.0
0.5
0
150 PSI
125 PSI
100 PSI
75 PSI
50 PSI
25 PSI
CAPACITY-U.S. GPM
12
10
8
6
4
2
0
25 PSI
50 PSI
100 PSI
150 PSI
VISC: 38 SSU
BASED ON 10 IN.-HG.
200 400 600 800 1000 1200 1400 1600 1800
DRIVE SPEEDS
350 420 520 640 780 950 1150 1450 1750
PUMP SPEED-RPM
GG495 & 4195
CURVE NO. 144-2

STORAGE TANK DIAGRAMS



10,000 GAL. DIESEL FUEL STORAGE TANK

(9,000 GAL. ACTUAL CAPACITY)

SHEET 1 of 2

(SEE SHEET 2 FOR NOZZLE SCHEDULE)

NOZZLE SCHEDULE

NOZZLE NO.	SIZE	DESCRIPTION
1	8" DIA	PRIMARY TANK EMERGENCY VENT
2	8" DIA	SECONDARY TANK EMERGENCY VENT
3	24" DIA	MANHOLE ACCESS
4	2" DIA	PRIMARY VENT
5	2" DIA	SECONDARY VENT
6	2" DIA	LEVEL INDICATION
7	4" DIA	RETURN
8	4" DIA	OVERFLOW FROM DAY TANK
9	2" DIA	LEAK DETECTION
10	4" DIA	SUPPLY
11	4" DIA	FILL
12	2" DIA	FROM RELIEF VALVE
13	2" DIA	SECONDARY DRAIN
14	4" DIA	MAIN DRAIN

SHEET 2 of 2

(SEE SHEET 1 FOR TANK PLAN & ELEVATION)

CRWMS/M&O

Design Analysis Cover Sheet

Complete only applicable items.

(1.)

WBS: 1.2.6
QA: QA

2. DESIGN ANALYSIS TITLE NORTH PORTAL FUEL STORAGE SYSTEM FIRE HAZARD ANALYSIS-ESF SURFACE DESIGN PACKAGE 1D			
3. DOCUMENT IDENTIFIER BABBDA000-01717-0200-00003		4. REV. NO. 0B	5. TOTAL PAGES 19
6. TOTAL ATTACHMENTS/NO. OF PAGES IN EACH 1	7. SYSTEM ELEMENT ESF		

	Print Name	Signature	Date
8. Originator	N. M. Ruonavaara	N M Ruonavaara	7-7-94
9. Checker	C. L. Mellen	C L Mellen	7-7-94
10. Lead Discipline Engineer	R. E. Flye	R. E. Flye	7-7-94
11. Department Manager	P. A. Pimentel		

12. REMARKS

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

CRWMS/M&O

Design Analysis Revision Record

Complete only applicable items.

(1.)

WBS: 1.2.6
QA: QA
Page: 2 Of:

2. DESIGN ANALYSIS TITLE
NORTH PORTAL FUEL STORAGE SYSTEM FIRE HAZARD ANALYSIS-ESF SURFACE DESIGN PACKAGE 1D

3. DOCUMENT IDENTIFIER
BABBDA000-01717-0200-00003

4. REVISION NO.
0B

5. Revision No.	6. Pages Added	7. Pages Deleted	8. Description of Revision
0A	20	0	Issue for Inter-Discipline review.
0B	0	1	Issue for 90% Design Review

QAP-3-9 0487 (Rev. 03/10/94)

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

TABLE OF CONTENTS

1. PURPOSE

1.1 The purpose of the fire hazard analysis is to comprehensively assess the risk from fire within the individual fire areas. This document will only assess the fire hazard analysis within the Exploratory Studies Facility (ESF) Design Package 1D, which includes the fuel storage system area of the North Portal facility, and evaluate whether the following objectives are met:

1.1.1 This analysis, performed in accordance with the requirements of this document, will satisfy the requirements for a fire hazard analysis in accordance with U.S. Department of Energy (DOE) Order 5480.7A.

1.1.2 Ensure that property damage from fire and related perils does not exceed an acceptable level.

1.1.3 Provide input to the BFD.

1.1.4 Provide input to the facility Safety Analysis Report (SAR) (Paragraph 3.8).

2. QUALITY ASSURANCE

Work required by this analysis shall be Quality Assurance classified as None. There are no Determination of Importance Evaluation (DIE) controls affected by this analysis.

3. METHOD

A fire hazard analysis includes a detailed narrative description and fire safety review of the facility, its location, fire areas, processes, occupancy, construction, fire and life safety features and hazards. Deficiencies within the body of this section of the fire hazard analysis should be noted and referenced in the Conclusions section. A fire hazard analysis shall be performed under the direction of a qualified fire protection engineer.

3.1 FACILITY DESCRIPTION, PROCESSES, AND CLASSIFICATION

3.1.1 Provide a general description and location.

3.1.2 Provide a short narrative description of the facility, including its location within the site area and its intended use and occupancy.

3.1.3 Provide a detailed summary of the operations, processes, and activities that take place within the facility or are planned for new facilities. Provide product and process information concerning the raw materials, products, waste streams, production sequence, essential safety related equipment, and other information required to assess the fire and life safety risks within the facility or individual fire areas.

3.1.4 Provide details on the construction classification of the facility based on National Fire Protection Association (NFPA) 220 and the Uniform Building Code (UBC). Provide occupancy and hazards classifications for the facility based on the Life Safety Code, UBC, and NFPA 13, as applicable, including the anticipated or actual personnel occupancy of the facility.

3.2 FIRE AREA DESCRIPTIONS AND FEATURES

3.2.1 Provide a detailed description of the facility by fire area, including information on the following:

1. Fire protection features
2. Description of fire hazards
3. Life safety considerations
4. Damage potential according to Maximum Credible Fire Loss (MCFL) and Maximum Possible Fire Loss (MPFL)
5. Fire department/Reynolds Electrical & Engineering Co., Inc. (REECo) Fire Protection Services response
6. Potential for a toxic, biological and/or radiation incident due to a fire
7. Emergency planning
8. Impact of natural hazards (earthquake, flood, wind) on fire safety
9. Exposure fire potential, including the potential for fire spread between fire areas.

3.2.2 Fire area boundaries and physical separation shall be analyzed based on the requirements of the applicable building codes [UBC, Uniform Fire Code (UFC) and DOE Order 6430.1A], the monetary values and limits set for DOE orders, national codes and standards (NFPA, Factory Mutual, etc.), and hazard inventory in each fire area.

3.2.3 The hazard inventories shall identify the combustibles in each fire area.

3.3 SPECIAL CONSIDERATIONS

3.3.1 Assess the potential impact on fire safety from natural hazards such as earthquake, flood, lightning, windstorm, etc.

3.3.2 Provide a description of the REECo Fire Protection Services response to a fire incident, including anticipated response times, apparatus available to respond, appliances and equipment condition and availability, accessibility of the facility or fire areas, water supply available for fire fighting operations, fire pre-plan adequacy, and emergency planning (including non-fire events). Response time shall be the total of the following events: alarm receipt, turn out time, travel time, and fire scene set up.

3.3.3 Identify, describe, and assess the administrative controls in place or anticipated for the facility. Include compensatory measures when fire protection systems are out of service, control of combustibles, technical fire specifications, smoking controls, welding and cutting controls, surveillance and maintenance procedures, personnel fire training, and any other programs or systems in place.

3.4 FIRE EFFECTS AND DAMAGE POTENTIAL

Fire effects and damage potential scenarios and costs must be reviewed with the facility personnel prior to being finalized to ensure that the scenario and loss figures are reasonable and justified.

3.5 MAXIMUM POSSIBLE FIRE LOSS (MPFL)

The MPFL is the single worst case fire scenario for a facility, with no mitigating actions to suppress the fire. The MPFL will be the highest value fire area in the facility, including building, contents, equipment, decontamination and cleanup, and consequent effects of fire fighting.

3.5.1 Describe the fire scenario, the fire area involved, and any exposures or consequent effects anticipated in adjacent fire areas.

3.5.2 Provide the fire loss amount for building, contents, and equipment. Provide an estimated cost, with appropriate details and assumptions, for the fire fighting, decontamination and cleanup, and any ancillary costs (inflation, engineering design, overheads, etc.).

3.5.3 Describe the programmatic consequences that would result from the MPFL fire scenario. Provide recovery potential details including temporary power, interim production, and other measures that could be implemented to improve damage recovery.

3.5.4 Compare the MPFL costs and consequences to the criteria in DOE Orders 5480.7 and 6430.1A, Section 1530-2.3, and determine into which category the MPFL fits. From this analysis, determine the level of protection required and determine if it is achieved. Make any required recommendations in the Conclusions section for additional measures to achieve the necessary protection.

3.6 MAXIMUM CREDIBLE FIRE LOSS (MCFL)

The MCFL is the fire scenario that would cause the largest single fire loss able to be controlled by the installed automatic fire protection systems. The MCFL can be assumed to be the single highest cost piece of equipment or process in the facility (from MCFL) that will burn. The installed automatic fire protection systems are assumed to control the fire and limit damage to the involved piece of equipment.

3.6.1 Describe the fire scenario, the equipment and fire area involved, and any exposures or consequent effects to adjacent equipment or contents of the fire area.

3.6.2 Provide the fire loss amount for building, contents, and equipment. Provide an estimated cost, with appropriate details and assumptions, for fire fighting, decontamination and cleanup, and any ancillary costs (inflation, engineering design, overheads, etc.).

3.6.3 Describe the programmatic consequences that would result from the MCFL fire scenario. Provide recovery potential details including temporary power, interim production, spare equipment, and replacement times, if available.

3.6.4 Analyze the fire scenario and its consequences and determine if the MCFL is acceptable to DOE objectives and the facility or process involved. Make the necessary recommendations for additional protection to achieve any required improvements to reduce or mitigate the consequences of the MCFL.

3.7 MOST PROBABLE FIRE (MPF) SCENARIO

The MPF is the single most likely significant fire scenario that can be anticipated to occur in the facility. The MPF is not the insignificant "trash can" fire. The MPF scenario must be developed using sound professional judgment, including fire loss historical data, possible ignition sources, type of occupancy, potential fire growth and development, and anticipated automatic suppression effects.

3.7.1 Describe the MPF scenario, including the basis for its selection. Include potential risk, ignition method, and suppression results.

3.7.2 Describe anticipated fire loss and consequences of the fire. Include normal cleanup and fire fighting costs, decontamination if required, and any anticipated ancillary costs.

3.7.3 Develop and describe the anticipated risk of the MPF occurring, and provide data for use in the facility SAR if required.

3.8 RECORDS

The fire hazard analysis shall be maintained as a lifetime record as part of the facility project files and shall be referenced in the facility SAR.

3.9 TERMS AND DEFINITIONS

Terms and definitions have been established based upon the DOE orders, the UBC, and applicable national standards.

3.9.1 **Acceptable** - When applied to fire safety, "acceptable" is a level of protection which the Authority Having Jurisdiction (AHJ), after consultation with the cognizant DOE fire protection engineer(s), considers sufficient to achieve the objectives defined above. In some instances, it is a level of protection that deviates (plus or minus) from a code or standard as necessary and yet adequately protects against the inherent fire hazards.

3.9.2 **Authority Having Jurisdiction (AHJ)** - The decision-making authority in matters concerning fire protection. Except as directed by the Program Secretarial Officers, the Heads of Field Organizations or designee is the AHJ. Decisions impacting fire safety shall be made by the AHJ only after consultation with the cognizant DOE fire protection engineer(s). Where an Area Office or Site Office exists within the DOE organization, a formal, clearly defined delegation of fire protection responsibility shall be established regarding the AHJ.

3.9.3 **DOE Fire Protection Program** - Those fire protection requirements, hardware, administrative controls, procedures, guidelines, plans, personnel, analyses, and technical criteria that comprehensively ensure that DOE objectives relating to fire safety are achieved.

3.9.4 **Equivalency** - The approved alternate means of satisfying the technical provisions of a fire protection code or standard. (Deviations from specific requirements of occupational safety and health standards, as delineated in the Code of Federal Regulations (CFR), are treated as variances as defined in the DOE's Occupational Safety and Health Program.)

3.9.5 **Exemption** - The approved deviation from a non-statutory code, standard, or DOE order. (Deviations from specific requirements of occupational safety and health standards, as delineated in the CFR, are treated as variances as defined in the DOE's Occupational Safety and Health Program).

3.9.6 **Fire Area** - A location bounded by construction having a minimum fire resistance rating of two hours with openings protected by appropriate fire-rated doors, dampers, or penetration seals. The boundaries of exterior fire areas (yard areas) shall be as determined by the AHJ.

3.9.7 **Fire Loss** - The dollar cost of restoring damaged property to its pre-fire condition (refer to DOE Order 5484.1). In determining loss, the estimated damage to the facility and contents shall include replacement costs, less salvage value. Losses will exclude the cost of restoring:

- Property that is scheduled for demolition
- Property that is decommissioned and not carried on books as a value
- Property with no loss potential.

Include the cost of decontamination and cleanup, the loss of production or program continuity, the indirect costs of fire extinguishment (such as damaged fire department equipment), and consequent effects on related areas in all property loss amounts.

3.9.8 **Fire Protection** - A broad term which encompasses all aspects of fire safety, including:

- Building construction and fixed building fire features
- Fire suppression and detection systems
- Fire water systems
- Emergency process safety control systems
- Emergency fire fighting organizations (fire departments, fire brigades, etc.)
- Fire protection engineering
- Fire prevention.

Fire protection is concerned with preventing or minimizing the direct and indirect consequences of fire. It also includes aspects of the following perils as they relate to fire protection: explosion, natural phenomena, smoke and water damage from fire.

3.9.9 **Fire Protection System** - Any system designed to detect, extinguish, and limit the extent of fire damage or enhance life safety. Where redundant fire protection systems are required, any two of the following will satisfy that requirement:

- Automatic suppression systems, such as fire sprinklers, foam, gaseous, explosion suppression, or other specialized extinguishing systems, plus appropriate alarms. An adequate supply, storage, and distribution system is an essential element.

- Automatic fire detection, occupant warning, manual fire alarm, and fire alarm reporting systems combined with properly equipped and adequately trained fire departments.

- Fire barrier systems or combinations of physical separation and barriers for outdoor locations.

- Other systems, such as alternate process control systems, as approved by the AHJ.

3.9.10 **Maximum Credible Fire Loss (MCFL)** - The property damage that would be expected from a fire, assuming that all installed fire protection systems function as designed, and the effect of emergency response is omitted except for post-fire actions such as salvage work, shutting down water systems, and restoring operation.

3.9.11 **Maximum Possible Fire Loss (MPFL)** - The value of property (excluding land) within a fire area, unless a fire hazard analysis demonstrates a lesser (or greater) loss potential. This assumes the failure of both automatic fire suppression systems and manual fire fighting efforts.

3.9.12 **Property** - All government-owned or leased structures and contents for which DOE has responsibility, including:

- All DOE land, structures, and contents
- All leased locations
- All other Government property on DOE land or in DOE structures
- Other property that occupies DOE land or is in DOE structures.

3.9.13 **Qualified Fire Protection Engineer** - A graduate of an accredited engineering curriculum who has completed not less than four years of engineering practice, three of which shall have been in responsible charge of diverse fire protection engineering work. If not such a graduate, a qualified engineer shall either: demonstrate a knowledge of the principles of engineering and have completed not less than six years engineering practice, three of which shall have been in responsible charge of diverse fire protection engineering projects; be a registered professional engineer in fire protection; or meet the requirements for a Grade 11 or higher Fire Protection Engineer as defined by the U.S. Office of Personnel Management.

3.9.14 **Related Perils** - Aspects of the following as they relate to fire protection: explosion, natural phenomena, smoke, and water damage.

3.9.15 **Risk** - A term used to describe the overall potential for loss (refer to DOE Order 5481.1B).

3.9.16 **Safety Class Equipment** - Systems, structures, or components including primary environment monitors and portions of process systems, whose failure could adversely affect the environment or the safety and health of the public.

3.9.16.1 For nuclear reactors and non-reactor nuclear facilities, Class A Equipment includes those systems, structures, or components with the following characteristics:

- Those whose failure would produce exposure consequences that would exceed DOE established guidelines at the site boundary or nearest point of uncontrolled public access.

- Those required to maintain operating parameters within the safety limits specified in Technical Safety Requirements (Technical Specification or Operational Safety Requirements) during normal operations and anticipated operational occurrences.

- Those required for nuclear criticality safety.

- Those required to monitor the release of radioactive materials to the environment during and after a design basis accident.

- Those required to monitor and maintain the facility in a safe shutdown condition.

- Those that control the safety class items described above.

3.9.17 **Vital Program** - A DOE program so defined by the Program Secretarial Officers.

4. CODES AND STANDARDS

4.1 U.S. DEPARTMENT OF ENERGY (DOE):

DOE Order 4700.1	Project Management System	1987 Edition
DOE Order 5480.4	Environmental Protection, Safety, and Health Protection Standards	1984 Edition
DOE Order 5480.5	Safety of Nuclear Facilities	1984 Edition
DOE Order 5480.7A	Fire Protection	1993 Edition
DOE Order 5484.1	Environmental Protection, Safety and Health Protection Information Reporting Requirements	1981 Edition
DOE Order 6430.1A	General Design Criteria	1989 Edition

4.2 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA):

NFPA 10	Portable Fire Extinguishers	1990 Edition
NFPA 24	Private Fire Service Mains and Their Appurtenances	1992 Edition
NFPA 30	Flammable and Combustible Liquids Code, 17th Edition	1993 Edition
NFPA 70	National Electrical Code	1993 Edition

NFPA 80A	Recommended Practice for Protection of Buildings from Exterior Fire Exposures	1989 Edition
NFPA 220	Standards on Types of Building Construction	1989 Edition

Fire Protection Handbook

4.3 CODE OF FEDERAL REGULATIONS (CFR):

29 CFR 1910	Occupational Safety and Health Administration (OSHA) Regulations, July 1, 1992
29 CFR 1910	Subpart L - OSHA Regulations, Fire Protection, July 1, 1992
29 CFR 1926	Safety and Health Regulations for Construction (OSHA), July 1, 1992

4.4 FACTORY MUTUAL ENGINEERING CORPORATION (FM):

Loss Prevention Data Sheets

Approval Guide 1993 Edition

4.5 UNDERWRITERS LABORATORIES, INC. (UL):

UL 142	Steel Above Ground Tanks for Flammable and Combustible Liquids	1993 Edition
UL Fire Protection Equipment Directory		1993 Edition
UL Fire Resistance Directory		1993 Edition
UL Building Materials Directory		1993 Edition

4.6 UNIFORM BUILDING CODE (UBC) - 1991 EDITION

4.7 UNIFORM FIRE CODE (UFC) - 1990 EDITION

5. DESIGN INPUTS

5.1 ESF BFD document, CRWMS M&O Document No. BAB000000-01717-6300-00002, Rev. 05, Section 7.2.4.1

5.2 DOE Order 5480.7A Requirements

5.2.1 A DOE facility shall be characterized by a level of fire protection sufficient to fulfill the requirements for the best protected class of industrial risks (Highly Protected Risk/Improved Risk). This program is characterized by the inclusion of a continuing, sincere interest on the part of management and employees in minimizing losses from fire and related perils and the inclusion of preventive features necessary to assure the satisfaction of objectives related to safety.

5.2.2 The DOE Fire Protection Program shall meet or exceed the minimum requirements established by the NFPA as directed by the Program Senior Official (PSO). Basic requirements shall include a reliable water supply of acceptable capacity for fire suppression; noncombustible construction of an acceptable nature for the occupancy of the facility; automatic fire extinguishing systems; a fully staffed, trained, and equipped emergency response force; a means to summon the emergency response force in the event of a fire; and a means to notify the building occupants to evacuate in the event of a fire. For areas subject to significant life safety risks, serious property damage, program interruption, or loss of safety class equipment as defined in the relevant facility SAR, additional protection measures may be deemed necessary as determined by the AHJ.

5.2.3 This level of protection also includes administrative procedures encompassing controls for hazardous substances/processes; inspection, maintenance, and testing of fire protection features; and other programmatic fire safety activities as defined below.

5.2.3.1 **Fire Department** - A fully staffed, trained, and equipped fire department/REECo Fire Protection Services shall service all DOE facilities, except as determined by the PSO. (Refer to the fire protection positions on minimum staffing levels in the DOE Fire Protection Resource Manual.)

5.2.3.2 **Fire Department Water Supply** - An automatic water supply for fire protection having a minimum two hours stored water capacity shall be maintained. Well water at Area 25 of the Nevada Test Site satisfies this requirement. Facilities having an MPFL in excess of $50 million shall be provided with an additional, independent source of fire protection water.

5.2.3.2.1 A water supply dedicated to fire protection may be necessary as determined by the PSO. A dedicated system shall be able to meet hose stream and sprinkler system demands.

5.2.3.2.2 A combined fire and process/domestic system shall be able to deliver the fire demand plus the maximum daily domestic demand for the required duration.

5.2.3.3 **Underground Piping** - Mains shall be sized for the largest fire flows anticipated but in no case shall they be less than 8-inch diameter. Supply piping to individual fire sprinkler systems shall be at least as large as the fire sprinkler system riser.

5.2.3.4 **Liquid Run-off Control** - Natural or artificial means of controlling liquid run-offs from a maximum credible fire shall be provided so that contaminated or polluting liquids will not escape the site, including potentially contaminated water resulting from fire fighting operations. The amount of fire water that must be controlled and the design of the containment systems shall be determined based on consultations with the cognizant DOE fire protection engineer.

5.2.3.5 **Fire Alarm Systems** - Where fire suppression or fire alarm systems are provided, local alarms in the protected area and alarm transmission to an acceptable remote attended location shall be provided.

5.2.3.6 **Impairment Control** - A fire protection system impairment program shall be provided for control of operations and tracking of impairments during periods when fire protection systems are out of service.

5.3 **Seismic Design Criteria** - The equipment shall be designed for UBC Seismic Zone 4 requirements.

5.4 **Wind Design Criteria** - The equipment shall be designed for an 80 MPH basic wind speed, Exposure "C".

6. CRITERIA

This document describes the methodology, structure, and responsibilities for performing fire hazard analysis to meet the requirements of DOE Orders 5480.7A, Section 9, 6430.1A, Section 0110-6.2, 0111-99.0.1, 1300-1.3, and 1530, and 4700.1. A fire hazard analysis shall review the facility fire protection and life safety features by fire area to assess compliance with DOE orders, national standards, and local site requirements.

6.1 A fire hazard analysis shall be performed to comprehensively assess the risks from fire within individual fire areas in the ESF project so as to ascertain whether the objectives of DOE Order 5480.7A are met.

6.2 A fire hazard analysis shall be performed for all new facilities as directed by DOE Order 6430.1A and the AHJ.

6.3 A fire hazard analysis shall be performed to provide the supporting documentation for the fire protection system selection in accordance with the ESF Basis For Design (BFD) Civilian Radioactive Waste Management System (CRWMS) Management and Operating Contractor (M&O) Document No. B00000000-01717-6300-00002.

7. ASSUMPTIONS

The diesel fuel stored in the storage tank is classified as a combustible liquid. Since the ambient temperatures in the area are above 100 degrees F, the tank is insulated to limit the temperature rise. As the final design of the tank has not been completed, the assumption has been made that the maximum temperature of the diesel fuel will not exceed 100 degrees F.

8. REFERENCES

8.1 ESFDR Document, YMP/CM-0019, Rev. 0

8.2 Engineering Drawings for ESF Design Package 1D

8.3 Attachment I - ESF Design Package 1D Cost Estimate

8.4 Specification Section 15482 Diesel Fuel Oil System

8.5 Specification Section 15060 Mechanical Piping

8.6 Specification Section 15260 Piping Insulation

8.7 Specification Section 16405 NEMA Frame Induction Motors (Small)

8.8 Specification Section 16152 Packaged Mechanical Equipment

8.9 Specification Section 16622 Packaged Engine Generator Systems

8.10 Determination of Important Evaluation (DIE) for ESF North Portal Pad, Document No. BABB00000-01717-2200-00001, Rev. 04A, Section 11.3

9. COMPUTER PROGRAMS

Not applicable.

10. DESIGN ANALYSIS

10.1 DIESEL FUEL OIL SYSTEM DESCRIPTION

10.1.1 General

10.1.1.1 The diesel fuel oil system provides diesel fuel to the standby generators.

10.1.1.2 All electrical equipment is UL listed and shall bear the UL label. Electrical components, controls, construction, and design are in accordance with Specification Sections 16152 and 16405.

10.1.1.3 All components of the system are restrained to meet UBC Seismic Zone 4 requirements.

10.1.1.4 All components of the system are suitable for outdoor installation.

10.1.2 Main Fuel Oil Storage Tank

10.1.2.1 One horizontal 10,000-gallon carbon steel tank for above ground installation is provided as shown on the Drawings. The tank has secondary containment construction and has been fabricated in accordance with the requirements of UL 142 and NFPA 30. The tank is self-contained and is designed to satisfy all requirements of NFPA 30, Paragraph 2.3.4.1, Exception No. 2.

10.1.2.2 The fuel oil storage tank is provided with the following connections:

- Two-inch diameter by 8-foot long vent stack
- Four-inch brass and iron lockable fill cap with overspill protection
- Six-inch emergency relief vent
- Two-inch liquid level gauge
- Secondary monitoring port
- Concrete inlet port
- Pump suction lines
- Fuel oil return lines
- Earthquake tiedowns.

10.1.3 Day Tanks (Future)

Day tanks and associated instrumentation to support the operations of standby generators (GN-401 through GN-408) will be analyzed later in a revision to this document.

10.2 DIESEL FUEL PUMPS

The three diesel fuel pumps are rated 1 horsepower, 460 volts, 3 phase, 60 Hertz, 10 GPM, and a head pressure of 25 psig. The pumps are supplied with standby power.

10.3 FIRE AREA DESCRIPTIONS AND FEATURES

10.3.1 The diesel fuel storage tank pad is located approximately 30 feet north-northeast of the standby generator's pad; only 15 feet is required by NFPA 30. The pump pad is immediately west of the storage tank.

10.3.1.1 The diesel storage tanks are constructed with secondary containment and are listed by UL in accordance with UL 142 and are installed in accordance with the requirements of NFPA 30.

10.3.1.2 The tanks contain a diesel fuel classified as a combustible liquid in accordance with the definitions of NFPA 30.

10.3.1.3 No special extinguishing systems are required to protect either the tanks or any adjacent exposure.

10.3.1.4 The tanks are separated to limit exposure damage in case of a fire. The tank pads are separated from adjacent structure to prevent exposure from fire-related incidents, in accordance with NFPA 80A, Uniform Fire Code Tables 79.503A and 79.503F, and BFD Section 7.2.4.1.IV.18 for maintenance.

10.3.1.5 The water supply for the permanent fire protection installation is provided by a dedicated source with sufficient capacity (based on maximum demand) for fire fighting until other sources become available.

10.3.2 Yard hydrants are provided at a minimum space of 400 feet. Location of the hydrants considers the possible locations of fires outside. Hydrant demands comply with DOE Order 6430.1A, Section 1530-3.3.3.

10.3.3 Portable Fire Extinguishers

Two portable fire extinguishers rated 4A/40B:C are provided as required and comply with NFPA 10.

10.3.4 Water System

A separate firewater and construction water system supplies water for fire protection. Lines or subsystems handling water for fire protection have a minimum earth cover of three feet.

10.4 FIRE HAZARDS

10.4.1 Description

The diesel fuel supply tanks are designed in accordance with applicable NFPA and ASME codes and standards. Combustible liquids are in suitably listed containers with spill protection and electrical equipment is suitably listed and classified. The tank spacing is based on complying with UFC Tables 79.503A and 79.503F. The tank construction and spacing are the same for either a Type I or Type II flammable or combustible liquid.

10.4.2 Mitigation

Yard hydrants and portable fire extinguishers are provided. Two fire extinguishers are rated minimum 4A40B:C in accordance with NFPA 10. The pads for the diesel fuel supply tanks are approximately 400 feet from the tunnel entrance and do not endanger the portal entrance.

10.4.3 Life Safety Considerations

The units are located in an open area.

10.4.4 Essential Safety Class Systems

The diesel fuel supply tanks for the standby generators and air compressors do not supply any essential safety class systems.

10.5 DAMAGE POTENTIAL

10.5.1 Maximum Possible Fire Loss

The value in 1994 of the tanks is $50,000.

10.5.2 Largest Possible Fire Loss

This can be expected to be the same as the maximum possible fire loss since the facility does not include materials or processes that would add significant costs for cleanup or decontamination.

10.5.3 Maximum Credible Fire Loss

The maximum credible fire loss for the diesel fuel supply tanks would be the loss of a tank plus cleanup costs or $50,000.

10.6 FIRE DEPARTMENT RESPONSE

Since the minimum possible response time for the REECo fire department would exceed 45 minutes, no credit is taken for any mitigation by the fire department.

10.7 RECOVERY POTENTIAL

No adverse recovery time is required to be mitigated.

10.8 FIRE RELATED POTENTIAL

No toxic, biological, or radiation releases are possible due to a fire in this area. No special emergency planning or security precautions are required. The units are designed for outdoor and seismic constraints of the area according to UBC Seismic Zone 4 requirements. The units are separated from each other and adjacent areas in accordance with NFPA 80A and NFPA 30.

11. CONCLUSIONS

The ESF North Portal does not exhibit any unusual hazards or unmitigated loss potential that exceeds the guidelines of an "improved risk" as defined by DOE Order 5480.7A.

12. ATTACHMENTS

ATTACHMENT	TITLE
I	FUEL STORAGE SYSTEM - ESF DESIGN PACKAGE 1D COST ESTIMATE

ATTACHMENT I

FUEL STORAGE SYSTEM - ESF DESIGN PACKAGE 1D COST ESTIMATE

CRWMS/M&O

Design Analysis Cover Sheet

Complete only applicable items.

(1.)

WBS: 1.2.6
QA: QA

2. DESIGN ANALYSIS TITLE NORTH PORTAL SURFACE-BASED COMPRESSED AIR SYSTEM ANALYSIS			
3. DOCUMENT IDENTIFIER BABBDF000-01717-0200-00023		4. REV. NO. 01A	5. TOTAL PAGES 20
6. TOTAL ATTACHMENTS/NO. OF PAGES IN EACH (I-4pg)(II-1pg)(III-1pg)(IV-1pg)		7. SYSTEM ELEMENT SURFACE COMPRESSED AIR	

	Print Name	Signature	Date
8. Originator	C. Mellen	R. E. Flye FOR C. [illegible] MELLEN	7-7-94
9. Checker	D. Vanica	R. E. Flye	7-7-94
10. Lead Discipline Engineer	R. Flye	R. E. Flye	7-7-94
11. Department Manager	P. A. Pimental		

12. REMARKS

QAP-3-9 0492 (Rev. 03/14/94)

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

CRWMS/M&O

Design Analysis Revision Record

Complete only applicable items.

(1.) WBS: 1.2.6
QA: QA

2. DESIGN ANALYSIS TITLE
NORTH PORTAL SURFACE-BASED COMPRESSED AIR SYSTEM ANALYSIS

3. DOCUMENT IDENTIFIER
BABBDF000-01717-0200-00023

4. REVISION NO.
01A

5. Revision No.	6. Pages Added	7. Pages Deleted	8. Description of Revision
00			Issued for Construction.
01A			Issued for 90% Design Review.

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

1. PURPOSE

The purpose of this analysis is to capture the design requirements and analyze equipment performance relevant to the Surface-Based Compressed Air System (CAS) design at the Yucca Mountain Site Characterization Project (YMP) Exploratory Studies Facility (ESF).

2. QUALITY ASSURANCE

The work developed within this analysis relates to temporary equipment not included on the Q-list.

2.1 The Quality Assurance (QA) classification of this analysis is QA - NONE.

2.2 This analysis recognizes the controls as established by the Determination of Importance Evaluation (DIE) for ESF Surface Compressed Air and Standby Power Systems (Reference Section 5.18). These controls will be included in the design of the CAS. DIE controls affecting this analysis include the following:

2.2.1 Minimize the potential for waste isolation and/or test interference impacts from hydrocarbon or water penetration into the soil. Periodic inspections shall be conducted to ensure compliance. Leaks and spills are to be repaired, cleaned up, and reported upon discovery.

2.2.2 All tracers, fluids, and materials (TFM) used in the construction or operation of the CAS shall be monitored and handled in accordance with the TFM Management Plan.

3. METHOD

The method used in this design analysis involves capturing data and requirements, modifying or developing conceptual design criteria (Title I), then developing final design criteria (Title II). Much data has evolved since initial compilation began, with significant and major changes occurring late in the working design. Design data and requirements are captured from the following sources:

3.1 Local Records Center (LRC), search for records associated with work previously done on the ESF CAS.

3.2 The Title I Design Summary Report (DSR) for the Exploratory Studies Facility provides a preliminary conceptual design basis for the CAS.

3.3 The ESF Design Requirements Document (ESFDR) provides criteria and requirements compiled from upper tier documents.

3.4 Meetings with project participants involved with the design, construction, and testing of the YMP ESF.

3.5 Discussions with equipment vendors to evaluate available equipment and suitability for incorporation within the design.

3.6 ESF project status meetings, establishing constraints on construction and budgeting of the ESF.

3.7 Design reviews of the CAS, generating a wide variety of requirements and constraints.

4. CODES AND STANDARDS

4.1 American National Standards Institute, Inc. (ANSI)/Instrument Society of America (ISA)-S7.3-1975 Instrument Air Standard.

4.2 U.S. Department of Energy (DOE) 6430.1A General Design Criteria.

5. DESIGN INPUTS

5.1 Design Review Comment (response) DA-TR-ESF-S-14, J. Lathrop regarding ST-ME-011, 08/12/91.

5.2 U.S. Geological Survey (USGS) Memorandum from B. Craig to A. Yang, RE: Gas-tracer Concentration, NNA.891226.0205 (GS.89.A.001669),11/03/89.

5.3 InterOffice Correspondence (IOC) from L. Engwall to J. Naaf, LV.ESSD.LGE.5/93-099, RE: Request for information, 05/12/93.

5.4 IOC from C. Mellen to distribution, LV.ESSD.CM.9/93.516, RE: Outline Scope and Meeting announcement, 09/17/93.

5.5 IOC from C. Mellen to distribution, LV.ESSD.CM.9/93.527, RE: Meeting findings, 09/30/93.

5.6 IOC from R. M. Sandifer "FY 94 Revised Work Plan," LV.SE.SB.10/93-089.

5.7 IOC from D. F. Vanica to L.G. Engwall, LV.ESSB.DFV.5/93-075, RE: Revised Compressed Air System requirements, 5/14/93.

5.8 IOC from D. Parker to distribution, LV.ESSD.DHP.11/93.545, RE: REECo meeting 11/10 - discussion notes, 11/17/93.

5.9 IOC from C. Mellen to D. Parker, LV.ESSC.CLM.8/93-253, RE: ESF 1C Package Mechanical Scope Outline, 8/17/93.

5.10 IOC from C. Mellen to R. Dresel, LV.ESSD.CM.12/93.558, RE: Request for additional information for three Air Compressors, 12/02/93.

5.11 Teleconference with Tom Leonard of REECo: request for 4 inch CAS line to shop, 10/4/93.

5.12 Teleconference with Tom Leonard of REECo: request for 4 inch CAS line to shop - verified, 1/21/94.

5.13 Title I Design Summary Report (DSR) for the Exploratory Studies Facility, Rev. 1. 05/06/92.

5.14 Exploratory Studies Facility Design Requirements Document (ESFDR), YMP/CM-0019 Rev. 0, July 1993.

5.15 Design Analysis: BABFAG000-01717-0200-00161 Rev. 0A, Compressed Air Distribution Design Analysis, D. F. Vanica, 12/07/93.

5.16 Design Analysis: BABFAG000-01717-0200-00161 Rev. 00, Compressed Air Distribution Design Analysis, D. F. Vanica, 03/29/94.

5.17 Design Analysis: ST-ME-011, Underground Support Systems, D. A. Veronica (RSN), 07/18/91.

5.18 Determination of Importance Evaluation for ESF Surface Compressed Air and Standby Power Systems, BABBD0000-01717-2200-00022, Rev. 00.

5.19 Letter from R. Sandifer to J. Replogle, LV.MG.RMS.12/93.191, RE: NTS Surplus Equipment, 12/01/93.

5.20 IOC from J. J. Salchak to A. Segrest, LV.ESSD.Ref.3/94-177, RE: Compressed Air System (CAS) - Package 1C 90 Percent Design, 3/25/94.

5.21 Waste Isolation Evaluation: Tracers, Fluids, and Materials for Use in the Package 2C Exploratory Studies Facility Construction, BABE00000-01717-2200-0007, Rev. 00, Draft 4/22/94.

5.22 Letter from A. Segrest to J. Replogle, LV.ESSD.REF. 3/94-.099, RE: Revision of CAS Requirements from 90% Design Review, 3/4/94.

5.23 Letter from C. T. Statton to N. Z. Elkins. #LV.SC.BWD. 2/94-208; RE: Request for Exemption of Tracers..., 2/22/94.

5.24 LANL IOC #LA-EES-13-LV-02-94-054 from N. Z. Elkins to C. T. Statton. RE: Support for Exemption from Use of Tracers..., 2/22/94.

6. CRITERIA

6.1 FROM THE DSR, SECTION 3.4.6 (REFERENCE SECTION 5.13)

"The compressed air system supplies compressed air for ESF construction, testing, and operation. The surface compressed air system consists of pad-mounted compressor units producing the compressed air, as well as auxiliary equipment conditioning the compressed air (Reference Design Analysis ST-ME-011). The compressed air system will contain an approved tracer gas metered for control."

"The conditioning equipment includes oil separators and aftercoolers to provide a product safe for personnel use. The surface compressed air system supplies compressed air to meet the 100-psig demands of subsurface construction and testing. Booster compressors will be provided for the 200-psig pressure requirements of the large diameter drills."

6.2 FROM THE ESFDR SECTION 3.2.5.2.6 COMPRESSED AIR SYSTEM (REFERENCE SECTION 5.14)

A. "The compressed air system shall provide compressed air throughout the designated areas of the ESF with flow rates and pressures to support construction and operations of the facilities, site characterization testing requirements, and drilling requirements including additional drift excavation."

B. "Compressed air shall be conditioned as required and a quantity maintained to meet drilling and test apparatus requirements (Reference ESFDR Appendix B). Suitable filtering shall be provided where oil-free air is required."

C. "The air compressor(s) shall be of a size to meet the requirements of ESF construction, testing, and operations. Modularity of the system to accommodate variable loads and system maintenance shall be considered."

D. "All compressed air used during operation and construction of the ESF shall be provided with chemical tracers unless exempted by the ESF Test Coordinator. All tracers and substances added shall be approved per Section 3.2.1.M.3. [TBD]"

E. "As an energy conservation measure, designers will examine the use of electrical and/or electrohydraulic drives for underground construction equipment as an alternative to compressed air wherever possible and feasible."

7. ASSUMPTIONS

7.1 Stated volumetric values (cfm) are assumed at standard temperature and pressure (STP) unless stated otherwise. STP is 70°F and 14.7 psia.

7.2 Compressor inlet air conditions are expected to approximate ideal gas laws.

7.3 The ambient temperature data source citing a maximum of 108°F and minimum of -14°F will not be exceeded for the life of the ESF North Portal Pad utilities. If actual temperature exceeds this range, the time spent outside the range is expected to be minimal with nominal effects to the operation of the CAS. (Reference Sections 5.3 and 8.2)

7.4 A 4 inch compressed air line to the Shop Building provides no additional load to the total CAS quantity. Items using compressed air in the shop are the same items (hand tools, drills, etc.) that would normally be used for subsurface excavation. Therefore, the compressed air used to maintain these items at the shop is not added to the subsurface supply. The net total is the same overall quantity required for subsurface operations. (Reference Sections 5.11 and 5.12)

8. REFERENCES

8.1 Compressed Air and Gas Handbook, fifth ed., Prentice-Hall Inc. 1989.

8.2 17-year Climatological Summary for Yucca Flat, Nevada. January 1962-April 1978. Provided to the M&O by B. Anzai of Raytheon Services Nevada. (Attachment I)

8.3 Fluor Daniel Engineering Practices, Heating, Ventilating, and Air Conditioning (HVAC) Design Guide. Section 000 235 1310.

8.4 Mechanical Engineering Reference Manual, eighth ed., Michael Lindeburg, P.E.

8.5 Manchester Tank Catalog 4954-2/91.

9. COMPUTER PROGRAMS

No computer programs were used for this analysis.

10. BODY

The body of this analysis is divided into three sections consisting of CAS requirements, CAS design, and CAS equipment analysis.

10.1 CAS REQUIREMENTS

The following requirements capture the evolution of the CAS. Some may no longer be applicable but are captured in this analysis to provide a traceable history of development. The latest and most current requirements are summarized in Section 10.2.

10.1.1 ESFDR Requirements (Reference Section 6.2)

10.1.1.1 The CAS shall provide compressed air at the flow rates and pressures required to support construction, operations, site characterization testing, and additional drift excavation. (ESFDR 3.2.5.2.6 A.)

10.1.1.2 The compressed air shall be conditioned and filtered to meet testing and drilling requirements. (ESFDR 3.2.5.2.6 B.)

10.1.1.3 The air compressors shall be of a size to meet the requirements of ESF construction, testing, and operations. Modularity of the system and maintenance shall be a consideration. (ESFDR 3.2.5.2.6 C.)

10.1.1.4 All compressed air used during operation and construction shall be injected with approved chemical tracers. (ESFDR 3.2.5.2.6 D.)

10.1.1.5 To conserve energy, the subsurface designers shall examine the use of electrical drives for subsurface construction equipment where applicable. (ESFDR 3.2.5.2.6 E.)

10.1.2 CAS Design Volume Requirements

10.1.2.1 Original air volume requirement: 2200 CFM (125 psig discharge pressure and 100 psig to tools. A total of six (6) 1500 cfm compressors, 3 at each portal entrance was planned. A grand total of 9000 cfm was to be installed with 3000 cfm of this available as standby capacity. (Reference Sections 5.1 and 5.17) These requirements were based on the simultaneous operation of two tunnel boring machines at each portal.

10.1.2.2 Interim air volume requirement: Based on conversation with sub-surface engineers on the potential for expansion, 4000 cfm was identified as a future operating requirement. (Reference Section 5.3)

10.1.2.3 Interim air volume requirement: Request from D.F. Vanica to revise requirements to 2200 cfm. (Reference Section 5.7)

10.1.2.4 Interim air volume requirement: Volumetric requirements established at 2560 cfm based on meeting with subsurface engineers and the testing and performance assessment community. (Reference Section 5.5)

10.1.2.5 Interim air volume requirement: Design air volume requirement established at 2500 cfm, with a peak demand of 3000 cfm. (Reference Section 5.15)

10.1.2.6 Final air volume requirement: Design air volume requirement established at 2376 scfm from subsurface design analysis. (Reference Section 5.16)

10.1.3 CAS Pressure Requirements

10.1.3.1 The original air pressure requirement was 125 psig discharge pressure allowing a conservative 100 psig for tools (@2200 cfm). (Reference Section 5.17)

10.1.3.2 The final pressure requirements established at 125 psig to North Portal entrance. (Reference Section 5.5)

10.1.4 CAS Air Quality Requirements

10.1.4.1 Oil-free air is identified as an operating requirement. (Reference Section 5.3)

10.1.4.2 Preliminary DIE analysis indicates that the compressed air system be oil-free. (Reference Section 5.4)

10.1.4.3 ANSI/ISA-S7.3-1975 was determined as a reference for air quality (Instrument Air Standard). Nominal filtering of particulates established at 3 microns. Dewpoint established at least 18°F below ambient. Hydrocarbons established at less than one (1) ppm concentration. (Reference Section 5.5)

10.1.4.4 Comments from B. Anzai at the 90 percent design review for Design Package 1C questioned the need for air quality up to the ANSI/ISA standard as determined in Reference Section 5.5. Re-assessment by the testing and performance assessment community determined that the requirement for air drying and hydrocarbon vapor removal could be deleted. This decision resulted in the removal of the air dryer skid, carbon adsorption filters, and chemical injection system. (Reference Sections 5.20, 5.22, 5.23 and 5.24)

10.1.4.5 Subsurface Waste Isolation Analysis indicates that the minimum recommended level of organic deposition within the tunnel be limited to 10 grams per meter of total excavation. (Reference Section 5.21)

10.1.5 Equipment and Piping Requirements

10.1.5.1 Originally, the equipment specified for the CAS would be new equipment. However, DOE program budgetary constraints have forced YMP to use excess Nevada Test Site (NTS) equipment for the CAS. (Reference Section 5.6)

10.1.5.2 Originally, six (6) rotary-screw compressors rated at 1500 cfm, 125 psig, and 300 hp were proposed (Reference Section 10.1.2.1). Three units located at each portal shall allow for system maintenance and reliability. (Reference Sections 5.17 and 5.1)

10.1.5.3 Piping for the surface portion of the compressed air system will be supported from beneath the muck conveyer. (Reference Section 5.8)

10.1.5.4 Provide a 4 inch line to the Shop Building for supporting maintenance of underground equipment. (Reference Sections 5.11 and 5.12)

10.1.5.5 Preliminary DIE analysis indicates that the compressed air system utilize air-cooled equipment. (Reference Section 5.4)

10.1.5.6 Oil-free air-cooled rotary screw (ACRS) compressors are required based on meeting with the subsurface design group and the testing-performance assessment community. The compressor module size approximates 750 cfm. Electrical requirements are 480 V, 3 ph, 200 hp, for each of five (5) compressors. Redundancy established at one (1) module. Compressors to be mounted on oil-field type skids, not requiring a pad (Reference Section 5.5)

10.1.5.7 Excess oil-injected ACRS compressors (3) are identified at NTS and are set aside for use by YMP M&O in designing the ESF CAS. The excess equipment is skid mounted and will require a concrete slab for installation. (Reference Sections 5.19 and 5.10)

10.1.5.8 Two (2) ACRS compressor units were purchased with YMP funds and never installed. These units were manufactured by Ingersoll-Rand (I-R) in 1983 and are rated at 1500 scfm @ 125 psig. The I-R compressors are field-mounted on skids along with motor control centers. Assembly drawings and procurement specifications are reported missing and presumed lost at NTS. These units have been in storage for approximately 10 years. Conversation with the manufacturer's representative indicates that these units will require refurbishment of the seals, shafts, and bearings. Recalibration to 1365 scfm @ 150 psig by a factory authorized service center will also be required.

10.1.5.9 One (1) compressor unit is a "Quincy" model Q-1500, rated at 1500 scfm @ 125 psig and manufactured by Colt Industries in 1981. The unit has been in operation at the NTS having logged 12,000 hrs. Refurbishment to ensure reliability is required as well as recalibration to 1365 scfm @ 150 psig by a factory authorized service center during refurbishment.

10.1.6 CAS Interfacing Requirements

10.1.6.1 Interface point with the subsurface compressed air piping is established at the base of the conveyer tower and in proximity of the CAS pad. (Reference Section 5.9)

10.1.6.2 Interface point with the subsurface compressed air piping established at the chemical injection skid located in proximity of the conveyer tower. A four by six foot concrete slab and 110V electrical power will be required for the injection system and will be shown by electrical surface design. Subsurface designers will be responsible for the design of the tracer injection system. (Reference Section 5.5)

10.1.6.2.1 The gas-tracer injection system shall inject a nominal concentration of six parts per million of sulfur hexafluoride (SF6) into the compressed air system provided to the ESF portal. (Reference Section 5.2)

10.1.6.3 The surface-based tracer injection system has been deleted. CAS tracers (where required) are to be administered underground near the required testing apparatus. (Reference Sections 5.20, 5.22, 5.23 and 5.24)

10.1.6.4 Coordination with civil designers determines the following interfaces for CAS piping. The handoff to civil occurs at the backside of flanged elbows turned downward.

10.1.6.4.1 The 8 inch main CAS supply interface established at coordinates: N765192.24, E570042.44.

10.1.6.4.2 The 4 inch CAS supply to shop interface established at coordinates: N765188.43, E570055.58.

10.2 CAS DESIGN

From Section 10.1, the design requirements for the CAS are as summarized:

10.2.1 References Sections 5.17 and 5.1 assume two tunnel boring machines, one approaching from each portal and meeting in the middle. Current philosophy is to use only one machine to do the main tunnel excavation. This change requires that the supporting utilities be sized for the entire tunnel excavation. Therefore, provisions are to be made to add three (3) more 1500 cfm compressors (excess equipment) to the North Portal in the future.

10.2.2 The design volume and pressure requirements are 2376 acfm and 125 psig provided to the north portal entrance. The discharge pressure of the compressors will be 150 psig to overcome the pressure drop associated with ancillary equipment.

10.2.3 To satisfy the requirements of Section 10.1.4.3 and the testing and performance assessment requirements of the project (Reference Section 5.5), the following compressed air system accessory components are required (as skid mounted packaged modules). The following will be located in built-up trains of in-line components:

10.2.3.1 External aftercoolers - sized to cool the discharge air to within 3°F of ambient.

10.2.3.2 Moisture separator - Automatically purges condensate produced by the aftercooler. Protects air tools from excessive gumming.

10.2.3.3 Air receivers - sized to serve each compressor. Protects system components from oil slugs possible when oil-injected screw compressors suffer a massive failure. Improves equipment life by providing a reservoir to prevent compressor short cycling. Provides additional refuge air capacity under emergency situations.

10.2.3.4 Coalescing filter - captures hydrocarbon particulates and aerosols to protect downstream piping from excessive oil buildup.

10.3 EQUIPMENT ANALYSIS

10.3.1 Definitions

acfm: Actual cubic feet per minute corrected for temperature and pressure.

scfm: Standard cubic feet per minute @14.7 psia, 70°F (528°R), dry air.

10.3.2 Compressors - The compressors are nominally rated for applications at STP. Corrections for altitude and temperature are calculated to predict actual performance.

For low temperatures and pressures, air can be considered an ideal gas. By definition, ideal gases behave according to the ideal gas laws. The general ideal gas law shows the relationships between pressure, volume, and temperature (Reference Section 8.4):

$$\frac{P_1V_1}{T_1T_2} = P_2V_2$$

where:

P= pressure in lbs./ sq. ft. absolute
V= volume in cu. ft.
T= absolute temperature (°R)

Avogado's law states that equal volumes of different gases with the same temperature and pressure contain equal numbers of molecules. For one mole of any gas the ideal gas law and Avogado's law can be combined and reformulated as the Equation of State,

$$\frac{pV}{T} = R^*$$

where R* is the universal gas constant (1545.33 ft-lb/pmole-°R). Or for n moles,

$$pV = nR^*T$$

A screw compressor is a constant volume device with a fixed compression ratio. By analysis of the inlet air conditions the actual performance of the compressor can be approximated. In this case, we know the performance at STP from the manufacture data. We need to approximate the actual delivery of compressed air at the site conditions. These conditions are 3680 feet of elevation and 108 °F temperature.

For 1 mole of air at STP, $p_1V_1=nR^*T_1$. At elevation (pressure decrease) and temperature held constant, $p_2V_2=nR^*T_1$. Therefore,

$$\frac{p_1V_1}{p_2} = p_2V_2 \quad \text{also} \quad V_2 = p_1V_1$$

or volume changes are inversely proportional to pressure. The same can be applied to holding pressure constant and changing temperature,

$$\frac{V_1T_2}{T_1} = V_2T_1 \quad \text{also} \quad V_2 = V_1T_2$$

or volume changes are directly proportional to temperature.

The relationship can be expressed as multiplying the initial volume by several factors p_1/p_2 and T_2/T_1 to get the final volume.

The screw compressor is a constant volume machine that processes a given quantity of air to a fixed final pressure and temperature. Therefore, changes in the inlet air density influence the final volume delivered. The final temperature and pressure generally are unchanged. Volumetric processing remains constant so the portion of the volume V_2 that is processed in a given time is actually the reciprocal of the air density (correction) factors p_1/p_2 and T_2/T_1 shown above. (Reference 8.1)

Correction factors are shown in table format in Attachment II. For 3680 feet of elevation and 108 °F ambient the combined factor is shown as 0.811436. This factor is applied to the recalibrated rating of 1365 scfm for 150 psig to yield a corrected capacity of 1108 say 1110 acfm.

1110 acfm X 3 compressors = 3330 acfm

Given that the demand requirement of 2376 scfm (10.1.2.6) represents the actual tool demands from the corrected supply of 3330 acfm, the actual compressor loading factor is:

$$\frac{2376}{3330} = .7135 \text{ or } 71\%$$

10.3.3 Compressed Air Receiver Sizing

A common approach to sizing receivers is to select one to provide 1 minute's storage. The following formula is normally used (Reference Section 8.3):

$$\text{Volume (cu. ft.)} = \frac{\text{comp. rating (scfm) x Inlet pressure (psia)}}{\text{Outlet pressure (psia)}}$$

$$\frac{1500 \text{ scfm } x\ (14.7)}{(14.7 + 150)} = \underline{134 \text{ cu. ft.}}$$

$$\frac{134 \text{ cu. ft.}}{0.134} = \underline{1000 \text{ gallons}}$$

from Reference Section 8.5, chose a 1060 gallon tank for each compressor.

10.3.4 Oil Entrainment Calculation

The purpose of injecting oil into a rotary screw compressor is to provide a seal between the helical rotors. Some of this "seal oil" is entrained in the discharge air and is mostly removed by the integral oil separator. Of the small amount of oil left, much is condensed from the discharge air along with water as the airstream cools, some is removed by the coalescing filter, and the remainder ends up at the end user.

Depending on the age of the compressor, the discharge air oil concentration can be between two and six parts per million. Because of the potential for interference with ESF characterization procedures, the amount of oil entrained in the compressor discharge air needs to be accounted for. Attachment IV calculates the amount of oil expected to be entrained in the air or removed by filters in the system.

Assumptions used for input to calculate the oil entrainment and removal are as follows:

1. Discharge from the compressor air end estimated at 4 ppm (average between 2 and 6 ppm). Reference Attachment V for determination of gallons of oil produced.

2. Air density used is at standard conditions, 70°F, 14.7 psia, and 0.075 lb/ft^3.

3. The excavation operation is expected to run for 2 shifts, 5 days a week, for an annual total of 4160 hours.

4. A total of 25,000 feet of excavation is expected to be accomplished within two years.

5. The deposition rate of oil on the tunnel walls is assumed at 80 percent.

6. The efficiency of the coalescing filter, initially rated at 99.99 percent (at 35°F), is estimated to fall to 68 percent at the 108°F summer extreme.

The maximum amount of oil entrained at the compressor discharge is estimated by the following equation (used in Attachment IV):

$$\left[\frac{2.46\ \text{Gal}}{1000\ \text{HR}\ X\ 1000\ \text{CFM}}\right]_{\text{Oil}} x \left[\left(\frac{2\ \text{Shift}}{\text{Day}}\right)\left(\frac{8\ Hr}{\text{Shift}}\right)\left(\frac{5\ \text{Day}}{\text{Week}}\right)\left(\frac{52\ \text{Week}}{\text{Yr}}\right)\right]_{\text{Hr}} X$$

$$\left[\left(\frac{54.9032\ \text{lb}}{\text{cu ft}}\right)\left(\frac{\text{cu ft}}{7.48\ \text{Gal}}\right)\right]_{\text{Oil}} \times \left[\frac{2376\ \text{cu ft}}{\text{Min}}\right]_{\text{Air}} = 178.47\ \text{lb/yr}$$

with the coalescing filter rated at 68% removal efficiency, the remainder is:

[1.00 - 0.68] 178.47 = 57.11 lb/yr

Estimated deposition rate:

$$\left(\frac{57.11\ \text{lb}}{\text{Yr.}}\right)(0.80)\left(\frac{2\ \text{Yr}}{25{,}000\ \text{ft}}\right)\left(\frac{453.59\ \text{gm}}{\text{lb}}\right)\left(\frac{3.28\ \text{ft}}{\text{m}}\right) = 5.44\ \text{gm/m}$$

The results of the oil entrainment calculation on Attachment IV indicate that the coalescing filter will remove a minimum of over 121 lbs of oil annually from the compressed air supply. Under actual operating conditions, the coalescing filter will remove more oil as the average ambient temperature is much less than the summer extreme used for design.

After the coalescing filter, the annual amount of entrained oil in the supply air is a maximum of 57.1 pounds. This translates into an estimated deposition of oil on the tunnel surfaces of 5.4 grams per meter of excavation. The 10 gram per meter limit imposed by Reference Section 5.21 is thereby accomplished.

10.3.5 Condensate Removal System

Liquid condensate produced by the CAS must be controlled as described in Section 2.1.2. These controls indicate that a receiver is required to hold the condensate. This section shall size the receiver.

The method of sizing a condensate receiver is as follows:

1. Determine the amount of condensate produced.

2. Combine water and coalesced oil amounts to determine the total volume of receiver required.

3. Select and size a condensate receiving/removal system.

10.3.5.1 Assumptions

1. Assume conditions at STP (neglect elevation). (no verification required)

2. Moisture content of ambient air and compressed air is estimated from Tables 4.6 and 4.7 (Reference Section 8.1) for multiples of 10°F, 5 percent relative humidity, and 10 psig. Conditions are rounded to nearest table values. (no verification required)

3. Current operations philosophy for subsurface excavation is as follows: (Normal work week - 5 days)

1st Shift	07:00-15:00	Maintenance
2nd Shift	15:00-23:00	TBM Operation
3rd Shift	23:00-07:00	TBM Operation

(Verification required)

10.3.5.2 Calculations

10.3.5.2.1 Determine the Average Ambient Condensate Production

From Attachment I and Table 4.6 (Reference Section 8.1) the following values have been tabulated.

Month	Avg Dry Bulb Temp (°F)	Relative Humidity					Ambient Moisture (Gal/1000 ft³)
		Hour				Avg	
		04	10	16	22		
Jan	35.8	71	53	39	65	57	.0215
Feb	41.3	69	45	32	57	51	.0238
Mar	44.6	61	34	25	47	42	.0190
Apr	50.9	53	27	19	38	35	.0244
May	61.3	48	22	15	32	29	.0301
Jun	69.6	39	18	13	25	24	.0356
Jul	76.8	39	19	14	27	25	.0498*
Aug	75.4	43	22	15	29	27	.0498*
Sep	66.7	45	22	18	33	30	.0427
Oct	55.9	52	27	21	41	35	.0351
Nov	44.3	62	39	30	53	46	.0314
Dec	36.9	68	48	39	63	55	.0215

*July and August have the highest average ambient moisture values of .0498 gallons/1000 ft³. The average ambient temperature plus 3 degrees superheat (aftercooler approach temperature) yields 79.8°F, or say 80°F. Comparison with the value in Table 4.7 (Reference Section 8.1) of moisture content of saturated air at 80°F and 150 psig gives .0177 gallons of water/1000 ft³ air.

The estimated average amount of condensate produced for three compressors is:

[2376 scfm x (.0498 - .0177) Gal]/1000 ft^3

= .0763 Gal/Min
= 4.58 Gal/Hr
= 73.2 Gal/Day (16 Hr Operation)
= 110 Gal/Day (24 Hr Operation)

10.3.5.2.2 Determine Estimated Peak Condensate Production

The peak estimated amount of condensate produced will most likely occur within the three months shown with the highest average ambient moisture content shown in Table 10.3.5.2.1. Further expansion is needed to establish peak loads. Using the peak monthly temperature along with the relative humidity occurrence in hour 1600 will give a better estimate of the peak load.

Month	Peak Temp of	R. H. @ 1600 hr. %	Interpolated Moisture Content Table 4.6 (Ref. 8.1)
Jul	108	14	.06680
Aug	108	15	.07162
Sep	105	18	.07918*

*The estimated peak ambient moisture content is: .07918 gal/1000 ft^3

Comparison with the value shown in Table 4.7 (Reference Section 8.1) estimated for an ambient of 110°F and 150 psig gives .0447 gallons water/1000 ft^3 air.

[2376 scfm x (.07918 - .0447) Gal]/1000 ft^3
= 4.91 Gal/Hr
= 78.6 Gal/Day (16 Hr Operation)
= 117.9 Gal/Day (24 Hr Operation)

Comparison with average ambient conditions as shown in Section 10.3.5.2.2, indicates that peak conditions dominate condensate production over average conditions.

10.3.5.2.3 Condensate Receiver Sizing

From 10.3.5.2.1 and 10.3.5.2.2 the average condensate productions estimated at 78 gallons daily. From Attachment IV, oil removal at a temperature similar to the peak condensate production temperature is estimated at 121 lb/yr. Oil removal converted to gallons yields:

$$(121 \text{ lbs/yr})\left(\frac{1 \text{ work year}}{4160 \text{ hr}}\right)\left(\frac{\text{ft}^3}{54.9 \text{ lb}}\right)\left(\frac{7.48 \text{ Gal}}{\text{ft}^3}\right) = .00396 \text{ Gal/Hr}$$

= .095 Gal/Day.

Compared to the peak daily production of condensate at 118 gallons, oil addition is insignificant.

To size the receiver, use average condensate production rates as determined in 10.3.5.2.1 for 1st and 3rd shifts. For 2nd shift use the peak rate determined in 10.3.5.2.2.

Correct compressed air demand during maintenance periods to 10% of peak demand to account for system leakage.

SHIFT	AIR DEMAND (SCFM)	CONDENSATE PRODUCTION RATE (Gal/Hr)	CONDENSATE FOR SHIFT (Gal)
1st	238	4.58	3.66
2nd	2,376	4.9	39.28
3rd	2,376	4.58	36.64

Total Daily Condensate 79.58 Gallons

Say 80 Gallons/Day

Allowing for the receiver to be pumped out by a tanker truck with capacity for 1150 gallons (Attachment III) allows for a service interval of 1150÷80 = 14.4 days.

By allowing a storage safety factor of 30%, the total storage volume is: 1150 x 1.3 = 1495 say 1500 gallons.

11. CONCLUSIONS

11.1 The air volume requirement needed to support the initial subsurface and surface needs are supported by 2376 scfm at 150 psig.

11.2 The current CAS design uses three compressors to support current requirements. A total of 3330 acfm is available to provide a 71 percent loading factor.

11.3 The CAS design can accommodate future unspecified needs with up to three additional compressors (six total).

11.4 The CAS design supports compressed air requirements by providing suitable filtering, storage, and condensate containment accessories.

11.5 Excessed compressors at NTS have been identified to be re-furbished to supply the needs of the CAS.

11.6 Coalescing filtration is the only technology used to meet air quality requirements. The estimated maximum subsurface oil deposition rate of 5.4 grams per meter is under the 10 gram per meter limit.

11.7 Injection of tracers in the compressed air is not required.

11.8 The estimated peak condensate production is approximately 80 gallons per day.

11.9 The receiver volume for each compressor is sized at 1060 gallons.

11.10 The condensate receiver volume is sized at 1500 gallons.

11.11 The recommended service interval for draining the condensate receiver is 14 days.

12. ATTACHMENTS

ATTACHMENT	TITLE
I	Climatological Summary
II	Combined Air Density Correction Factors
III	NTS Condensate Disposal Summary
IV	Oil Entrainment Calculation Spreadsheet
V	Oil Content of Compressed Air

Latitude 36°57'N
Longitude 116°03'W
Elevation 3924 Feet
(1196 Meters)

17-YEAR CLIMATOLOGICAL SUMMARY

(JANUARY 1962 - APRIL 1978)
YUCCA FLAT, NEVADA - NEVADA TEST SITE
WEATHER SERVICE NUCLEAR SUPPORT OFFICE

Received April 1991
Nevada Coordinate System (Central)
E680,875
N803,600

MONTH			JAN	FEB	MAR	APR	MAY	JUN		JUL	AUG	SEP	OCT	NOV	DEC		ANN
TEMPERATURE	AVERAGES	DAILY MAXIMUM	51.1	56.9	60.9	67.7	79.2	88.9		96.3	94.3	96.3	76.1	61.6	51.8		72.5
		DAILY MINIMUM	20.7	26.8	28.3	34.0	43.3	50.4		57.2	56.6	47.1	36.7	26.9	20.1		37.1
		MONTHLY	35.9	41.3	44.6	50.9	61.3	69.6		76.8	75.4	66.7	56.9	44.3	36.9		54.9
	EXTREMES	HIGHEST	73	77	87	89	98	107		108	108	105	94	83	71		108
		YEAR	1971/766	1963	1966	1962	1974	1970		1972	1972	1971	1963/64	1976	1975		7-8/72
		LOWEST	0.10	5	9	13	26	29		40	38	26	12	5	14		14
		YEAR	1973	1965/71	1969/77	1906	1962	1967/71		1962/64	1968/75	1971	1971	1975	1967		12/1967
DEGREE DAYS (Base 65°)		HEATING	893	704	664	422	156	27		0	1	46	284	616	894		4658
		COOLING	0	0	0	1	39	170		371	332	104	8	11	0		1023

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

MONTH			JAN	FEB	MAR	APR	MAY	JUN		JUL	AUG	SEP	OCT	NOV	DEC		ANN
PRECIPITATION (Inches)		AVERAGE	0.87	1.05	0.65	0.41	0.33	0.31		0.53	0.45	0.81	0.40	0.59	0.68		6.88
		GREATEST MONTHLY	4.02	3.60	3.50	2.57	1.62	2.66		1.87	2.52	2.38	1.69	3.02	2.06		4.02
		YEAR	1969	1978	1978	1965	1971	1972		1976	1977	1969	1978	1965	1965		1/69
		LEAST MONTHLY	0	0	0	T	0	0		0	0	0	0	0	T		0
		YEAR	1972/76	1972/77	1972	1962/77	1976	1974/76		1963	1962	1968	1967	1962/76	1969/72		2/77
		GREATEST DAILY	1.25	1.51	0.99	1.08	0.86	1.03		1.10	2.18	2.13	1.65	1.10	1.31		2.18
		YEAR	1969	1976	1978	1965	1971	1972		1976	1977	1969	1976	1970	1965		8/77
	SNOW	AVERAGE	2.9	1.3	1.9	0.4	*	0		0	0	0	*	0.7	2.1		9.3
		GREATEST MONTHLY	29.1	17.4	9.0	3.0	0.2	0		0	0	0	T	6.6	9.9		29.1
		YEAR	1974	1969	1969	1964	1975						1971	1972	1971		1/74
		GREATEST DAILY	10.0	6.2	7.5	3.0	0.2	0		0	0	0	T	6.6	7.4		10.0
		YEAR	1974	1969	1969	1964	1975						1971	1972	1971		1/74
RELATIVE HUMIDITY (%)	HOUR (PST)																
		04	71	69	61	53	48	39		39	43	45	52	62	68		54
		10	63	45	34	27	22	18		19	22	22	27	39	48		31
		16	39	32	25	19	15	13		14	16	18	21	30	39		23
		22	65	57	47	38	32	25		27	29	33	41	53	63		42

* One or more occurrences during the period of record but average less than 0.5 day.
\# Most recent of multiple occurrences.
† Da[illegible] period fro[illegible]uary 1962 to December 1971.

(a) Sky cover is expressed in the range from 0 for no clouds to 10 when the sky is completely covered with clouds. Clear, partly cloudy and cloudy are defined as average daytime cloudiness of 0-3, 4-7 and 8-10 tenths, respectively.

MONTH		JAN	FEB	MAR	APR	MAY	JUN		JUL	AUG	SEP	OCT	NOV	DEC		ANN
WIND (Speeds in MPH)	AVERAGE SPEED	6.0	6.8	8.6	9.1	8.0	7.9		7.5	6. 8	6.7	6.5	6.0	6.2		7.2
	PEAK SPEED	58	60+	56+	60+	80+	60		55	80+	80	80	60+	53		60+
	YEAR	1965	1976	1975	1967/70	1967	1967		1971	1968	1976	1971	1973	1970		2/76
VECTOR WIND (Dir/Spd)	23-02 (PST)	233/01	275/01	240/02	250/02	280/02	272/02		278/01	222/02	281/01	286/01	234/01	288/02		281/01
	11-14 (PST)	135/03	118/03	186/05	198/05	179/07	185/08		185/12	182/12	183/06	138/04	152/04	109/01		174/06
STATION PRESSURE (Inches)	AVERAGES	26.09	26.06	25.98	25.95	25.93	25.93		26.00	26.00	26.00	26.05	26.08	26.08		26.01
	HIGHEST	26.54	26.47	26.43	26.39	26.39	26.26		26.22	26.22	26.36	26.40	26.58	26.59		26.59
	LOWEST	25.42	25.31	25.47	25.50	25.42	25.42		25.67	25.71	25.56	25.52	26.31	25.49		25.31
(a) AVERAGE SKY COVER SUNRISE TO SUNSET		4.9	5.2	5.1	4.4	4.2	3.0		2.7	2.7	2.3	3.1	4.7	4.5		3.9

* One or more occurrences during the period of record but average less than 0.5 day.
# Most recent of multiple occurrences.
† Data period from January 1962 to December 1971.

(a) Sky cover is expressed in the range from 0 for no clouds to 10 when the sky is completely covered with clouds. Clear, partly cloudy and cloudy are defined as average daytime cloudiness of 0-3, 4-7 and 8-10 tenths, respectively.

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

MONTH			JAN	FEB	MAR	APR	MAY	JUN		JUL	AUG	SEP	OCT	NOV	DEC		ANN
AVERAGE NUMBER OF DAYS	SUNRISE TO SUNSET	CLEAR	13	11	12	13	16	18		20	21	21	20	13	15		192
		PARTLY CLOUDY	8	7	8	9	9	8		8	7	8	7	8	7		92
		CLOUDY	10	10	11	8	7	4		3	3	3	4	9	9		81
	PRECIPITATION	.01 INCH OR MORE	3	4	4	3	2	2		3	3	2	2	3	3		34
		.10 INCH OR MORE	2	2	2	1	1	1		1	1	1	1	2	1		16
		.50 INCH OR MORE	1	1	*	*	*	*		*	*	*	*	*	1		3
		1.00 INCH OR MORE	*	*	0	*	0	*		*	*	*	*	*	*		1
	1.0 INCH OR MORE OF SNOW		1	1	1	*	0	0		0	0	0	0	*	1		4
	THUNDERSTORMS		*	0	1	1	2	2		3	3	2	1	*	*		15
	TEMPERATURE MAXIMUM	90° F OR MORE	0	0	0	0	4	15		29	26	11	1	0	0		86
		32° F OR LESS	1	0	0	0	0	0		0	0	0	0	0	1		2
	TEMPERATURE MINIMUM	32°F OR LESS	29	24	23	13	2	0		0	0	1	9	24	30		166
		0° F OR LESS	1	0	0	0	0	0		0	0	0	0	0	0		1

* One or more occurrences during the period of record but average less than 0.5 day.
# Most recent of multiple occurrences.
† D[illegible] period fro[illegible] [illegible]nuary 1962 to December 1971.

(a) Sky cover is expressed in the range from 0 for no clouds to 10 when the sky is completely covered with clouds. Clear, partly cloudy and cloudy are defined as average daytime cloudiness of 0-3, 4-7 and 8-10 tenths, respectively.

Title: North Portal Surface-Based Compressed Air System Analysis
Originator: C. L. Mellen

COMBINED AIR DENSITY CORRECTION FACTORS

(COMPRESSOR INLET CONDITIONS)

Date: 04/04/94
Revision: 0
By: C. Mellen
Page: 1 of 1

REFERENCE DENSITY 0.075 lb/cu. ft.
REFERENCE TEMP. = 70° F

Elevation (Feet)	Elevation Factor	-20	-14	-10	0	10	20	30	40	50	60	70	80	90	100	108	110
5000	0.822846	0.991155	0.977821	0.96913	0.948061	0.92789	0.908559	0.890017	0.872217	0.855114	0.83867	0.822846	0.807608	0.792924	0.778765	0.767796	0.765102
4800	0.829932	0.999691	0.986242	0.977475	0.956226	0.935881	0.916383	0.897682	0.879728	0.862478	0.845892	0.829932	0.814563	0.799753	0.785471	0.774408	0.771691
4600	0.837018	1.008226	0.994663	0.985821	0.96439	0.943872	0.924208	0.905346	0.887239	0.869842	0.853115	0.837018	0.821518	0.806581	0.792178	0.78102	0.77828
4400	0.844104	1.016762	1.003084	0.994167	0.972555	0.951862	0.932032	0.913011	0.894751	0.877206	0.860337	0.844104	0.828473	0.81341	0.798884	0.787633	0.784869
4200	0.85119	1.025298	1.011504	1.002513	0.980719	0.959853	0.939856	0.920675	0.902262	0.88457	0.86756	0.85119	0.835428	0.820238	0.805591	0.794245	0.791458
4000	0.858277	1.033833	1.019925	1.010859	0.988884	0.967844	0.94768	0.92834	0.909773	0.891935	0.874782	0.858277	0.842383	0.827067	0.812298	0.800857	0.798047
3800	0.865363	1.042369	1.028346	1.019205	0.997048	0.975835	0.955505	0.936005	0.917285	0.899299	0.882004	0.865363	0.849338	0.833895	0.819004	0.807469	0.804636
3680	0.869615	1.04749	1.033398	1.024213	1.001947	0.980629	0.960199	0.940603	0.921791	0.903717	0.886338	0.869615	0.853511	0.837992	0.823028	0.811436	0.808589
3600	0.872449	1.050904	1.036767	1.027551	1.005213	0.983825	0.963329	0.943669	0.924796	0.906663	0.889227	0.872449	0.856293	0.840724	0.825711	0.814081	0.811224
3400	0.879535	1.05944	1.045188	1.035897	1.013377	0.991816	0.971153	0.951334	0.932307	0.914027	0.896449	0.879535	0.863247	0.847552	0.832417	0.820693	0.817813
3200	0.886621	1.067976	1.053608	1.044243	1.021542	0.999807	0.978978	0.958999	0.939819	0.921391	0.903672	0.886621	0.870202	0.854381	0.839124	0.827305	0.824402
3000	0.893707	1.076511	1.062029	1.052589	1.029706	1.007798	0.986802	0.966663	0.94733	0.928755	0.910894	0.893707	0.877157	0.861209	0.84583	0.833917	0.830991
2800	0.900794	1.085047	1.07045	1.060935	1.037871	1.015789	0.994626	0.974328	0.954841	0.936119	0.918117	0.900794	0.884112	0.868038	0.852537	0.840529	0.83758
2600	0.90788	1.093583	1.078871	1.069281	1.046035	1.023779	1.002451	0.981992	0.962353	0.943483	0.925339	0.90788	0.891067	0.874866	0.859243	0.847141	0.844169
2400	0.914966	1.102118	1.087291	1.077627	1.0542	1.03177	1.010275	0.989657	0.969864	0.950847	0.932561	0.914966	0.898022	0.881694	0.86595	0.853753	0.850758
2200	0.922052	1.110654	1.095712	1.085973	1.062364	1.039761	1.018099	0.997322	0.977375	0.958211	0.939784	0.922052	0.904977	0.888523	0.872657	0.860366	0.857347
2000	0.929138	1.119189	1.104133	1.094318	1.070529	1.047752	1.025924	1.004986	0.984887	0.965575	0.947006	0.929138	0.911932	0.895351	0.879363	0.866978	0.863936
1800	0.936224	1.127725	1.112554	1.102664	1.078693	1.055743	1.033748	1.012651	0.992398	0.972939	0.954229	0.936224	0.918887	0.90218	0.88607	0.87359	0.870525
1600	0.943311	1.136261	1.120975	1.11101	1.086858	1.063733	1.041572	1.020316	0.999909	0.980303	0.961451	0.943311	0.925842	0.909008	0.892776	0.880202	0.877113
1400	0.950397	1.144796	1.129395	1.119356	1.095022	1.071724	1.049396	1.02798	1.007421	0.987667	0.968674	0.950397	0.932797	0.915837	0.899483	0.886814	0.883702
1200	0.957483	1.153332	1.137816	1.127702	1.103187	1.079715	1.057221	1.035645	1.014932	0.995031	0.975896	0.957483	0.939752	0.922665	0.906189	0.893426	0.890291
1000	0.964569	1.161867	1.146237	1.136048	1.111351	1.087706	1.065045	1.04331	1.022443	1.002395	0.983119	0.964569	0.946707	0.929494	0.912896	0.900038	0.89688
800	0.971655	1.170403	1.154658	1.144394	1.119516	1.095696	1.072869	1.050974	1.029955	1.009759	0.990341	0.971655	0.953662	0.936322	0.919602	0.90665	0.903469
600	0.978741	1.178939	1.163078	1.15274	1.12768	1.103687	1.080694	1.058639	1.037466	1.017124	0.997563	0.978741	0.960617	0.943151	0.926309	0.913262	0.910058
400	0.985828	1.187474	1.171499	1.161086	1.135845	1.111678	1.088518	1.066303	1.044977	1.024488	1.004786	0.985828	0.9675720.97	0.949979	0.933015	0.919874	0.916647
200	0.992914	1.19601	1.17992	1.169432	1.144009	1.119669	1.096342	1.073968	1.052489	1.031852	1.012008	0.992914	4527	0.956808	0.939722	0.926486	0.923236
0	1	1.204545	1.188341	1.177778	1.152174	1.12766	1.104167	1.081633	1.06	1.039216	1.019231	1	0.981481	0.963636	0.946429	0.933099	0.929825
Temperature Factor =		1.204545	1.188341	1.177778	1.152174	1.12766	1.104167	1.081633	1.06	1.039216	1.019231	1	0.981481	0.963636	0.946429	.933099	0.929825

TEMPERATURE (DEGREES F)

elevation factor
$$\frac{\text{ref. pressure} - (\text{ref. density} * \text{actual elevation})/144}{\text{ref. pressure}}$$

temperature factor:
$$\frac{\text{ref. temp.} + 460}{\text{actual temp.} + 460}$$

PRELIMINARY PREDECISIONAL DRAFT MATERIAL

NTS CONDENSATE DISPOSAL SUMMARY

REYNOLDS ELECTRICAL & ENGINEERING CO. INC.

SUMMARY SHEET

JK.OR.No | WBS No.

ESTIMATE TYPE: R.O.M. | REECO COST FOR OILY WATER DISPOSAL | ESTIMATE No. REV. 0 oilh2o

DATE : 6-10-94 | REF. FAX TO BRUCE GARDELLA DATED 6-8-94 | SHEET 1 OF 1

AREA : AREA 25 - YUCCA MOUNTAIN PROJECT | TAKE-OFF MW

DRG. No. & REVISION: | EXTENDED MW

	DESCRIPTION	QUANTITY	LABOR COST		MATERIAL COST			EQUIPMENT COST			TOTAL
		MANHOURS	COST/HR	TOTAL	QTY	COST/EA	TOTAL	DAYS/HRS	COST/EA	TOTAL	
1	CHARACTERIZATION OF WASTE STREAM REQUIRED PRIOR TO ACCEPTANCE FOR DISPOSAL										
	CHARACTERIZATION COST ONLY										10000
	ANNUAL SAMPLING REQUIRED										
	ANNUAL SAMPLING COST										3000
2	DISPOSAL FEE IS $0.15 PER GALLON										
3	MERCURY HAS OILY WATER SEPERATOR CAPABLE OF 30 GALLONS/MINUTE										
4	OILY WATER PICKUP WITH 1150 GALLON VACUUM TRUCK ONCE A WEEK										
	ESTIMATED COST = $1.00 PER GALLON										
	OIL IS RECYCLED										
	WASTE WATER GOES TO LAGOON										

OIL ENTRAINMENT CALCULATION SPREADSHEET

COMPRESSED AIR OIL ENTRAINMENT CALCULATION Rev. 00 Date: 04/20/94 Page 1 of 1
Status FINAL FN CASANL00 WK3 By C Mellen

ASSUMPTIONS
** = based on Atlas-Copco data for 4 ppm, 2.46 gallons/1000 hrs-1000cfm

Density: Air = 0.075 lb/cuft Oil = 54.9032 lb/cuft

Operations: 2 shifts for 5 days / wk 52 weeks/year 4160 annual hours (total)
25000 feet of total excavation 80.00% HC deposition rate
2 year excavation lifespan

Flow Schematic	Air Flow Rate	Air Stream HC entrained	Underground HC deposition rate	Remarks
Air compressors 150 psig; each @ 1500 scfm; req # units 1.584; load fact 0.792; HC ave 4 ppm; 2.46E-06 gal/hr-cfm	2376	178.4723 lb/yr *	16.99371 gm/m	oil entrained in air
Integral aftercooler; est. cooling 50 degrees F	2376			
External aftercooler and Moisture separator	2376			
Coalescing filter; eff = 68.00% HC	2376	57.11115 lb/yr *	5.437987 gm/m	HC left in air; est. removal eff @ [illegible]
121.3612 lb-yr				oil removed by filter

Component Demands	L.F.	Air Flow Rate	Component Air Stream HC entrained	Component Underground HC deposition rate	Remarks
Surface maint. 0 scfm	1	2376	0 lb/yr *	0 gm/m	est. load factor; no concurrent demand identified
Leakage @ 10.00% 216 scfm	1	2376	5.191923 lb/yr *	0.494362 gm/m	est. leakage rate of 10%
TBM 0 scfm	0.75	2160	0 lb/yr *	0 gm/m	
Mapping 400 scfm	0.75	2160	7.211004 lb/yr *	0.686615 gm/m	
Shotcreting 400 scfm	0.75	1880	7.211004 lb/yr *	0.686615 gm/m	
Core drill 400 scfm	0.75	1560	7.211004 lb/yr *	0.686615 gm/m	requires subsurf filtration
Hand tools 1500 scfm	0.75	1260	27.04126 lb/yr *	2.574805 gm/m	
Alcove test 180 scfm	0.75	135	3.244952 lb/yr *	0.308977 gm/m	requires subsurf filtration
			Total Air Stream HC entrained	Total Underground HC deposition rate	
			57.11115 lb/yr *	5.437987 gm/m	

* One or more occurrences during the period of record but average less than 0.5 day.
# Most recent of multiple occurrences.
† Data period from January 1962 to December 1971.

(a) Sky cover is expressed in the range from 0 for no clouds to 10 when the sky is completely covered with clouds. Clear, partly cloudy and cloudy are defined as average daytime cloudiness of 0-3, 4-7 and 8-10 tenths, respectively.

OIL CONTENT OF COMPRESSED AIR