CRWMS/M&O

Design Analysis Cover Sheet

WBS: 1.2.6
QA: QA
PAGE 1

Design Analysis Title				
ESTIMATE OF DIESEL EMISSIONS EXPECTED DURING NORTH RAMP EXCAVATION				
Document Identifier	Rev. No.	Total Pages	Total Attachments	Volumes
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System Element	Configuration Item Name
MGDS	RAMPS

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Checker			
Lead Design Engineer			
Department Manager			

DRAFT

Remarks:

1. This design analysis covers QA classification Q items.

DRAFT

102

QAP-3-9 0339 (10/30/93)

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PDR WASTE
WM-11 PDR

Rec'd w/LTR DTD 9405160191 940408 AND 9405160193

CRWMS/M&O

Design Analysis Revision Record

WBS: 1.2.6
QA: QA
Page: 2 Of:

Design Analysis Title	ESTIMATE OF DIESEL EMISSIONS EXPECTED DURING NORTH RAMP EXCAVATION
Document Identifier	BABEA0000-01717-0200-00003 00
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1. PURPOSE

The purpose of this Design Analysis is to develop a conservative estimate of the diesel emissions which would result from support of the excavation of the Exploratory Studies Facility (ESF) North Ramp with diesel powered equipment. This calculation is intended to provide input to an analysis to be done by the Civilian Radioactive Waste Management System Management and Operations (CRWMS M&O) Contractor's Performance Assessment (PA) group. The PA analysis will ultimately be used to determine if the use of diesel equipment in the North Ramp of the ESF is likely to be of concern to a potential repository from the standpoint of waste isolation. If the diesel pollutants are found to have a significant waste isolation impact, diesel engines will be precluded from the subsurface portions of the ESF except in emergency situations.

2. QUALITY ASSURANCE

The construction and operation of the ESF, when it may have an effect on testing or potential repository performance, is considered to be quality affecting.

3. METHOD

Engineering calculations were used in the development of this analysis.

4. CODES AND STANDARDS

The Exploratory Studies Facility must comply with the following state and federal codes:

Code of Federal Regulations (CFR):

10 CFR 60	Disposal of High-Level Radioactive Waste in Geologic Repositories
10 CFR 960	General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories
29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1926	Safety and Health Regulations for Construction

30 CFR Chapter I	Mine Safety and Health Administration
40 CFR 191	Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes

California Administrative Code - Title 8, Division 1; Chapter 4; Subchapter 20 - California Tunneling Orders

Nevada Revised Statutes, Title 46, Mines and Minerals - Chapter 512, State of Nevada Health and Safety Standards for Open Pit and Underground Metal and Nonmetal Mines and Sand, Gravel, and Crushed Stone Operations.

Nevada Revised Statutes Title 53, Labor and Industrial Relations - Chapter 618, Occupational Safety and Health

In addition to these requirements, the design and operation of the ESF is subject to an extensive list of guidelines including: DOE Orders, State statutes, and Standards of various Industrial and Professional Societies (ASTM, ASCE, etc.). A complete listing of these orders, statutes and standards is given in Appendix E of the Exploratory Studies Facility Design Requirements (YMP/CM-0019).

5. DESIGN INPUTS

Input to this calculation includes:

- An estimate of the number of hours of diesel operation required to support the excavation of the ESF North Ramp. This information was further broken down to identify the approximate number of diesel operating hours required to develop each of twelve different segments of the ramp.
- Data on unit emission rate of diesel pollutants from an unscrubbed diesel engine operating in a "Worst Case Scenario" per Ref. 8.2.

6. DESIGN CRITERIA

Section 3 of the ESF Design Requirements document (YMP/CM-0019) contains the criteria governing design and operation of the ESF.

7. ASSUMPTIONS

This analysis is intended to support a conservative "bounding" evaluation of the potential impact of diesel emissions on long term waste isolation in a potential repository. As such, many of the assumptions made were conservative. Assumptions included:

- The estimated number of hours of diesel operation included all levels of engine speed from idle to full throttle. However, the calculation was performed assuming a "Worst Case" emission rate. This results in a conservative (ie: high) estimate of pollutant output.

- The engine size used in the analysis is 200 Brake Horsepower (BHP). It is not known what size would ultimately be employed, but 200 BHP is felt to be a conservative value. This engine size is compatible with a locomotive in the 20 to 25 ton range.

8. SOURCES OF INFORMATION

8.1 The estimate of diesel operating hours was provided by the excavation subcontractor, Kiewit/PB. The Kiewit/PB analysis included:

- The use of muck trains for the first 4,100 ft of the ramp excavation.

- Diesel requirements for excavation and haulage of muck for Alcove #2, four equipment niches, and a refuge chamber.

- Diesel requirements for support of the installation of the conveyor system

- Service trains for transport of tunneling crew, scientific personnel, and utility/maintenance personnel.

- An allowance for idling at the face.

8.2 CRWMS M&O Calculation # B00000000-AA-12-00002-00, "Underground Diesel Emission Analysis, May 24, 1993, pp. 31-35.

9. COMPUTER PROGRAMS

A "spreadsheet" program, Lotus 1-2-3, was used to facilitate the repetitive calculations in this analysis. A copy of the products, labelled to show row and column designations, is included in the attachments along with a printout of the cell contents showing the formulae used to make the calculations.

10. DISCUSSION

10.1 BACKGROUND

A decision must soon be made on whether the use of diesel powered support equipment will be allowed in the construction and/or operation of all or part of the ESF. This decision will be based on an assessment of the potential impacts which the residual diesel contaminants may have on long term waste isolation. The use of diesel is desirable from both operational and cost standpoints. The alternative, electric haulage using both battery-powered and trolley systems, is somewhat higher in cost and may cause some restriction of activity in the tunnel due to the presence of the trolley line. The decision, however, will be driven by the waste isolation impact analysis.

10.2 STATEMENT OF THE PROBLEM

The objective in this analysis is to estimate the quantities of various diesel exhaust constituents that would be released if the excavation of the north ESF ramp were supported by diesel equipment. Further, it was desired to determine an approximate distribution of the exhaust constituents along the ramp alignment. The tasks included:

- Development of a distribution calculation in which the diesel operating hours (furnished by Kiewit/PB) were allocated to the various segments of the north ramp (the underlying assumption here is that pollutants released from the exhaust of the engine will be deposited on the tunnel walls close to the release point, therefore, it is important to know not only how much is released, but also where in the tunnel it is released).

- Calculation of the amount of each diesel exhaust constituent released in each segment of the north ramp. The unit exhaust figures are intended to represent a

"worst Case" diesel emission scenario, as described in Ref. 8.2.

10.2.1 Development of the Distribution Calculation

Input from the excavation subcontractor, Kiewit/PB, is shown in Table 1 (the complete spreadsheet, including clarifying notes, is included as Attachment I). In order to distribute the contaminants throughout the tunnel in a realistic manner, the following logic was used:

Segment #1:

All diesel operation for Segment #1 is IN segment #1, so all 48.2 diesel hours are attributed to Segment #1.

NOTE: Figure 1 shows the approximate location of each of the 12 ramp segments.

Segment #2:

28.8 diesel hours were estimated to excavate Segment #2. Of this, 1.9 hours was travel ("tram") time, and the balance was in idling time at the face. Due to the cyclical nature of the operation (ie: trains traveling up and down the entire length of the tunnel.) the exhaust from the 1.9 travel hours is not concentrated in segment # 2, but instead is distributed over Segment #2 as well as Segment #1. Therefore, the travel hours are distributed proportionately to the length of the segments, while the idle time is accounted for in the segment in which it occurs:

[seg. #1 length/(seg.#1 length + seg. #2 length)] * 1.9 =

diesel hours from seg. 2 excavation attributed to seg 1.,

or 1.17 hours.

Similarly, for Segment 2:

[seg. #2 length/(seg.#1 length + seg. #2 length)] * 1.9 =

diesel hours from seg. 2 excavation attributed to seg.2,

or 0.73 hours.

TABLE 1 Diesel Hours Required for Development of Each Ramp Segment

SEGMENT #	LOCATION	DIESEL HOURS
1	2+00 >> 3+60	48.2
2	3+60 >> 4+60	28.8
3	4+60 >> 6+20	46.0
4	6+20 >> 8+50	72.3
5	8+50 >> 10+50	52.9
6	10+50 >> 15+00	310.3 [1]
7	15+00 >> 25+00	645.7 [2]
8	25+00 >> 43+00	1384.4 [3]
9	43+00 >> 57+00	425.9 [4]
10	57+00 >> 61+00	171.1 [5]
11	61+00 >> 79+00	449.2 [6]
12	79+00 >> 91+85	250.9

[1] Includes excavation of the indicated segment plus excavation of Alcove #2

[2] Includes excavation of the indicated segment plus excavation of Equipment Niche #1

[3] Includes excavation of the indicated segment plus excavation of Equipment Niche #2 and conveyor installation

[4] Includes excavation of the indicated segment plus excavation of the Refuge Chamber

[5] Includes excavation of the indicated segment plus excavation of Equipment Niche #3

[6] Includes excavation of the indicated segment plus excavation of Equipment Niche #4

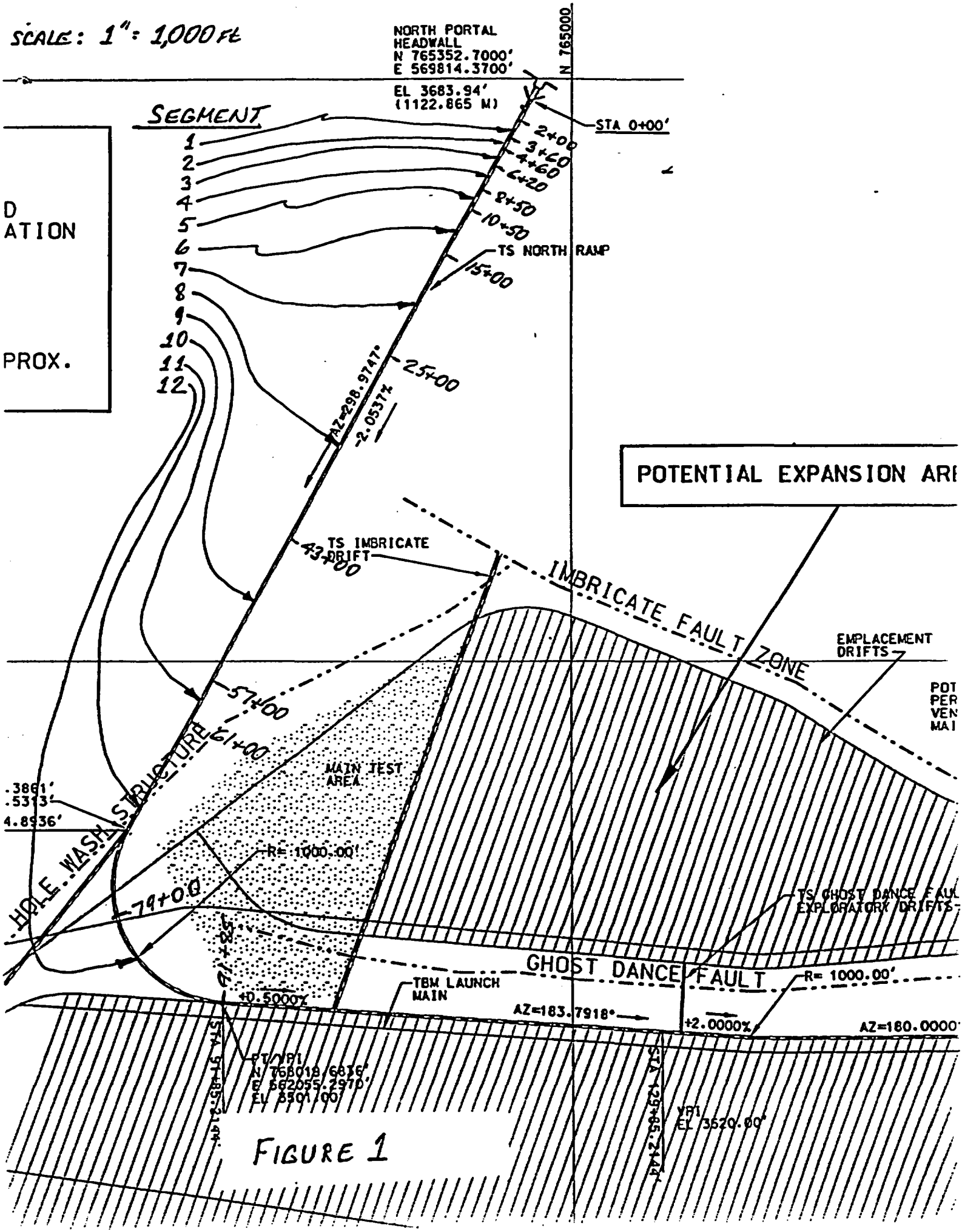
SCALE: 1" = 1,000 FT
NORTH PORTAL HEADWALL
N 765352.7000'
E 569814.3700'
EL 3683.94'
(1122.865 M)
N 765000
SEGMENT
1
2
3
4
5
6
7
8
9
10
11
12
STA 0+00'
2+00
3+60
4+60
6+20
8+50
10+50
TS NORTH RAMP
15+00
25+00
AZ=298.9747°
-2.0537%
43+00
TS IMBRICATE DRIFT
IMBRICATE FAULT ZONE
POTENTIAL EXPANSION ARE
EMPLACEMENT DRIFTS
57+00
61+00
MAIN TEST AREA
HOLE WASH STRUCTURE
R= 1000.00'
79+00
TS GHOST DANCE FAULT EXPLORATORY DRIFTS
GHOST DANCE FAULT
TBM LAUNCH MAIN
+0.5000%
AZ=183.7918°
+2.0000%
AZ=180.0000°
PT/VPI
N 768019.6836'
E 562055.2970'
EL 3501.00'
VPI
EL 3620.00'
D
ATION
PROX.

FIGURE 1

Segment #3:

The same logic applies as for Segment #2. The travel time hours of diesel operation for the excavation of Segment #3 are distributed to segments #1, #2, and #3 in proportion to their lengths, while the idle time hours for segment 3 are kept in the segment 3 total.

This method was applied for all twelve segments. Table 2 shows the results for each segment, and the total diesel operation hours ultimately attributed to each segment are totaled across the bottom of the table. Included as Attachment II to this analysis is a copy of the complete spreadsheet from which Table 2 was developed. Also included is a complete listing of the cell contents of the file. This will enable the reader, if desired, to check the source of the calculated values.

10.2.2 Calculation of the Total Diesel Exhaust Constituents Released for Each Segment

Table 3 shows the diesel exhaust unit output parameters used in the calculation. Table 4 contains the spreadsheet in which the total released diesel exhaust products were calculated for each segment. The calculation was a simple multiplication in which the unit exhaust product output was multiplied by the power rating of the engine and multiplied again by the number of operating hours developed above in Section 10.2.1.

For Example:

The unit output rate of Carbon Monoxide (CO) was found from the literature to be 0.486 Ft^3/BHP-Hr. The engine size assumed was 200 BHP. The number of hours of operation attributed to, say, Segment #8, was 1268.09 Hours, therefore:

$$0.486\ Ft^3/BHP\text{-}Hr * 200\ BHP * 1268.09\ Hrs = 123{,}258.35\ Ft^3.$$

Examination will show that the calculation is dimensionally correct, and the result is in cubic feet.

TABLE 2 - Distribution of Diesel Hours by Segment

SEGMENT	1	2	3	4	5	6	7	8	9	10	11	12
1	2.10											
2	1.17	0.73										
3	1.45	0.90	1.45									
4	1.94	1.22	1.94	2.80								
5	1.36	0.85	1.36	1.95	1.69							
6	6.35	3.97	6.35	9.13	7.94	17.86						
7	11.29	7.06	11.29	16.23	14.11	31.75	70.57					
8	20.22	12.64	20.22	29.07	25.28	56.88	126.39	227.50				
9	5.66	3.54	5.66	8.14	7.08	15.93	35.40	63.72	49.56			
10	2.21	1.38	2.21	3.18	2.77	6.22	13.83	24.89	19.36	5.53		
11	5.00	3.12	5.00	7.19	6.25	14.06	31.25	56.24	43.75	12.50	56.24	
12	2.62	1.64	2.62	3.77	3.28	7.38	16.41	29.53	22.97	6.56	29.53	21.08
IDLE TIME AT THE FACE	46.1	26.9	42.2	64.4	45.7	258.7	483.4	866.2	231.2	89.5	208.6	103.5
TOTALS	107.5	64.0	100.3	145.9	114.1	408.8	777.2	1268.1	366.8	114.1	294.4	124.6

TABLE 3 - UNIT OUTPUT OF DIESEL EXHAUST CONSTITUENTS *

DIESEL EXHAUST CONSTITUENT	VOLUME RELEASED (FT^3 / BHP-HOUR, unless noted)
CARBON MONOXIDE (CO)	0.486
UNBURNED HYDROCARBONS (HC)	0.097
NITRIC OXIDE (NO)	0.194
NITROGEN DIOXIDE (NO_2)	0.0162
CARBON DIOXIDE (CO_2)	22.9
SULFUR DIOXIDE (SO_2)	0.0194
DIESEL PARTICULATE MATTER (DPM)	649.6 (mg/BHP-Hr)

* From "Worst Case Scenario" with no exhaust treatment, Ref. 8.2

TABLE 4

SEGMENT # 1

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.496	200	107.48	10,447.06
HC	0.097	200	107.48	2,065.11
NO	0.194	200	107.48	4,170.22
NO2	0.0162	200	107.48	348.24
CO2	22.9	200	107.48	492,268.40
SO2	0.0194	200	107.48	417.02
	(mg/BHP-HR)			(mg)
DPM	649.6	200	107.48	13,963,801.60

SEGMENT # 2

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.496	200	63.96	6,216.94
HC	0.097	200	63.96	1,240.63
NO	0.194	200	63.96	2,481.26
NO2	0.0162	200	63.96	207.20
CO2	22.9	200	63.96	292,891.00
SO2	0.0194	200	63.96	248.13
	(mg/BHP-HR)			(mg)
DPM	649.6	200	63.96	8,308,384.00

SEGMENT # 3

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.496	200	100.31	9,750.13
HC	0.097	200	100.31	1,946.01
NO	0.194	200	100.31	3,892.03
NO2	0.0162	200	100.31	326.00
CO2	22.9	200	100.31	459,419.60
SO2	0.0194	200	100.31	389.20
	(mg/BHP-HR)			(mg)
DPM	649.6	200	100.31	13,032,276.20

SEGMENT # 4

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.496	200	146.86	14,177.89
HC	0.097	200	146.86	2,829.66
NO	0.194	200	146.86	5,659.37
NO2	0.0162	200	146.86	472.89
CO2	22.9	200	146.86	669,039.60
SO2	0.0194	200	146.86	566.94
	(mg/BHP-HR)			(mg)
DPM	649.6	200	146.86	18,950,131.20

SEGMENT # 5

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.496	200	114.1	11,090.82
HC	0.097	200	114.1	2,213.64
NO	0.194	200	114.1	4,427.08
NO2	0.0162	200	114.1	369.66
CO2	22.9	200	114.1	522,678.00
SO2	0.0194	200	114.1	442.71
	(mg/BHP-HR)			(mg)
DPM	649.6	200	114.1	14,823,872.00

SEGMENT # 6

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.496	200	408.79	39,734.39
HC	0.097	200	408.79	7,930.83
NO	0.194	200	408.79	15,861.06
NO2	0.0162	200	408.79	1,324.48
CO2	22.9	200	408.79	1,872,268.20
SO2	0.0194	200	408.79	1,586.11
	(mg/BHP-HR)			(mg)
DPM	649.6	200	408.79	53,109,996.80

SEGMENT # 7

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.496	200	777.24	75,547.73
HC	0.097	200	777.24	15,078.46
NO	0.194	200	777.24	30,156.91
NO2	0.0162	200	777.24	2,518.26
CO2	22.9	200	777.24	3,559,759.20
SO2	0.0194	200	777.24	3,018.69
	(mg/BHP-HR)			(mg)
DPM	649.6	200	777.24	100,979,020.80

SEGMENT # 8

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.496	200	1268.09	123,268.38
HC	0.097	200	1268.09	24,600.95
NO	0.194	200	1268.09	49,201.89
NO2	0.0162	200	1268.09	4,108.61
CO2	22.9	200	1268.09	5,807,852.20
SO2	0.0194	200	1268.09	4,920.19
	(mg/BHP-HR)			(mg)
DPM	649.6	200	1268.09	164,760,252.80

SEGMENT # 9

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.496	200	366.84	35,656.85
HC	0.097	200	366.84	7,116.70
NO	0.194	200	366.84	14,233.39
NO2	0.0162	200	366.84	1,188.58
CO2	22.9	200	366.84	1,650,127.20
SO2	0.0194	200	366.84	1,423.34
	(mg/BHP-HR)			(mg)
DPM	649.6	200	366.84	47,669,652.80

SEGMENT # 10

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.496	200	114.09	11,069.86
HC	0.097	200	114.09	2,213.36
NO	0.194	200	114.09	4,426.69
NO2	0.0162	200	114.09	369.66
CO2	22.9	200	114.09	522,632.20
SO2	0.0194	200	114.09	442.67
	(mg/BHP-HR)			(mg)
DPM	649.6	200	114.09	14,822,672.80

SEGMENT # 11

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.496	200	294.37	28,612.78
HC	0.097	200	294.37	5,710.78
NO	0.194	200	294.37	11,421.56
NO2	0.0162	200	294.37	953.76
CO2	22.9	200	294.37	1,348,214.60
SO2	0.0194	200	294.37	1,142.16
	(mg/BHP-HR)			(mg)
DPM	649.6	200	294.37	38,244,880.40

SEGMENT # 12

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.496	200	124.88	12,109.18
HC	0.097	200	124.88	2,418.86
NO	0.194	200	124.88	4,837.70
NO2	0.0162	200	124.88	403.64
CO2	22.9	200	124.88	570,578.40
SO2	0.0194	200	124.88	483.37
	(mg/BHP-HR)			(mg)
DPM	649.6	200	124.88	16,186,433.60

A copy of the spreadsheet shown as Table 4 is included as Attachment III to this analysis. The attachment is annotated to show the column and row designations. Also included in the attachment is a listing of the contents of all cells in the spreadsheet. If desired, the reader can check the cell formulae to ascertain that the calculation is correctly done.

11.0 CONCLUSIONS

Because this is an interim step in a longer calculation process, there are no conclusions to be drawn as such. The results of this analysis will be used as input to a Performance Assessment calculation. It is this PA analysis which will allow conclusions to be made regarding the use of diesel equipment in the excavation and operation of the ESF.

12. ATTACHMENTS

The following attachments are a part of this analysis:

I. Spreadsheet supplied by the excavation subcontractor, Kiewit/PB, detailing an estimate of the number of diesel engine operating hours required to support the excavation and misc. operations in the North Ramp. [7 pages]

II. Spreadsheet showing the distribution of diesel operating hours by tunnel segment, labelled to show rows and columns, and a corresponding listing of cell contents. This sheet contains the complete calculation described in Section 10.2.1 of the main document. [4 pages]

III. Spreadsheet, labelled to show rows and columns, and a corresponding listing of cell contents. This sheet contains the calculation of total diesel exhaust output for each tunnel segment. [14 pages]

ATTACHMENT I

ESTIMATE OF THE NUMBER OF HOURS OF DIESEL ENGINE OPERATION REQUIRED TO SUPPORT EXCAVATION AND CONCURRENT TESTING/OPERATIONS IN THE NORTH ESF RAMP

DIESEL LOCOMOTIVE OPERATION
EXPLORATORY STUDIES FACILITY -- TOPOPAH SPRINGS NORTH RAMP
KIEWIT/PB

Column 1		Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11
						DIESEL USE FOR MUCK HAULAGE					
						TBM Excavation		Alcove Excavation		Total Hours for Each Segment	
Segment Stations, ft from	to	Tunnel Advance, ft	Alcove Excavation, bcy	Mining Rate, ft/ day	Operating Days, days	Total Muck Trains, trains/day	Muck Train Load Time, min/day	Total Muck Trains, trains/day	Muck Train Load Time, min	Muck Train Load Time, hours	Muck Train Tram Time, hours
2+00	3+60	160		11	15	5	100			28.8	1.3
3+60	4+60	100		15	7	7	140			18.8	1.3
4+60	6+20	160		15	11	7	140			29.5	2.7
6+20	8+50	230		20	14	9	180			48.3	5.9
8+50	10+50	200		30	7	14	280			37.6	5.9
10+50	15+00	450		30	15	14	280			80.5	17.1
Test Alcove #2			400		15			10	1800	34.5	1.0
15+00	25+00	1000		30	44	14	280			236.1	78.7
Equipment Niche #1			107		10			3	480	9.2	0.5
25+00	43+00	1800		30	66	14	280			354.2	200.7
Conveyor Installation					35					0.0	0.0
Equipment Niche #2			107		10			3	480	9.2	0.8
43+00	57+00	1400		65	22					0.0	0.0
Refuge Chamber			160		20			4	720	13.8	1.5
57+00	61+00	400		65	7					0.0	0.0
Equipment Niche #3			107		10			3	480	9.2	1.2
61+00	79+00	1800		65	30					0.0	0.0
Equipment Niche #4			107		10			3	480	9.2	1.5
79+00	91+85	1285		65	20					0.0	0.0
TOTALS		8985 ft	987 bcy		368 days					918.9 hrs	320.1 hrs

Column 12	Column 13	Column 14	Column 15	Column 16	Column 17	Column 18	Column 19	Column 20
DIESEL USE FOR PERSONNEL and MATERIAL [illegible]					COMBINED MUCK HAUL AND SERVICE TRAIN			
One-way Train Trips/day			Total Hours for Each Segment		Total Hours for Each Segment			
Crew	Science	Utility and Maintenance	Service Loci Idle Time, hours	Service Loci Tram Time, hours	Idle & Muck Load Total Time, hours	Tram Total Time, hours	Total Oper Time, hours	Comments
0	0	6	17.3	0.8	46.1	2.1	48.2	Start TBM tunneling at North Portal
0	0	6	8.1	0.6	26.9	1.9	28.8	
0	0	6	12.7	1.1	42.2	3.8	46.0	
0	0	6	16.1	2.0	64.4	7.9	72.3	Bow Ridge Fault area, includes 2 additional days for steel set erection
0	0	6	8.1	1.3	45.7	7.2	52.9	
7	10	6	66.1	14.1	146.6	31.2	177.8	
7	10	10	77.6	19.4	112.1	20.4	132.5	Drill and blast excavation, using diesel powered rubber tired equipment
7	10	6	194.0	64.7	430.1	143.4	573.5	5 fault zones, 10 additional days for steel set erection
7	6	10	44.1	18.4	53.3	18.9	72.2	Drill and blast excavation, using diesel powered rubber tired equipment
7	10	6	291.0	164.9	645.2	365.6	1010.8	3 fault zones, 6 additional days for steel set erection
7	6	12	167.7	120.2	167.7	120.2	287.9	Mining operation is shut down during the conveyor installation
7	6	10	44.1	31.6	53.3	32.4	85.7	Drill and blast excavation, using diesel powered rubber tired equipment
7	10	10	113.9	94.9	113.9	94.9	208.8	
7	10	10	103.5	98.3	117.3	99.8	217.1	Drill and blast excavation, using diesel powered rubber tired equipment
7	10	10	36.2	35.6	36.2	35.6	71.8	
7	6	10	44.1	44.8	53.3	46.0	99.3	Drill and blast excavation, using diesel powered rubber tired equipment
7	10	10	155.3	181.1	155.3	181.1	336.4	1 fault zone, 2 additional days for steel set erection
7	6	10	44.1	58.0	53.3	59.5	112.8	Drill and blast excavation, using diesel powered rubber tired equipment
7	10	10	103.5	147.4	103.5	147.4	250.9	Tunneling to end TS North Ramp
					2466 hrs	1419 hrs	3886 hrs	

Note: Column 1: Location of operation requiring diesel operation, either locomotives or LHDs.

Note: Column 2: Tunnel advance is the total feet of excavation for each segment as shown by the stationing in column 1.

Note: Column 3: Alcove excavation includes test alcoves and equipment niches. The excavation volume is in Bank Cubic Yards (bcy)
Test alcove size: 12 ft high, 12 ft wide, 75 ft deep
Equipment niche size: 30 ft long, 12 ft high, 8 ft deep
Refuge chamber size: 30 ft long, 12 ft high, 12 ft wide

Note: Column 4: Mining rate is the daily average advance for the TBM excavation.

Note: Column 5: Operating days are based on a five day mining operation. These durations are developed from current K/PB estimate of the work involved.

Note: Column 6: The number of muck trains is based on a three-car train. The capacity of each train is 60 cubic yards. The excavated volume per foot of tunnel is 18.2 Bank Cubic Yards.

Note: Column 7: Muck train loading time is based on a mining rate of 2 inches per minute, with mining a 30 inch stroke per train. An additional 5 minutes idle time is included for each train. Tot muck train load time is 20 minutes per train.

Note: Column 8: The number of muck trains is based on a three-car train. The capacity of each train is 60 cubic yards.

Note: Column 9: Drill/Blast excavation muck loading time is based on an estimated 3 minutes of diesel operation per cubic yard and includes both locomotive and LHD.

Note: Column 10: Muck train load time is the daily load time (column 6) times the operating days (column 5), plus the alcove muck time (column 8). 15 % is added for programatic delays.

Note: Column11: Muck train tram time is the total tram time for the segment of tunnel. The tram time is based on an average tram speed of 600 feet per minute. The tram distance is from the portal to the mid-point of the segment, shown in column 1 for each increment of tunnel excavation. 15 % is added for programatic delays.

Note: Column 12: Crew mantrips are the one way trips required to transport mining crews to and from the heading. This represents the daily average for a five day mining operation and one maintenance shift on the sixth day.

Note: Column 13: Science mantrips are the one way trips required to transport science crews to and from the heading. This represents the daily average for a five day mining operation and one shift on the sixth day.

Note: Column 14: Utility and maintenance trips are the one way trips required to transport materials, including utilities, segments, maintenance supplies, etc. to and from the heading to support mining activities. This represents the daily average for a five day mining operation and one shift on the sixth day.

Note: Column 15: Idle time is based on 10 minutes of operation for each trip shown in columns 12, 13, 14 for each increment of tunnel excavation. 15 % is added for programatic delays.

Note: Column 16: Travel time is based on an average train speed of 600 feet per minute. The travel distance is from the portal to the mid-point of the section shown in column 1 for each increment of tunnel excavation. 15 % is added for programatic delays.

Note: Column 17: Combined muck loading and service idle time for each segment of tunnel.

Note: Column 18: Combined mucktrain and service train tram time for each segment of tunnel.

Note: Column 19: Total operating time is the sum of the combined idle time (column 17) and combined tram time (column 18).

	A	B	C	D	E	F	G	H	I
1	DIESEL LOCOMOTIVE O								
2	EXPLORATORY STUDIE								
3	KIEWIT/PB								
4									
5									
6									
7									
8	1	=1+A8	=1+B8	=1+C8	=1+D8	=1+E8	=1+F8	=1+G8	=1+H8
9									
10						DIESEL USE			
11									
12									
13						TBM Excavatio		Alcove Excavation	
14		Tunnel	Alcove	Mining	Operating	Total	Muck Train	Total	Muck Train
15	Segment Stations, ft	Advance,	Excavation,	Rate,	Days,	Muck Trains,	Load Time,	Muck Trains,	Load Time,
16	from to	ft	bcy	ft/ day	days	trains/day	min/day	trains/day	min
17	2+00 3+60	160		11	15	5	=+F17*20		
18	3+60 4+60	100		15	7	7	=+F18*20		
19	4+60 6+20	160		15	11	7	=+F19*20		
20	6+20 8+50	230		20	14	9	=+F20*20		
21	8+50 10+50	200		30	7	14	=+F21*20		
22	10+50 15+00	450		30	15	14	=+F22*20		
23	Test Alcove #2		400		15			=+C23*1.5/60	=+C23*1.5*3
24	15+00 25+00	1000		30	44	14	=+F24*20		
25	Equipment Niche #1		=30*8*12/27		10			3	=+C25*1.5*3
26	25+00 43+00	1800		30	66	14	=+F26*20		
27	Conveyor Installation				35				
28	Equipment Niche #2		=30*8*12/27		10			3	=+C28*1.5*3
29	43+00 57+00	1400		65	22				
30	Refuge Chamber		=30*12*12/27		20			=+C30*1.5/60	=+C30*1.5*3
31	57+00 61+00	400		65	7				
32	Equipment Niche #3		=30*8*12/27		10			3	=+C32*1.5*3
33	61+00 79+00	1800		65	30				
34	Equipment Niche #4		=30*8*12/27		10			3	=+C34*1.5*3
35	79+00 91+85	=9185-7900		65	20				
36	TOTALS	=SUM(B17:B35)	=SUM(C17:C35)		=SUM(E17:E35)				
37									

	J	K
1		
2		
3		
4		
5		
6		
7		
8	=1+I8	=1+J8
9		
10		
11		
12		
13	Total Hours for Each Segment	
14	Muck Train	Muck Train
15	Load Time,	Tram Time,
16	hours	hours
17	=ROUND((E17*G17+I17)/60*1.15,1)	=ROUND(E17*(+F17*(SUM(B$17:B17)-B17/2+200)*2/600)/60*1.15+(+H17*(SUM(B$17:B17)-B17/2+200)*2/600)/60*1.15,1)
18	=ROUND((E18*G18+I18)/60*1.15,1)	=ROUND(E18*(+F18*(SUM(B$17:B18)-B18/2+200)*2/600)/60*1.15+(+H18*(SUM(B$17:B18)-B18/2+200)*2/600)/60*1.15,1)
19	=ROUND((E19*G19+I19)/60*1.15,1)	=ROUND(E19*(+F19*(SUM(B$17:B19)-B19/2+200)*2/600)/60*1.15+(+H19*(SUM(B$17:B19)-B19/2+200)*2/600)/60*1.15,1)
20	=ROUND((E20*G20+I20)/60*1.15,1)	=ROUND(E20*(+F20*(SUM(B$17:B20)-B20/2+200)*2/600)/60*1.15+(+H20*(SUM(B$17:B20)-B20/2+200)*2/600)/60*1.15,1)
21	=ROUND((E21*G21+I21)/60*1.15,1)	=ROUND(E21*(+F21*(SUM(B$17:B21)-B21/2+200)*2/600)/60*1.15+(+H21*(SUM(B$17:B21)-B21/2+200)*2/600)/60*1.15,1)
22	=ROUND((E22*G22+I22)/60*1.15,1)	=ROUND(E22*(+F22*(SUM(B$17:B22)-B22/2+200)*2/600)/60*1.15+(+H22*(SUM(B$17:B22)-B22/2+200)*2/600)/60*1.15,1)
23	=ROUND((E23*G23+I23)/60*1.15,1)	=ROUND(E23*(+F23*(SUM(B$17:B23)-B23/2+200)*2/600)/60*1.15+(+H23*(SUM(B$17:B23)-B23/2+200)*2/600)/60*1.15,1)
24	=ROUND((E24*G24+I24)/60*1.15,1)	=ROUND(E24*(+F24*(SUM(B$17:B24)-B24/2+200)*2/600)/60*1.15+(+H24*(SUM(B$17:B24)-B24/2+200)*2/600)/60*1.15,1)
25	=ROUND((E25*G25+I25)/60*1.15,1)	=ROUND(E25*(+F25*(SUM(B$17:B25)-B25/2+200)*2/600)/60*1.15+(+H25*(SUM(B$17:B25)-B25/2+200)*2/600)/60*1.15,1)
26	=ROUND((E26*G26+I26)/60*1.15,1)	=ROUND(E26*(+F26*(SUM(B$17:B26)-B26/2+200)*2/600)/60*1.15+(+H26*(SUM(B$17:B26)-B26/2+200)*2/600)/60*1.15,1)
27	=ROUND((E27*G27+I27)/60*1.15,1)	=ROUND(E27*(+F27*(SUM(B$17:B27)-B27/2+200)*2/600)/60*1.15+(+H27*(SUM(B$17:B27)-B27/2+200)*2/600)/60*1.15,1)
28	=ROUND((E28*G28+I28)/60*1.15,1)	=ROUND(E28*(+F28*(SUM(B$17:B28)-B28/2+200)*2/600)/60*1.15+(+H28*(SUM(B$17:B28)-B28/2+200)*2/600)/60*1.15,1)
29	=ROUND((E29*G29+I29)/60*1.15,1)	=ROUND(E29*(+F29*(SUM(B$17:B29)-B29/2+200)*2/600)/60*1.15+(+H29*(SUM(B$17:B29)-B29/2+200)*2/600)/60*1.15,1)
30	=ROUND((E30*G30+I30)/60*1.15,1)	=ROUND(E30*(+F30*(SUM(B$17:B30)-B30/2+200)*2/600)/60*1.15+(+H30*(SUM(B$17:B30)-B30/2+200)*2/600)/60*1.15,1)
31	=ROUND((E31*G31+I31)/60*1.15,1)	=ROUND(E31*(+F31*(SUM(B$17:B31)-B31/2+200)*2/600)/60*1.15+(+H31*(SUM(B$17:B31)-B31/2+200)*2/600)/60*1.15,1)
32	=ROUND((E32*G32+I32)/60*1.15,1)	=ROUND(E32*(+F32*(SUM(B$17:B32)-B32/2+200)*2/600)/60*1.15+(+H32*(SUM(B$17:B32)-B32/2+200)*2/600)/60*1.15,1)
33	=ROUND((E33*G33+I33)/60*1.15,1)	=ROUND(E33*(+F33*(SUM(B$17:B33)-B33/2+200)*2/600)/60*1.15+(+H33*(SUM(B$17:B33)-B33/2+200)*2/600)/60*1.15,1)
34	=ROUND((E34*G34+I34)/60*1.15,1)	=ROUND(E34*(+F34*(SUM(B$17:B34)-B34/2+200)*2/600)/60*1.15+(+H34*(SUM(B$17:B34)-B34/2+200)*2/600)/60*1.15,1)
35	=ROUND((E35*G35+I35)/60*1.15,1)	=ROUND(E35*(+F35*(SUM(B$17:B35)-B35/2+200)*2/600)/60*1.15+(+H35*(SUM(B$17:B35)-B35/2+200)*2/600)/60*1.15,1)
36	=SUM(J17:J35)	=SUM(K17:K35)
37		

	L	M	N	O	P
1					
2					
3					
4					
5					
6					
7					
8	=1+	=1+L8	=1+M8	=1+N8	=1+O8
9					
10	DIES				
11					
12					
13				Total Hours for Each Segment	
14				Service Loci	Service Loci
15				Idle Time,	Tram Time,
16	Crew	Science	Utility and Maintenance	hours	hours
17	0	0	6	=ROUND((L17+M17+N17)*10*E17/60*1.15,1)	=ROUND(((SUM(B$17:B17)-B17/2+200)/600*(L17+M17+N17))*E17/60*1.15,1)
18	0	0	6	=ROUND((L18+M18+N18)*10*E18/60*1.15,1)	=ROUND(((SUM(B$17:B18)-B18/2+200)/600*(L18+M18+N18))*E18/60*1.15,1)
19	0	0	6	=ROUND((L19+M19+N19)*10*E19/60*1.15,1)	=ROUND(((SUM(B$17:B19)-B19/2+200)/600*(L19+M19+N19))*E19/60*1.15,1)
20	0	0	6	=ROUND((L20+M20+N20)*10*E20/60*1.15,1)	=ROUND(((SUM(B$17:B20)-B20/2+200)/600*(L20+M20+N20))*E20/60*1.15,1)
21	0	0	6	=ROUND((L21+M21+N21)*10*E21/60*1.15,1)	=ROUND(((SUM(B$17:B21)-B21/2+200)/600*(L21+M21+N21))*E21/60*1.15,1)
22	7	10	6	=ROUND((L22+M22+N22)*10*E22/60*1.15,1)	=ROUND(((SUM(B$17:B22)-B22/2+200)/600*(L22+M22+N22))*E22/60*1.15,1)
23	7	10	10	=ROUND((L23+M23+N23)*10*E23/60*1.15,1)	=ROUND(((SUM(B$17:B23)-B23/2+200)/600*(L23+M23+N23))*E23/60*1.15,1)
24	7	10	6	=ROUND((L24+M24+N24)*10*E24/60*1.15,1)	=ROUND(((SUM(B$17:B24)-B24/2+200)/600*(L24+M24+N24))*E24/60*1.15,1)
25	7	6	10	=ROUND((L25+M25+N25)*10*E25/60*1.15,1)	=ROUND(((SUM(B$17:B25)-B25/2+200)/600*(L25+M25+N25))*E25/60*1.15,1)
26	7	10	6	=ROUND((L26+M26+N26)*10*E26/60*1.15,1)	=ROUND(((SUM(B$17:B26)-B26/2+200)/600*(L26+M26+N26))*E26/60*1.15,1)
27	7	6	12	=ROUND((L27+M27+N27)*10*E27/60*1.15,1)	=ROUND(((SUM(B$17:B27)-B27/2+200)/600*(L27+M27+N27))*E27/60*1.15,1)
28	7	6	10	=ROUND((L28+M28+N28)*10*E28/60*1.15,1)	=ROUND(((SUM(B$17:B28)-B28/2+200)/600*(L28+M28+N28))*E28/60*1.15,1)
29	7	10	10	=ROUND((L29+M29+N29)*10*E29/60*1.15,1)	=ROUND(((SUM(B$17:B29)-B29/2+200)/600*(L29+M29+N29))*E29/60*1.15,1)
30	7	10	10	=ROUND((L30+M30+N30)*10*E30/60*1.15,1)	=ROUND(((SUM(B$17:B30)-B30/2+200)/600*(L30+M30+N30))*E30/60*1.15,1)
31	7	10	10	=ROUND((L31+M31+N31)*10*E31/60*1.15,1)	=ROUND(((SUM(B$17:B31)-B31/2+200)/600*(L31+M31+N31))*E31/60*1.15,1)
32	7	6	10	=ROUND((L32+M32+N32)*10*E32/60*1.15,1)	=ROUND(((SUM(B$17:B32)-B32/2+200)/600*(L32+M32+N32))*E32/60*1.15,1)
33	7	10	10	=ROUND((L33+M33+N33)*10*E33/60*1.15,1)	=ROUND(((SUM(B$17:B33)-B33/2+200)/600*(L33+M33+N33))*E33/60*1.15,1)
34	7	6	10	=ROUND((L34+M34+N34)*10*E34/60*1.15,1)	=ROUND(((SUM(B$17:B34)-B34/2+200)/600*(L34+M34+N34))*E34/60*1.15,1)
35	7	10	10	=ROUND((L35+M35+N35)*10*E35/60*1.15,1)	=ROUND(((SUM(B$17:B35)-B35/2+200)/600*(L35+M35+N35))*E35/60*1.15,1)
36					
37					

	Q	R	S	T
1				
2				
3				
4				
5				
6				
7				
8	=1+P8	=1+Q8	=1+R8	=1+S8
9				
10		COMBINED MU		
11		SERVICE TRAIN		
12				
13		Total Hours for Eac		
14	Idle & Muck Load	Tram	Total	
15	Total Time,	Total Time,	Oper Time,	Comments
16	hours	hours	hours	
17	=+O17+J17	=+P17+K17	=+R17+Q17	Start TBM tunneling at North Portal
18	=+O18+J18	=+P18+K18	=+R18+Q18	
19	=+O19+J19	=+P19+K19	=+R19+Q19	
20	=+O20+J20	=+P20+K20	=+R20+Q20	Bow Ridge Fault area, includes 2 additional days for steel set erection
21	=+O21+J21	=+P21+K21	=+R21+Q21	
22	=+O22+J22	=+P22+K22	=+R22+Q22	
23	=+O23+J23	=+P23+K23	=+R23+Q23	Drill and blast excavation, using diesel powered rubber tired equipment
24	=+O24+J24	=+P24+K24	=+R24+Q24	5 fault zones, 10 additional days for steel set erection
25	=+O25+J25	=+P25+K25	=+R25+Q25	Drill and blast excavation, using diesel powered rubber tired equipment
26	=+O26+J26	=+P26+K26	=+R26+Q26	3 fault zones, 6 additional days for steel set erection
27	=+O27+J27	=+P27+K27	=+R27+Q27	Mining operation is shut down during the conveyor installation
28	=+O28+J28	=+P28+K28	=+R28+Q28	Drill and blast excavation, using diesel powered rubber tired equipment
29	=+O29+J29	=+P29+K29	=+R29+Q29	
30	=+O30+J30	=+P30+K30	=+R30+Q30	Drill and blast excavation, using diesel powered rubber tired equipment
31	=+O31+J31	=+P31+K31	=+R31+Q31	
32	=+O32+J32	=+P32+K32	=+R32+Q32	Drill and blast excavation, using diesel powered rubber tired equipment
33	=+O33+J33	=+P33+K33	=+R33+Q33	1 fault zone, 2 additional days for steel set erection
34	=+O34+J34	=+P34+K34	=+R34+Q34	Drill and blast excavation, using diesel powered rubber tired equipment
35	=+O35+J35	=+P35+K35	=+R35+Q35	Tunneling to end TS North Ramp
36	=SUM(Q17:Q35)	=SUM(R17:R35)	=SUM(S17:S35)	
37				

```
A:A6: {Page} [W17] 'DIESEL OPERATION HOURS PER SEGMENT AS A FUNCTION OF SEGM
A:A8: {Page} [W17] 'SEGMENT  #>>
A:B8: [W9] 1
A:C8: [W9] 2
A:D8: 3
A:E8: 4
A:F8: 5
A:G8: 6
A:H8: 7
A:I8: 8
A:J8: 9
A:K8: 10
A:L8: 11
A:M8: 12
A:A10: {Page} [W17] 'SEGMENT LENGTH>>
A:B10: [W9] 160
A:C10: [W9] 100
A:D10: 160
A:E10: 230
A:F10: 200
A:G10: 450
A:H10: 1000
A:I10: 1800
A:J10: 1400
A:K10: 400
A:L10: 1800
A:M10: 1285
A:A13: {Page} [W17] 'DIESEL HRS
A:A14: {Page} [W17] 'BY SEGMENT >>
A:B14: [W9] 2.1
A:C14: [W9] 1.9
A:D14: 3.8
A:E14: 7.9
A:F14: 7.2
A:G14: 51.6
A:H14: 162.3
A:I14: 518.2
A:J14: 194.7
A:K14: 81.6
A:L14: 240.6
A:M14: 147.4
A:A15: {Page} [W17] '(TRAM ONLY)
A:B18: (F2) [W9] +B14
A:B19: (F2) [W9] (B10/(B10+C10))*C14
A:C19: (F2) [W9] (C10/(B10+C10))*C14
A:B20: (F2) [W9] (B10/($B$10+$C$10+$D$10))*$D$14
A:C20: (F2) [W9] (C10/($B$10+$C$10+$D$10))*$D$14
A:D20: (F2) (D10/($B$10+$C$10+$D$10))*$D$14
A:B21: (F2) [W9] (B10/(@SUM($B$10..$E$10))*$E$14)
A:C21: (F2) [W9] (C10/(@SUM($B$10..$E$10))*$E$14)
```

```
A:D21: (F2) (D10/(@SUM($B$10..$E$10))*$E$14)
A:E21: (F2) (E10/(@SUM($B$10..$E$10))*$E$14)
A:B22: (F2) [W9] (B10/(@SUM($B$10..$F$10))*$F$14)
A:C22: (F2) [W9] (C10/(@SUM($B$10..$F$10))*$F$14)
A:D22: (F2) (D10/(@SUM($B$10..$F$10))*$F$14)
A:E22: (F2) (E10/(@SUM($B$10..$F$10))*$F$14)
A:F22: (F2) (F10/(@SUM($B$10..$F$10))*$F$14)
A:B23: (F2) [W9] (B10/(@SUM($B$10..$G$10))*$G$14)
A:C23: (F2) [W9] (C10/(@SUM($B$10..$G$10))*$G$14)
A:D23: (F2) (D10/(@SUM($B$10..$G$10))*$G$14)
A:E23: (F2) (E10/(@SUM($B$10..$G$10))*$G$14)
A:F23: (F2) (F10/(@SUM($B$10..$G$10))*$G$14)
A:G23: (F2) (G10/(@SUM($B$10..$G$10))*$G$14)
A:B24: (F2) [W9] (B10/(@SUM($B$10..$H$10))*$H$14)
A:C24: (F2) [W9] (C10/(@SUM($B$10..$H$10))*$H$14)
A:D24: (F2) (D10/(@SUM($B$10..$H$10))*$H$14)
A:E24: (F2) (E10/(@SUM($B$10..$H$10))*$H$14)
A:F24: (F2) (F10/(@SUM($B$10..$H$10))*$H$14)
A:G24: (F2) (G10/(@SUM($B$10..$H$10))*$H$14)
A:H24: (F2) (H10/(@SUM($B$10..$H$10))*$H$14)
A:B25: (F2) [W9] (B10/(@SUM($B$10..$I$10))*$I$14)
A:C25: (F2) [W9] (C10/(@SUM($B$10..$I$10))*$I$14)
A:D25: (F2) (D10/(@SUM($B$10..$I$10))*$I$14)
A:E25: (F2) (E10/(@SUM($B$10..$I$10))*$I$14)
A:F25: (F2) (F10/(@SUM($B$10..$I$10))*$I$14)
A:G25: (F2) (G10/(@SUM($B$10..$I$10))*$I$14)
A:H25: (F2) (H10/(@SUM($B$10..$I$10))*$I$14)
A:I25: (F2) (I10/(@SUM($B$10..$I$10))*$I$14)
A:B26: (F2) [W9] (B10/(@SUM($B$10..$J$10))*$J$14)
A:C26: (F2) [W9] (C10/(@SUM($B$10..$J$10))*$J$14)
A:D26: (F2) (D10/(@SUM($B$10..$J$10))*$J$14)
A:E26: (F2) (E10/(@SUM($B$10..$J$10))*$J$14)
A:F26: (F2) (F10/(@SUM($B$10..$J$10))*$J$14)
A:G26: (F2) (G10/(@SUM($B$10..$J$10))*$J$14)
A:H26: (F2) (H10/(@SUM($B$10..$J$10))*$J$14)
A:I26: (F2) (I10/(@SUM($B$10..$J$10))*$J$14)
A:J26: (F2) (J10/(@SUM($B$10..$J$10))*$J$14)
A:B27: (F2) [W9] (B10/(@SUM($B$10..$K$10))*$K$14)
A:C27: (F2) [W9] (C10/(@SUM($B$10..$K$10))*$K$14)
A:D27: (F2) (D10/(@SUM($B$10..$K$10))*$K$14)
A:E27: (F2) (E10/(@SUM($B$10..$K$10))*$K$14)
A:F27: (F2) (F10/(@SUM($B$10..$K$10))*$K$14)
A:G27: (F2) (G10/(@SUM($B$10..$K$10))*$K$14)
A:H27: (F2) (H10/(@SUM($B$10..$K$10))*$K$14)
A:I27: (F2) (I10/(@SUM($B$10..$K$10))*$K$14)
A:J27: (F2) (J10/(@SUM($B$10..$K$10))*$K$14)
A:K27: (F2) (K10/(@SUM($B$10..$K$10))*$K$14)
A:B28: (F2) [W9] (B10/(@SUM($B$10..$L$10))*$L$14)
A:C28: (F2) [W9] (C10/(@SUM($B$10..$L$10))*$L$14)
A:D28: (F2) (D10/(@SUM($B$10..$L$10))*$L$14)
```

```
A:E28: (F2) (E10/(@SUM($B$10..$L$10))*$L$14)
A:F28: (F2) (F10/(@SUM($B$10..$L$10))*$L$14)
A:G28: (F2) (G10/(@SUM($B$10..$L$10))*$L$14)
A:H28: (F2) (H10/(@SUM($B$10..$L$10))*$L$14)
A:I28: (F2) (I10/(@SUM($B$10..$L$10))*$L$14)
A:J28: (F2) (J10/(@SUM($B$10..$L$10))*$L$14)
A:K28: (F2) (K10/(@SUM($B$10..$L$10))*$L$14)
A:L28: (F2) (L10/(@SUM($B$10..$L$10))*$L$14)
A:B29: (F2) [W9] (B10/(@SUM($B$10..$M$10))*$M$14)
A:C29: (F2) [W9] (C10/(@SUM($B$10..$M$10))*$M$14)
A:D29: (F2) (D10/(@SUM($B$10..$M$10))*$M$14)
A:E29: (F2) (E10/(@SUM($B$10..$M$10))*$M$14)
A:F29: (F2) (F10/(@SUM($B$10..$M$10))*$M$14)
A:G29: (F2) (G10/(@SUM($B$10..$M$10))*$M$14)
A:H29: (F2) (H10/(@SUM($B$10..$M$10))*$M$14)
A:I29: (F2) (I10/(@SUM($B$10..$M$10))*$M$14)
A:J29: (F2) (J10/(@SUM($B$10..$M$10))*$M$14)
A:K29: (F2) (K10/(@SUM($B$10..$M$10))*$M$14)
A:L29: (F2) (L10/(@SUM($B$10..$M$10))*$M$14)
A:M29: (F2) (M10/(@SUM($B$10..$M$10))*$M$14)
A:A30: {Page} [W17] 'IDLE TIME
A:A31: {Page} [W17] 'AT FACE >>
A:B31: [W9] 46.1
A:C31: [W9] 26.9
A:D31: 42.2
A:E31: 64.4
A:F31: 45.7
A:G31: 258.7
A:H31: 483.4
A:I31: 866.2
A:J31: 231.2
A:K31: 89.5
A:L31: 208.6
A:M31: 103.5
A:A33: {Page} [W17] 'HOURS/SEGMENT >>
A:B33: (F2) [W9] @SUM(B18..B31)
A:C33: (F2) [W9] @SUM(C18..C31)
A:D33: (F2) @SUM(D18..D31)
A:E33: (F2) @SUM(E18..E31)
A:F33: (F2) @SUM(F18..F31)
A:G33: (F2) @SUM(G18..G31)
A:H33: (F2) @SUM(H18..H31)
A:I33: (F2) @SUM(I18..I31)
A:J33: (F2) @SUM(J18..J31)
A:K33: (F2) @SUM(K18..K31)
A:L33: (F2) @SUM(L18..L31)
A:M33: (F2) @SUM(M18..M31)
A:B35: [W9] @SUM(B33..M33)
A:C35: [W9] '= TOTAL DIESEL HOURS IN DEVELOPMENT OF NORTH RAMP
```

ATTACHMENT II

SPREADSHEET SHOWING THE DISTRIBUTION OF DIESEL OPERATING HOURS BY SEGMENT OVER THE NORTH RAMP ALIGNMENT. ALSO INCLUDED IS A LISTING OF THE CELL CONTENTS OF THE SPREADSHEET.

	A	B	C	D	E	F	G	H	I	J	K	L	M
6	DIESEL OPERATION HOURS PER SEGMENT AS A FUNCTION OF SEGMENT LENGTH												
	SEGMENT #>>	1	2	3	4	5	6	7	8	9	10	11	12
10	SEGMENT LENGTH>	160	100	160	230	200	450	1000	1800	1400	400	1800	1285
14	DIESEL HRS BY SEGMENT >> (TRAM ONLY)	2.1	1.9	3.8	7.9	7.2	51.6	162.3	518.2	194.7	81.6	240.6	147.4
18		2.10											
		1.17	0.73										
		1.45	0.90	1.45									
21		1.94	1.22	1.94	2.80								
		1.36	0.85	1.36	1.95	1.69							
		6.35	3.97	6.35	9.13	7.94	17.86						
		11.29	7.06	11.29	16.23	14.11	31.75	70.57					
25		20.22	12.64	20.22	29.07	25.28	56.88	126.39	227.50				
		5.66	3.54	5.66	8.14	7.08	15.93	35.40	63.72	49.56			
		2.21	1.38	2.21	3.18	2.77	6.22	13.83	24.89	19.36	5.53		
		5.00	3.12	5.00	7.19	6.25	14.06	31.25	56.24	43.75	12.50	56.24	
29		2.62	1.64	2.62	3.77	3.28	7.38	16.41	29.53	22.97	6.56	29.53	21.08
31	IDLE TIME AT FACE >>	46.1	26.9	42.2	64.4	45.7	258.7	483.4	866.2	231.2	89.5	208.6	103.5
33	HOURS/SEGMENT >	107.48	63.95	100.31	145.86	114.10	408.79	777.24	1268.09	366.84	114.09	294.37	124.58

3885.7 = TOTAL DIESEL HOURS IN DEVELOPMENT OF NORTH RAMP

ATTACHMENT III

SPREADSHEET SHOWING THE CALCULATION OF THE VARIOUS DIESEL EXHAUST CONSTITUENTS RELEASED IN EACH SEGMENT OF THE NORTH RAMP. ALSO INCLUDED IS A LISTING OF THE CELL CONTENTS OF THE SPREADSHEET.

A B C D E F G H I J K L M N O P Q

2

SEGMENT # 1

	COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
1	CO	0.486	200	107.48	10,447.06
	HC	0.097	200	107.48	2,086.11
	NO	0.194	200	107.48	4,170.22
	NO2	0.0162	200	107.48	348.24
	CO2	22.9	200	107.48	492,268.40
4	SO2	0.0194	200	107.48	417.02
		(mg/BHP-HR)			(mg)
8	DPM	649.6	200	107.48	13,963,601.60

SEGMENT # 5

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.486	200	114.1	11,090.52
HC	0.097	200	114.1	2,213.54
NO	0.194	200	114.1	4,427.08
NO2	0.0162	200	114.1	369.68
CO2	22.9	200	114.1	522,578.00
SO2	0.0194	200	114.1	442.71
	(mg/BHP-HR)			(mg)
DPM	649.6	200	114.1	14,823,872.00

SEGMENT # 9

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.486	200	366.84	35,656.65
HC	0.097	200	366.84	7,116.70
NO	0.194	200	366.84	14,233.39
NO2	0.0162	200	366.84	1,188.60
CO2	22.9	200	366.84	1,680,127.20
SO2	0.0194	200	366.84	1,423.34
	(mg/BHP-HR)			(mg)
DPM	649.6	200	366.84	47,669,862.80

SEGMENT # 2

	COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
28	CO	0.486	200	63.95	6,216.94
	HC	0.097	200	63.95	1,240.63
	NO	0.194	200	63.95	2,481.26
	NO2	0.0162	200	63.95	207.20
	CO2	22.9	200	63.95	292,891.00
33	SO2	0.0194	200	63.95	248.13
		(mg/BHP-HR)			(mg)
37	DPM	649.6	200	63.95	8,308,384.00

SEGMENT # 6

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.486	200	408.79	39,734.38
HC	0.097	200	408.79	7,930.63
NO	0.194	200	408.79	15,861.06
NO2	0.0162	200	408.79	1,324.48
CO2	22.9	200	408.79	1,872,268.20
SO2	0.0194	200	408.79	1,586.11
	(mg/BHP-HR)			(mg)
DPM	649.6	200	408.79	53,109,996.80

SEGMENT # 10

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.486	200	114.09	11,089.65
HC	0.097	200	114.09	2,213.35
NO	0.194	200	114.09	4,426.69
NO2	0.0162	200	114.09	369.65
CO2	22.9	200	114.09	522,532.20
SO2	0.0194	200	114.09	442.67
	(mg/BHP-HR)			(mg)
DPM	649.6	200	114.09	14,822,572.80

SEGMENT # 3

	COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
47	CO	0.486	200	100.31	9,750.13
	HC	0.097	200	100.31	1,948.01
	NO	0.194	200	100.31	3,892.03
	NO2	0.0162	200	100.31	325.00
	CO2	22.9	200	100.31	459,419.80
52	SO2	0.0194	200	100.31	389.20
		(mg/BHP-HR)			(mg)
56	DPM	649.6	200	100.31	13,032,275.20

SEGMENT # 7

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.486	200	777.24	75,647.73
HC	0.097	200	777.24	15,078.46
NO	0.194	200	777.24	30,156.91
NO2	0.0162	200	777.24	2,518.26
CO2	22.9	200	777.24	3,559,759.20
SO2	0.0194	200	777.24	3,015.69
	(mg/BHP-HR)			(mg)
DPM	649.6	200	777.24	100,979,020.80

SEGMENT # 11

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.486	200	294.37	28,612.76
HC	0.097	200	294.37	5,710.79
NO	0.194	200	294.37	11,421.58
NO2	0.0162	200	294.37	953.76
CO2	22.9	200	294.37	1,348,214.60
SO2	0.0194	200	294.37	1,142.16
	(mg/BHP-HR)			(mg)
DPM	649.6	200	294.37	38,244,550.40

SEGMENT # 4

	COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
66	CO	0.486	200	146.86	14,177.59
	HC	0.097	200	146.86	2,829.66
	NO	0.194	200	146.86	5,669.37
	NO2	0.0162	200	146.86	472.69
	CO2	22.9	200	146.86	668,038.80
71	SO2	0.0194	200	146.86	566.94
		(mg/BHP-HR)			(mg)
75	DPM	649.6	200	146.86	19,950,131.20

SEGMENT # 8

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.486	200	1268.09	123,268.36
HC	0.097	200	1268.09	24,600.96
NO	0.194	200	1268.09	49,201.89
NO2	0.0162	200	1268.09	4,106.61
CO2	22.9	200	1268.09	5,807,852.20
SO2	0.0194	200	1268.09	4,920.19
	(mg/BHP-HR)			(mg)
DPM	649.6	200	1268.09	164,750,252.80

SEGMENT # 12

COMPONENT	UNIT VOLUME (FT3/BHP-HR)	ENGINE SIZE (BHP)	ENGINE HOURS IN SEGMENT	TOTAL EMISSIONS IN SEGMENT (FT3)
CO	0.486	200	124.68	12,109.18
HC	0.097	200	124.68	2,418.86
NO	0.194	200	124.68	4,833.70
NO2	0.0162	200	124.68	403.64
CO2	22.9	200	124.68	570,676.40
SO2	0.0194	200	124.68	483.37
	(mg/BHP-HR)			(mg)
DPM	649.6	200	124.68	16,186,433.60

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A:A2: {Page} [W12] 'SEGMENT # 1
A:G2: [W11] 'SEGMENT # 5
A:M2: [W11] 'SEGMENT # 9
A:B4: [W12] ^UNIT
A:C4: ^ENGINE
A:D4: [W11] ^ENGINE
A:E4: [W14] ^TOTAL
A:H4: [W11] ^UNIT
A:I4: ^ENGINE
A:J4: [W11] ^ENGINE
A:K4: [W15] ^TOTAL
A:N4: [W11] ^UNIT
A:O4: ^ENGINE
A:P4: [W11] ^ENGINE
A:Q4: [W15] ^TOTAL
A:A5: {Page} [W12] ^COMPONENT
A:B5: [W12] ^VOLUME
A:C5: ^SIZE
A:D5: [W11] ^HOURS
A:E5: [W14] ^EMISSIONS
A:G5: [W11] ^COMPONENT
A:H5: [W11] ^VOLUME
A:I5: ^SIZE
A:J5: [W11] ^HOURS
A:K5: [W15] ^EMISSIONS
A:M5: [W11] ^COMPONENT
A:N5: [W11] ^VOLUME
A:O5: ^SIZE
A:P5: [W11] ^HOURS
A:Q5: [W15] ^EMISSIONS
A:B6: [W12] ^(FT3/BHP-HR)
A:C6: ^(BHP)
A:D6: [W11] ^IN SEGMENT
A:E6: [W14] ^IN SEGMENT
A:H6: [W11] ^(FT3/BHP-HR)
A:I6: ^(BHP)
A:J6: [W11] ^IN SEGMENT
A:K6: [W15] ^IN SEGMENT
A:N6: [W11] ^(FT3/BHP-HR)
A:O6: ^(BHP)
A:P6: [W11] ^IN SEGMENT
A:Q6: [W15] ^IN SEGMENT
A:E7: [W14] ^(FT3)
A:K7: [W15] ^(FT3)
A:Q7: [W15] ^(FT3)
A:A9: {Page} [W12] ^CO
A:B9: [W12] 0.486
A:C9: 200
A:D9: [W11] 107.48
A:E9: (,2) [W14] +B9*C9*D9
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A:G9: [W11] ^CO
A:H9: [W11] 0.486
A:I9: 200
A:J9: [W11] 114.1
A:K9: (,2) [W15] +H9*I9*J9
A:M9: [W11] ^CO
A:N9: [W11] 0.486
A:O9: 200
A:P9: [W11] 366.84
A:Q9: (,2) [W15] +N9*O9*P9
A:A10: {Page} [W12] ^HC
A:B10: [W12] 0.097
A:C10: 200
A:D10: [W11] 107.48
A:E10: (,2) [W14] +B10*C10*D10
A:G10: [W11] ^HC
A:H10: [W11] 0.097
A:I10: 200
A:J10: [W11] 114.1
A:K10: (,2) [W15] +H10*I10*J10
A:M10: [W11] ^HC
A:N10: [W11] 0.097
A:O10: 200
A:P10: [W11] 366.84
A:Q10: (,2) [W15] +N10*O10*P10
A:A11: {Page} [W12] ^NO
A:B11: [W12] 0.194
A:C11: 200
A:D11: [W11] 107.48
A:E11: (,2) [W14] +B11*C11*D11
A:G11: [W11] ^NO
A:H11: [W11] 0.194
A:I11: 200
A:J11: [W11] 114.1
A:K11: (,2) [W15] +H11*I11*J11
A:M11: [W11] ^NO
A:N11: [W11] 0.194
A:O11: 200
A:P11: [W11] 366.84
A:Q11: (,2) [W15] +N11*O11*P11
A:A12: {Page} [W12] ^NO2
A:B12: [W12] 0.0162
A:C12: 200
A:D12: [W11] 107.48
A:E12: (,2) [W14] +B12*C12*D12
A:G12: [W11] ^NO2
A:H12: [W11] 0.0162
A:I12: 200
A:J12: [W11] 114.1
A:K12: (,2) [W15] +H12*I12*J12
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A:M12: [W11] ^NO2
A:N12: [W11] 0.0162
A:O12: 200
A:P12: [W11] 366.84
A:Q12: (,2) [W15] +N12*O12*P12
A:A13: {Page} [W12] ^CO2
A:B13: [W12] 22.9
A:C13: 200
A:D13: [W11] 107.48
A:E13: (,2) [W14] +B13*C13*D13
A:G13: [W11] ^CO2
A:H13: [W11] 22.9
A:I13: 200
A:J13: [W11] 114.1
A:K13: (,2) [W15] +H13*I13*J13
A:M13: [W11] ^CO2
A:N13: [W11] 22.9
A:O13: 200
A:P13: [W11] 366.84
A:Q13: (,2) [W15] +N13*O13*P13
A:A14: {Page} [W12] ^SO2
A:B14: [W12] 0.0194
A:C14: 200
A:D14: [W11] 107.48
A:E14: (,2) [W14] +B14*C14*D14
A:G14: [W11] ^SO2
A:H14: [W11] 0.0194
A:I14: 200
A:J14: [W11] 114.1
A:K14: (,2) [W15] +H14*I14*J14
A:M14: [W11] ^SO2
A:N14: [W11] 0.0194
A:O14: 200
A:P14: [W11] 366.84
A:Q14: (,2) [W15] +N14*O14*P14
A:B16: [W12] ^(mg/BHP-HR)
A:E16: (,2) [W14] ^(mg)
A:H16: [W11] ^(mg/BHP-HR)
A:K16: (,2) [W15] ^(mg)
A:N16: [W11] ^(mg/BHP-HR)
A:Q16: (,2) [W15] ^(mg)
A:A18: {Page} [W12] ^DPM
A:B18: [W12] 649.6
A:C18: 200
A:D18: [W11] 107.48
A:E18: (,2) [W14] +B18*C18*D18
A:G18: [W11] ^DPM
A:H18: [W11] 649.6
A:I18: 200
A:J18: [W11] 114.1
```

```
A:K18: (,2) [W15] +H18*I18*J18
A:M18: [W11] ^DPM
A:N18: [W11] 649.6
A:O18: 200
A:P18: [W11] 366.84
A:Q18: (,2) [W15] +N18*O18*P18
A:A21: {Page} [W12] 'SEGMENT # 2
A:G21: [W11] 'SEGMENT # 6
A:M21: [W11] 'SEGMENT # 10
A:B23: [W12] ^UNIT
A:C23: ^ENGINE
A:D23: [W11] ^ENGINE
A:E23: [W14] ^TOTAL
A:H23: [W11] ^UNIT
A:I23: ^ENGINE
A:J23: [W11] ^ENGINE
A:K23: [W15] ^TOTAL
A:N23: [W11] ^UNIT
A:O23: ^ENGINE
A:P23: [W11] ^ENGINE
A:Q23: [W15] ^TOTAL
A:A24: {Page} [W12] ^COMPONENT
A:B24: [W12] ^VOLUME
A:C24: ^SIZE
A:D24: [W11] ^HOURS
A:E24: [W14] ^EMISSIONS
A:G24: [W11] ^COMPONENT
A:H24: [W11] ^VOLUME
A:I24: ^SIZE
A:J24: [W11] ^HOURS
A:K24: [W15] ^EMISSIONS
A:M24: [W11] ^COMPONENT
A:N24: [W11] ^VOLUME
A:O24: ^SIZE
A:P24: [W11] ^HOURS
A:Q24: [W15] ^EMISSIONS
A:B25: [W12] ^(FT3/BHP-HR)
A:C25: ^(BHP)
A:D25: [W11] ^IN SEGMENT
A:E25: [W14] ^IN SEGMENT
A:H25: [W11] ^(FT3/BHP-HR)
A:I25: ^(BHP)
A:J25: [W11] ^IN SEGMENT
A:K25: [W15] ^IN SEGMENT
A:N25: [W11] ^(FT3/BHP-HR)
A:O25: ^(BHP)
A:P25: [W11] ^IN SEGMENT
A:Q25: [W15] ^IN SEGMENT
A:E26: [W14] ^(FT3)
A:K26: [W15] ^(FT3)
```

```
A:Q26: [W15] ^(FT3)
A:A28: {Page} [W12] ^CO
A:B28: [W12] 0.486
A:C28: 200
A:D28: [W11] 63.95
A:E28: (,2) [W14] +B28*C28*D28
A:G28: [W11] ^CO
A:H28: [W11] 0.486
A:I28: 200
A:J28: [W11] 408.79
A:K28: (,2) [W15] +H28*I28*J28
A:M28: [W11] ^CO
A:N28: [W11] 0.486
A:O28: 200
A:P28: [W11] 114.09
A:Q28: (,2) [W15] +N28*O28*P28
A:A29: {Page} [W12] ^HC
A:B29: [W12] 0.097
A:C29: 200
A:D29: [W11] 63.95
A:E29: (,2) [W14] +B29*C29*D29
A:G29: [W11] ^HC
A:H29: [W11] 0.097
A:I29: 200
A:J29: [W11] 408.79
A:K29: (,2) [W15] +H29*I29*J29
A:M29: [W11] ^HC
A:N29: [W11] 0.097
A:O29: 200
A:P29: [W11] 114.09
A:Q29: (,2) [W15] +N29*O29*P29
A:A30: {Page} [W12] ^NO
A:B30: [W12] 0.194
A:C30: 200
A:D30: [W11] 63.95
A:E30: (,2) [W14] +B30*C30*D30
A:G30: [W11] ^NO
A:H30: [W11] 0.194
A:I30: 200
A:J30: [W11] 408.79
A:K30: (,2) [W15] +H30*I30*J30
A:M30: [W11] ^NO
A:N30: [W11] 0.194
A:O30: 200
A:P30: [W11] 114.09
A:Q30: (,2) [W15] +N30*O30*P30
A:A31: {Page} [W12] ^NO2
A:B31: [W12] 0.0162
A:C31: 200
A:D31: [W11] 63.95
```

```
A:E31: (,2) [W14] +B31*C31*D31
A:G31: [W11] ^NO2
A:H31: [W11] 0.0162
A:I31: 200
A:J31: [W11] 408.79
A:K31: (,2) [W15] +H31*I31*J31
A:M31: [W11] ^NO2
A:N31: [W11] 0.0162
A:O31: 200
A:P31: [W11] 114.09
A:Q31: (,2) [W15] +N31*O31*P31
A:A32: {Page} [W12] ^CO2
A:B32: [W12] 22.9
A:C32: 200
A:D32: [W11] 63.95
A:E32: (,2) [W14] +B32*C32*D32
A:G32: [W11] ^CO2
A:H32: [W11] 22.9
A:I32: 200
A:J32: [W11] 408.79
A:K32: (,2) [W15] +H32*I32*J32
A:M32: [W11] ^CO2
A:N32: [W11] 22.9
A:O32: 200
A:P32: [W11] 114.09
A:Q32: (,2) [W15] +N32*O32*P32
A:A33: {Page} [W12] ^SO2
A:B33: [W12] 0.0194
A:C33: 200
A:D33: [W11] 63.95
A:E33: (,2) [W14] +B33*C33*D33
A:G33: [W11] ^SO2
A:H33: [W11] 0.0194
A:I33: 200
A:J33: [W11] 408.79
A:K33: (,2) [W15] +H33*I33*J33
A:M33: [W11] ^SO2
A:N33: [W11] 0.0194
A:O33: 200
A:P33: [W11] 114.09
A:Q33: (,2) [W15] +N33*O33*P33
A:B35: [W12] ^(mg/BHP-HR)
A:E35: (,2) [W14] ^(mg)
A:H35: [W11] ^(mg/BHP-HR)
A:K35: (,2) [W15] ^(mg)
A:N35: [W11] ^(mg/BHP-HR)
A:Q35: (,2) [W15] ^(mg)
A:A37: {Page} [W12] ^DPM
A:B37: [W12] 649.6
A:C37: 200
```

```
A:D37: [W11] 63.95
A:E37: (,2) [W14] +B37*C37*D37
A:G37: [W11] ^DPM
A:H37: [W11] 649.6
A:I37: 200
A:J37: [W11] 408.79
A:K37: (,2) [W15] +H37*I37*J37
A:M37: [W11] ^DPM
A:N37: [W11] 649.6
A:O37: 200
A:P37: [W11] 114.09
A:Q37: (,2) [W15] +N37*O37*P37
A:A40: {Page} [W12] 'SEGMENT # 3
A:G40: [W11] 'SEGMENT # 7
A:M40: [W11] 'SEGMENT # 11
A:B42: [W12] ^UNIT
A:C42: ^ENGINE
A:D42: [W11] ^ENGINE
A:E42: [W14] ^TOTAL
A:H42: [W11] ^UNIT
A:I42: ^ENGINE
A:J42: [W11] ^ENGINE
A:K42: [W15] ^TOTAL
A:N42: [W11] ^UNIT
A:O42: ^ENGINE
A:P42: [W11] ^ENGINE
A:Q42: [W15] ^TOTAL
A:A43: {Page} [W12] ^COMPONENT
A:B43: [W12] ^VOLUME
A:C43: ^SIZE
A:D43: [W11] ^HOURS
A:E43: [W14] ^EMISSIONS
A:G43: [W11] ^COMPONENT
A:H43: [W11] ^VOLUME
A:I43: ^SIZE
A:J43: [W11] ^HOURS
A:K43: [W15] ^EMISSIONS
A:M43: [W11] ^COMPONENT
A:N43: [W11] ^VOLUME
A:O43: ^SIZE
A:P43: [W11] ^HOURS
A:Q43: [W15] ^EMISSIONS
A:B44: [W12] ^(FT3/BHP-HR)
A:C44: ^(BHP)
A:D44: [W11] ^IN SEGMENT
A:E44: [W14] ^IN SEGMENT
A:H44: [W11] ^(FT3/BHP-HR)
A:I44: ^(BHP)
A:J44: [W11] ^IN SEGMENT
A:K44: [W15] ^IN SEGMENT
```

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A:N44: [W11] ^(FT3/BHP-HR)
A:O44: ^(BHP)
A:P44: [W11] ^IN SEGMENT
A:Q44: [W15] ^IN SEGMENT
A:E45: [W14] ^(FT3)
A:K45: [W15] ^(FT3)
A:Q45: [W15] ^(FT3)
A:A47: {Page} [W12] ^CO
A:B47: [W12] 0.486
A:C47: 200
A:D47: [W11] 100.31
A:E47: (,2) [W14] +B47*C47*D47
A:G47: [W11] ^CO
A:H47: [W11] 0.486
A:I47: 200
A:J47: [W11] 777.24
A:K47: (,2) [W15] +H47*I47*J47
A:M47: [W11] ^CO
A:N47: [W11] 0.486
A:O47: 200
A:P47: [W11] 294.37
A:Q47: (,2) [W15] +N47*O47*P47
A:A48: {Page} [W12] ^HC
A:B48: [W12] 0.097
A:C48: 200
A:D48: [W11] 100.31
A:E48: (,2) [W14] +B48*C48*D48
A:G48: [W11] ^HC
A:H48: [W11] 0.097
A:I48: 200
A:J48: [W11] 777.24
A:K48: (,2) [W15] +H48*I48*J48
A:M48: [W11] ^HC
A:N48: [W11] 0.097
A:O48: 200
A:P48: [W11] 294.37
A:Q48: (,2) [W15] +N48*O48*P48
A:A49: {Page} [W12] ^NO
A:B49: [W12] 0.194
A:C49: 200
A:D49: [W11] 100.31
A:E49: (,2) [W14] +B49*C49*D49
A:G49: [W11] ^NO
A:H49: [W11] 0.194
A:I49: 200
A:J49: [W11] 777.24
A:K49: (,2) [W15] +H49*I49*J49
A:M49: [W11] ^NO
A:N49: [W11] 0.194
A:O49: 200
```

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A:P49: [W11] 294.37
A:Q49: (,2) [W15] +N49*O49*P49
A:A50: {Page} [W12] ^NO2
A:B50: [W12] 0.0162
A:C50: 200
A:D50: [W11] 100.31
A:E50: (,2) [W14] +B50*C50*D50
A:G50: [W11] ^NO2
A:H50: [W11] 0.0162
A:I50: 200
A:J50: [W11] 777.24
A:K50: (,2) [W15] +H50*I50*J50
A:M50: [W11] ^NO2
A:N50: [W11] 0.0162
A:O50: 200
A:P50: [W11] 294.37
A:Q50: (,2) [W15] +N50*O50*P50
A:A51: {Page} [W12] ^CO2
A:B51: [W12] 22.9
A:C51: 200
A:D51: [W11] 100.31
A:E51: (,2) [W14] +B51*C51*D51
A:G51: [W11] ^CO2
A:H51: [W11] 22.9
A:I51: 200
A:J51: [W11] 777.24
A:K51: (,2) [W15] +H51*I51*J51
A:M51: [W11] ^CO2
A:N51: [W11] 22.9
A:O51: 200
A:P51: [W11] 294.37
A:Q51: (,2) [W15] +N51*O51*P51
A:A52: {Page} [W12] ^SO2
A:B52: [W12] 0.0194
A:C52: 200
A:D52: [W11] 100.31
A:E52: (,2) [W14] +B52*C52*D52
A:G52: [W11] ^SO2
A:H52: [W11] 0.0194
A:I52: 200
A:J52: [W11] 777.24
A:K52: (,2) [W15] +H52*I52*J52
A:M52: [W11] ^SO2
A:N52: [W11] 0.0194
A:O52: 200
A:P52: [W11] 294.37
A:Q52: (,2) [W15] +N52*O52*P52
A:B54: [W12] ^(mg/BHP-HR)
A:E54: (,2) [W14] ^(mg)
A:H54: [W11] ^(mg/BHP-HR)
```

```
A:K54: (,2) [W15] ^(mg)
A:N54: [W11] ^(mg/BHP-HR)
A:Q54: (,2) [W15] ^(mg)
A:A56: {Page} [W12] ^DPM
A:B56: [W12] 649.6
A:C56: 200
A:D56: [W11] 100.31
A:E56: (,2) [W14] +B56*C56*D56
A:G56: [W11] ^DPM
A:H56: [W11] 649.6
A:I56: 200
A:J56: [W11] 777.24
A:K56: (,2) [W15] +H56*I56*J56
A:M56: [W11] ^DPM
A:N56: [W11] 649.6
A:O56: 200
A:P56: [W11] 294.37
A:Q56: (,2) [W15] +N56*O56*P56
A:A59: {Page} [W12] 'SEGMENT # 4
A:G59: [W11] 'SEGMENT # 8
A:M59: [W11] 'SEGMENT # 12
A:B61: [W12] ^UNIT
A:C61: ^ENGINE
A:D61: [W11] ^ENGINE
A:E61: [W14] ^TOTAL
A:H61: [W11] ^UNIT
A:I61: ^ENGINE
A:J61: [W11] ^ENGINE
A:K61: [W15] ^TOTAL
A:N61: [W11] ^UNIT
A:O61: ^ENGINE
A:P61: [W11] ^ENGINE
A:Q61: [W15] ^TOTAL
A:A62: {Page} [W12] ^COMPONENT
A:B62: [W12] ^VOLUME
A:C62: ^SIZE
A:D62: [W11] ^HOURS
A:E62: [W14] ^EMISSIONS
A:G62: [W11] ^COMPONENT
A:H62: [W11] ^VOLUME
A:I62: ^SIZE
A:J62: [W11] ^HOURS
A:K62: [W15] ^EMISSIONS
A:M62: [W11] ^COMPONENT
A:N62: [W11] ^VOLUME
A:O62: ^SIZE
A:P62: [W11] ^HOURS
A:Q62: [W15] ^EMISSIONS
A:B63: [W12] ^(FT3/BHP-HR)
A:C63: ^(BHP)
```

```
A:D63: [W11] ^IN SEGMENT
A:E63: [W14] ^IN SEGMENT
A:H63: [W11] ^(FT3/BHP-HR)
A:I63: ^(BHP)
A:J63: [W11] ^IN SEGMENT
A:K63: [W15] ^IN SEGMENT
A:N63: [W11] ^(FT3/BHP-HR)
A:O63: ^(BHP)
A:P63: [W11] ^IN SEGMENT
A:Q63: [W15] ^IN SEGMENT
A:E64: [W14] ^(FT3)
A:K64: [W15] ^(FT3)
A:Q64: [W15] ^(FT3)
A:A66: {Page} [W12] ^CO
A:B66: [W12] 0.486
A:C66: 200
A:D66: [W11] 145.86
A:E66: (,2) [W14] +B66*C66*D66
A:G66: [W11] ^CO
A:H66: [W11] 0.486
A:I66: 200
A:J66: [W11] 1268.09
A:K66: (,2) [W15] +H66*I66*J66
A:M66: [W11] ^CO
A:N66: [W11] 0.486
A:O66: 200
A:P66: [W11] 124.58
A:Q66: (,2) [W15] +N66*O66*P66
A:A67: {Page} [W12] ^HC
A:B67: [W12] 0.097
A:C67: 200
A:D67: [W11] 145.86
A:E67: (,2) [W14] +B67*C67*D67
A:G67: [W11] ^HC
A:H67: [W11] 0.097
A:I67: 200
A:J67: [W11] 1268.09
A:K67: (,2) [W15] +H67*I67*J67
A:M67: [W11] ^HC
A:N67: [W11] 0.097
A:O67: 200
A:P67: [W11] 124.58
A:Q67: (,2) [W15] +N67*O67*P67
A:A68: {Page} [W12] ^NO
A:B68: [W12] 0.194
A:C68: 200
A:D68: [W11] 145.86
A:E68: (,2) [W14] +B68*C68*D68
A:G68: [W11] ^NO
A:H68: [W11] 0.194
```

```
A:I68: 200
A:J68: [W11] 1268.09
A:K68: (,2) [W15] +H68*I68*J68
A:M68: [W11] ^NO
A:N68: [W11] 0.194
A:O68: 200
A:P68: [W11] 124.58
A:Q68: (,2) [W15] +N68*O68*P68
A:A69: {Page} [W12] ^NO2
A:B69: [W12] 0.0162
A:C69: 200
A:D69: [W11] 145.86
A:E69: (,2) [W14] +B69*C69*D69
A:G69: [W11] ^NO2
A:H69: [W11] 0.0162
A:I69: 200
A:J69: [W11] 1268.09
A:K69: (,2) [W15] +H69*I69*J69
A:M69: [W11] ^NO2
A:N69: [W11] 0.0162
A:O69: 200
A:P69: [W11] 124.58
A:Q69: (,2) [W15] +N69*O69*P69
A:A70: {Page} [W12] ^CO2
A:B70: [W12] 22.9
A:C70: 200
A:D70: [W11] 145.86
A:E70: (,2) [W14] +B70*C70*D70
A:G70: [W11] ^CO2
A:H70: [W11] 22.9
A:I70: 200
A:J70: [W11] 1268.09
A:K70: (,2) [W15] +H70*I70*J70
A:M70: [W11] ^CO2
A:N70: [W11] 22.9
A:O70: 200
A:P70: [W11] 124.58
A:Q70: (,2) [W15] +N70*O70*P70
A:A71: {Page} [W12] ^SO2
A:B71: [W12] 0.0194
A:C71: 200
A:D71: [W11] 145.86
A:E71: (,2) [W14] +B71*C71*D71
A:G71: [W11] ^SO2
A:H71: [W11] 0.0194
A:I71: 200
A:J71: [W11] 1268.09
A:K71: (,2) [W15] +H71*I71*J71
A:M71: [W11] ^SO2
A:N71: [W11] 0.0194
```

```
A:O71: 200
A:P71: [W11] 124.58
A:Q71: (,2) [W15] +N71*O71*P71
A:B73: [W12] ^(mg/BHP-HR)
A:E73: (,2) [W14] ^(mg)
A:H73: [W11] ^(mg/BHP-HR)
A:K73: (,2) [W15] ^(mg)
A:N73: [W11] ^(mg/BHP-HR)
A:Q73: (,2) [W15] ^(mg)
A:A75: {Page} [W12] ^DPM
A:B75: [W12] 649.6
A:C75: 200
A:D75: [W11] 145.86
A:E75: (,2) [W14] +B75*C75*D75
A:G75: [W11] ^DPM
A:H75: [W11] 649.6
A:I75: 200
A:J75: [W11] 1268.09
A:K75: (,2) [W15] +H75*I75*J75
A:M75: [W11] ^DPM
A:N75: [W11] 649.6
A:O75: 200
A:P75: [W11] 124.58
A:Q75: (,2) [W15] +N75*O75*P75
```

EVALUATION OF WASTE ISOLATION IMPACT FOR USE OF DIESEL TRAIN TRANSPORTATION DURING EXCAVATION OF THE NORTH RAMP

Evaluation of the potential effects of diesel exhaust emissions in the North Ramp was performed using potential perturbations to ambient geochemistry in the expansion areas and potential repository block. These potential perturbations were calculated based on diesel operation estimates (McKenzie, 1994) and both worst-case emission factors presented by McKenzie (1994) and best-case emission factors from Yang (1993). Oxides of sulfur and nitrogen and diesel particulate matter (DPM) are assumed to be completely retained due to expected preferential partitioning into the aqueous phase, but hydrocarbon vapor is assumed to be effectively ventilated. Even though their concentrations in the tunnel atmosphere (Yang, 1993) may be comparable to the natural levels, carbon dioxide and monoxide are not expected to perturb significantly the geochemistry because the concentration of CO_2 in the vapor phase is buffered via the surrounding water-rock system.

The ramp, shown in the attached Figure 1, was divided into four segments corresponding to sections where projected diesel emissions are relatively uniform. The segments were then idealized as "line sources" for each of the diesel exhaust constituents. Three dimensional dispersion calculations were performed as a function of flow orientation to evaluate the peak concentrations of exhaust constituents at 7 points along the top of the potential repository horizon (TSw2) within the expansion boundary (Figure 1). For one additional case, flow is taken to be along the ramp alignment for the first three segments and nearly orthogonal to the fourth ramp segment within the repository block. For this case, the fourth segment is idealized as a "plane source", and its contribution to dissolved exhaust constituents at the nearest potential waste package (offset 37 meters from the tunnel) was assessed with a 1-dimensional dispersion transport calculation.

Calculations were performed by assuming saturated flow along several directions from the North Ramp to 7 "observation" points below the ramp at the TSw1/TSw2 contact in the potential expansion area, and at the closest "observation" point in the repository block. The calculations assume that the exhaust material completely dissolves and is transported by advection and dispersion mechanisms without chemical reaction with the surrounding rock. These result in the integrated aqueous-phase concentrations as a function of time for each constituent at each observation point. Calculations were performed for flow directions of vertical, 45 degrees from vertical, directly along the ramp, and from the end of the Starter Tunnel to the nearest potential waste emplacement location in the expansion boundary (Obs. Pt. #1 in Figure 1).

The attached table gives the peak concentrations calculated for each observation point. The results based on the worst-case emissions indicate that the dissolved aqueous concentrations of nitrate and organic carbon at the nearest potential emplacement areas could potentially be perturbed at levels greater than 10% of the natural background concentrations (see shaded regions in the attached table). The 10% perturbation has been chosen as a conservative surrogate indicator of potential waste isolation impact. Results of calculations using emission factors for a clean-operating diesel engine from Yang (1993) indicate that nearly all aqueous-phase concentrations at potential emplacement areas would be below the 10% perturbation level. All calculations used estimated diesel exhaust emissions without benefit of emission control technology.

Impact Calculation Summary for North Ramp Diesel Usage

Peak Concentrations of Exhaust Constituents Calculated at a Variety of Locations within the Expansion Boundary as a Functions of Flow Orientation

NOTE: Shaded Values are Greater Than 10% of Ambient -- Unshaded Values Represent Negligible Potential For Impact to Waste Isolation.

		DOC (ppm) ~1.0	Ambient Values SO4-2 (ppm) 20. to 170.	NO3- (ppm) ~10.

Using Worst-Case Emissions (McKenzie, 1994 [DI:BABEA0000-01717-0200-00003, Rev. 00] from Yang, 1993 [DI:B00000000-AA-12-00002-00, Rev. 00]):

Observation Point	Observation Point #	DOC (ppm)	Vertical Flow SO4-2 (ppm)	NO3- (ppm)	DOC (ppm)	Flow at 45° SO4-2 (ppm)	NO3- (ppm)	DOC (ppm)	Flow from End S.T. To Exp. Bound. SO4-2 (ppm)	NO3- (ppm)
Expanison Boundary	1	0.06	0.27	1.87	0.04	0.14	0.97	0.03	0.10	0.70
Below S1 Midpoint	2	0.13	0.43	2.98	0.07	0.24	1.70	0.05	0.17	1.16
Below S1/S2	3	0.31	1.04	7.30	0.26	0.89	6.21	0.17	0.56	3.92
Below S2 Midpoint	4	0.29	0.97	6.80	0.16	0.53	3.73	0.11	0.36	2.53
Below S2/S3	5	0.39	1.31	9.19	0.28	0.93	6.50	0.18	0.60	4.20
Below S3 Midpoint	6	0.49	1.65	11.57	0.31	1.04	7.30	0.20	0.66	4.61
Below S3/S4	7	0.49	1.65	11.57	0.32	1.07	7.46	0.20	0.66	4.61

Using Best-Case Emissions ("unscrubbed") (Yang, 1993 [DI:B00000000-AA-12-00002-00, Rev. 00]):

Observation Point	Observation Point #	DOC (ppm)	Vertical Flow SO4-2 (ppm)	NO3- (ppm)	DOC (ppm)	Flow at 45° SO4-2 (ppm)	NO3- (ppm)	DOC (ppm)	Flow from End S.T. To Exp. Bound. SO4-2 (ppm)	NO3- (ppm)
Expanison Boundary	1	0.01	0.10	0.19	0.01	0.05	0.10	0.00	0.04	0.07
Below S1 Midpoint	2	0.02	0.16	0.30	0.01	0.09	0.17	0.01	0.06	0.12
Below S1/S2	3	0.05	0.39	0.73	0.04	0.33	0.62	0.03	0.21	0.39
Below S2 Midpoint	4	0.05	0.36	0.68	0.03	0.20	0.37	0.02	0.13	0.25
Below S2/S3	5	0.06	0.49	0.92	0.04	0.34	0.65	0.03	0.22	0.42
Below S3 Midpoint	6	0.08	0.61	1.16	0.05	0.39	0.73	0.03	0.24	0.46
Below S3/S4	7	0.08	0.61	1.16	0.05	0.40	0.75	0.03	0.24	0.46

Peak Concentrations of Exhaust Constituents Calculated within the Potential Repository Block at a 37. m Offset from the Tunnel.

Flow is Along Ramp (Worst Case, i.e., Largest Effect from First Three Segments S1, S2, and S3 in Addition to 1-D Calculated Effect from Segment 4).

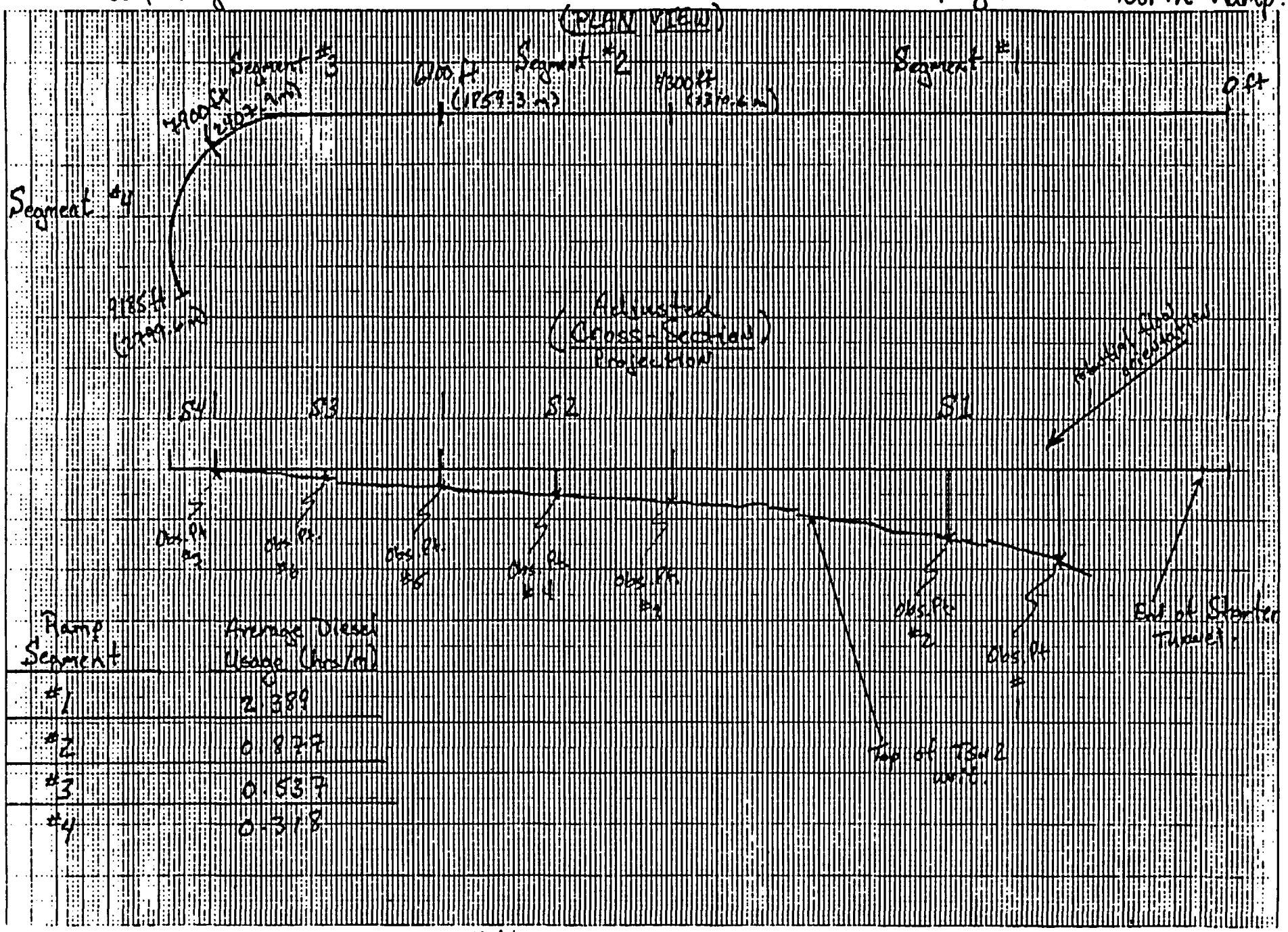
Using Worst-Case Emissions (McKenzie, 1994 [DI:BABEA0000-01717-0200-00003, Rev. 00] from Yang, 1993 [DI:B00000000-AA-12-00002-00, Rev. 00]):

DOC (ppm)	SO4-2 (ppm)	NO3- (ppm)
0.420	1.42	9.92

Using Best-Case Emissions ("unscrubbed") (Yang, 1993 [DI:B00000000-AA-12-00002-00, Rev. 00]):

DOC (ppm)	SO4-2 (ppm)	NO3- (ppm)
0.07	0.53	0.99

Figure 1. North Ramp.



Ramp Segment	Average Diesel Usage (hrs/m)
#1	2.389
#2	0.877
#3	0.537
#4	0.318

ATTACHMENT 4

SBT INPUT TO DIESEL STRATEGY

To: Jack Nesbitt (M&O)

PRELIMINARY DRAFT

From: Jeff McCleary (M&O)
Tom Statton (M&O)
Steve Nelson (M&O)

cc: Jean Younker (M&O)
Hugh Benton (M&O)
Bill Clarke (LLNL)
Claudia Newbury (DOE)
Paul Cloke (SAIC)

Subject: Diesel Exhaust Strategy

As a result of our November 19 telecon on the use of diesel equipment, and subsequent discussion within the Site Characterization Group, we have developed this input to the planning effort. Our observations and suggestions are presented by category below.

Schedule

An important component of a decision to proceed with diesel equipment while maintaining the option to transition to electric is the TBM schedule. It appears that the TBM will not become operational until Sept. 1, 1994. Assuming it takes one month for TBM operations to become proficient, and assuming 75 feet of tunneling per day thereafter, the TBM could reach the turn into the main drift in as little as 5 months (150 days). Thus, if it appears that electric equipment is required to construct the main drift, it may need to be on hand by Feb 1, 1995. Assuming it takes 6 months to procure electric equipment, a decision may have to be made *before* TBM operations begin (by Aug. 1, 1994). Even if the schedule for TBM operations slips considerably, there may be little or no time to monitor the effects of diesel exhaust in the tunnel, write a report, and make a procurement decision. Such a slippage in the schedule is obviously something we cannot plan for. Clearly, a strategy needs to be *implemented now* to evaluate, quantitatively, how exhaust products might partition to tunnel walls. Assuming a study will begin December, 1993, this would leave only 7 months to complete the study, write the report, and initiate procurement (if necessary) of electrical equipment.

Pre-Tunneling (TBM) Studies

While we fully support Bill Clarke's statement that the ESF is an experimental facility where monitoring of construction effects (including any effects from diesel exhaust) can be conducted, the schedule may require a decision before significant information is available from the ESF. Plans to sample the walls of N-tunnel at the NTS are important, but they will probably not give us a quantitative "source term" for diesel emission partitioning between tunnel air and tunnel walls. We do not have at hand the required mass-balance information to ascertain the degree of retention of important emission products. Therefore, geochemical studies (EQ3/6 simulations) will describe a range of interactions between rock and exhaust products and not their true magnitude. Without this latter ability, it will be difficult to predict the scale of effects which is what is needed to make a robust recommendation to DOE as the

TBM approaches the turn into the main drift. This turn can be viewed as a significant event as subsequent construction activities, including the use of diesel equipment, could potentially compromise the site. Thus, a decision to proceed with diesel equipment should be made with confidence prior to this event, or construction should proceed conservatively using electric equipment.

In item 2 of our INFORMAL MEMO-BASIS FOR DISCUSSION we identified the necessity of measuring or predicting 1) the partitioning of exhaust onto tunnel walls and probable contaminant levels as a function of position along the drifts, and 2) kinetic effects related to the production of hydrated acids. Much of this effort may be best accomplished by a mass balance approach. This would consist of a study by air-quality-tunneling-mine ventilation experts to predict, based upon experience and published data, the probable retention of emission products on tunnel walls.

Such a study would provide data for input into EQ3/6 models, which in turn will evaluate the capacity of the rock to buffer changes in water chemistry due to emissions. It would also augment studies conducted with samples from N-tunnel. As we have discussed, it will probably be very difficult to know the amount of diesel exhaust generated in N-tunnel and the fraction vented in mine exhaust in order to measure the relative retentivity of individual exhaust species. Thus, little hard data may come from N-tunnel samples to bound probable contaminant surface concentrations in the ESF.

We nonetheless feel it is important to sample N-tunnel. Samples from N-tunnel may represent an endmember for important changes in the vadose water/rock system. Such studies may also demonstrate whether the rock is an effective buffer. It may also be possible to gain insight into the *relative* retention of the various contaminant species by measuring their concentration ratios in the wallrock compared to those in the exhaust. This may allow us to determine whether there are any "bad actors" that are strongly retained, and through geochemical modeling, whether their consequences are important. It may also be valuable to examine the microbiological consequences of diesel exhaust. Not only may emissions acidify tunnel walls, but metabolic products of bacterial may also affect pH. Such tests will not be possible in the ESF, due to schedule considerations, until after an initial procurement decision is made.

ESF Monitoring Studies

Though it appears probable (based on the present schedule) that monitoring data and related analyses may not be available to guide a procurement decision by August 1, 1994, we nevertheless strongly support a monitoring program. As long as the electric option is preserved in the design, the decision to switch to electric equipment can be may at any time during ESF construction and operation if the data so warrant.

The monitoring program would consist of periodic sampling of emission products which could be compared against samples of mine exhaust in order to determine a partition factor (i.e. fraction of contaminant retained in the tunnel) for each of the important exhaust products. It would also be valuable to sample tunnel walls and measure the *in situ* effects of diesel emissions. The capability of the rock to buffer acid exhausts could be measured directly.

This could also include monitoring the populations of microorganism and the nutrients they feed upon as well as other exhaust products. The stimulation of growth of microorganisms is something that probably cannot be modeled. In all, this part of the program would provide powerful insights into a procurement decision if the TBM schedule slips. Even if it does not, it will provide the basis for predicting the effects of diesel on the main test level, alcoves, and repository. As such, the data could provide insight with respect to future (repository) procurements.

Without these studies, the Project may not be in a position to quantitatively evaluate the impacts of diesel emissions on the ESF. We may only be able to estimate a distribution of effects assuming a range of contaminant levels. The monitoring described would give the Project a restricted set of contaminant levels from which to estimate more meaningful impacts. Thus, this approach would give the project the *predictive* capability we need to make informed decisions. Such information would also give the project confidence before regulatory bodies and other stake holders concerned with the issue. Valuable information for test interference analyses in the ESF would be obtained. The process of gathering and interpreting these data would allow projections for the effects on a repository to be made.

Enclosure 1A

(Rev. 1, 2/24/94)

AGENDA

YUCCA MOUNTAIN PROJECT - PROJECT MANAGER'S/TPO MEETING

FEBRUARY 25, 1994, FRIDAY

SAIC CONFERENCE ROOM 450

TIME	WHAT	WHO	EXPECTED OUTCOME
9:00-9:15	Welcome & Introductions o Review Agenda	R. Dyer	
9:15-9:30	Status of Yucca Mountain Site Characterization Project	R. Nelson	Understand Current Status of Program and Project
9:30-9:45	Status of Design and Construction Effort Supporting the Exploratory Studies Facility (ESF)	W. Simecka	Understand Current Status of ESF Design and Construction Effort
9:45-10:00	Status of Site Characterization Testing Program and Preparation and Approval of Study Plans(SPs)	S. Jones	Understand Current Status of Testing Program and SPs
10:00-10:15	BREAK		
10:15-10:45	Status of Site Suitability Task Force Activities	M. Pendleton	Understand Planned Activities for FY94
10:45-11:15	Status of the Large Block Heater Tests at Fran Ridge	D. Wilder	Update on Construction and Testing Activities
11:15-11:45	Conceptual Model of the Saturated Zone Flow System	R. Luckey	Understand Definition of the Hydrologic Unit and Theories Related to the Large Hydraulic Gradient
11:45-12:00	Records Awareness Month	D. Warriner/ H. Ebner	Information on the Records Awareness Activities Planned for March 1994
12:00	ADJOURN FOR LUNCH		

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