QA: L

Civilian Radioactive Waste Management System
Management & Operating Contractor

Design Feature 7: Continuous Preclosure Ventilation

BCAD00000-01717-2200-00002 REV 00

June 1999

Prepared for:

U.S. Department of Energy
Yucca Mountain Site Characterization Office
P.O. Box 30307
North Las Vegas, Nevada 89036-0307

Prepared by:

TRW Environmental Safety Systems Inc.
1261 Town Center Drive
Las Vegas, Nevada 89134-6352

Under Contract Number
DE-AC08-91RW00134

Civilian Radioactive Waste Management System
Management & Operating Contractor

Design Feature 7: Continuous Preclosure Ventilation

BCAD00000-01717-2200-00002 REV 00

June 1999

Prepared by:

A.T. Watkins
Repository Subsurface Design

6/22/99
Date

Checked by:

C.L. Linden
Repository Subsurface Design

6/22/99
Date

Approved by:

D. G. McKenzie III, Responsible Manager
Repository Subsurface Design

6/22/99
Date

EXECUTIVE SUMMARY

This design feature (DF) is intended to evaluate the effects of continuous ventilation in the emplacement drifts during preclosure and how the effects, if any, compare to the Viability Assessment (VA) reference design for postclosure long term performance. This DF will be evaluated against a set of criteria provided by the License Application Design Selection (LADS) group.

The VA reference design included a continuous ventilation airflow quantity of 0.1 m^3/s in the emplacement drifts in the design of the repository subsurface facilities. The effects of this continuous ventilation during the preclosure was considered to have a negligible effect on postclosure performance and therefore is not included during postclosure in the assessment of the long term performance. This DF discusses the effects of continuous ventilation on the emplacement drift environment and surrounding rock conditions during preclosure for three increased airflow quantities. The three cases of continuous ventilation systems are: System A, 1.0 m^3/s (Section 8), System B, 5.0 m^3/s (Section 9), and System C, 10.0 m^3/s (Section 10) in each emplacement drift split. An emplacement drift split is half total length of emplacement drift going from the east or west main to the exhaust main. The difference in each system is the quantity of airflow in the emplacement drifts.

VA Reference Design–0.1 m^3/s per Emplacement Drift

Available data from the VA reference design, with an airflow quantity of 0.1 m^3/s in the emplacement drifts, was used regarding the emplacement drift environment and surrounding rock conditions during preclosure as discussed in Section 7.

System A–1.0 m^3/s per Emplacement Drift

The results from the *Repository Subsurface Waste Emplacement and Thermal Management Strategy* are used to estimate air and drift wall temperatures. The results are conservative because the temperatures are higher than estimates would be if moisture were considered. The peak air temperature and drift wall temperature, which occur at year 30, is 127.83°C and 143.85°C. The air temperature and the drift wall temperature at the time of closure at year 100, is 105.37°C and 120.32°C. The VA reference design drift wall temperature is above 150°C at 20 years after emplacement, System A would be a slight improvement as it lowers the temperatures below this, however the temperatures are still above boiling.

The total airflow quantity from primary intake airways (North Ramp, South Ramp and one intake shaft) required for System A is about 843 m^3/s for the Monitoring Phase. The Monitoring Phase is selected because that is the time when the maximum amount of airflow quantity is needed in the emplacement area. A total of 1,760 kW (2,360 brake horsepower) is required for monitoring operations. To accommodate the increased airflow quantity, System A needs one additional intake shaft at 10.5 meters excavated diameter and one additional exhaust shaft at 10.5 meters excavated diameter (typical liner thickness 0.3 m). The Emplacement Shaft and Development Shaft from the VA reference design will increase from 6.7 meters to 7.5 meters excavated diameter. An additional exhaust main at the same size as the other will be excavated so that the two drifts together will replace the exhaust tubes in the VA reference design. Two additional intake mains connecting the Intake Shafts with the East and West Mains at 7.62 meters excavated diameter and numerous other openings at various sizes will be required. For a more detailed discussion see Section 8.

System B–5.0 m^3/s per Emplacement Drift

The results from *Repository Subsurface Waste Emplacement and Thermal Management Strategy* were also used to estimate air and drift wall temperatures for System B. As with System A, the results are conservative because the effect of moisture is not considered. The peak air temperature, which occurs at year 20, is 66.08°C and the drift wall temperature at year 10 is 80.88°C. The air temperature and the drift wall temperature at the time of closure at year 100, is 45.76°C and 53.57°C respectively. Since the VA reference design drift wall temperature is above 150°C at 20 years after emplacement, System B would show a significant improvement as it lowers the temperatures below boiling.

The total airflow quantity from primary intake airways (North Ramp, South Ramp and two intake shafts) required for System B is approximately 2,171 m^3/s for the Monitoring Phase, again as in System A, this phase requires the maximum amount of airflow. For monitoring operations 7228 kW (9,689 brake horsepower) is needed. To accommodate the increased airflow quantity, System B needs two additional intake shafts at 10.5 meters excavated diameter, two additional exhaust shafts at 10.5 meters excavated diameter, and one additional exhaust shaft at 7.5 meters excavated diameter (typical liner thickness 0.3 m). The Emplacement Shaft and Development Shaft from the VA reference design will increase from 6.7 meters to 7.5 meters excavated diameter. An additional exhaust main the same size as the other will be excavated so that the two drifts together will replace the exhaust tubes in the VA reference design. Four additional intake mains at 7.62 meters excavated diameter and numerous other openings at various sizes will be required. For a more detailed discussion see Section 9.

System C–10.0 m^3/s per Emplacement Drift

Only the 10.0 m^3/s system has been evaluated for long term performance as a conservative bounding limit. Performance Assessment (PA) Operations, preliminary assessment indicates there is little discernable difference in the long term performance relative to the VA reference design, although it appears that the waste package corrosion regime is entered into slightly earlier.

The total airflow from primary intake airways (North Ramp, South Ramp and four intake shafts) quantity required for System C is approximately 3,563 m^3/s for the Monitoring Phase. Total ventilation energy required is 11,153 kW (14,951brake horsepower). In order to accommodate the increased airflow quantity, System C needs four additional intake shafts at 10.5 meters excavated diameter and four additional exhaust shafts at 10.5 meters excavated diameter (typical liner thickness 0.3 m). The Emplacement Shaft and Development Shaft from the VA reference design will increase from 6.7 meters to 7.5 meters excavated diameter. An additional exhaust main at the same size as the other will be excavated so that the two drifts together will replace the exhaust tubes in the VA reference design. Eight additional intake mains at 7.62 meters excavated diameter and numerous other openings at various sizes will be required. For a more detailed discussion see Section 10.

Design Feature Evaluation

- The DF evaluation can be summarized as follows:
  - There is little discernable difference between this DF (all three systems considered) and the VA reference design other than the additional construction, equipment and power costs occurring by virtue of each of the system demands.
  - No special equipment will be required. There will be more openings to construct and inspect. There are more fans, but they lie within the range of existing industrial systems, and are catalogue obtainable from fan manufacturers.
- Schedule
  - Assuming that two tunnel boring machines (TBMs) are used there would be no impact on the existing schedule.
- Cost
  - The cost differential between System A and the VA reference design is +$244 million. The cost differential between System B and the VA reference design is +$907 million. The cost differential between System C and the VA reference design is +$1,864 million.
- Environmental Considerations

  Environmental considerations were developed to provide engineering and technical information to the Environmental Impact Statement (EIS) contractor,who needed to ascertain if any potential environmental impacts of this design feature would be significant relative to other impacts addressed by the EIS. Environmental considerations were not assigned a numerical rating.

The conclusion drawn from this report concerning postclosure performance of the three preclosure systems is that System C provides no postclosure radiological advantage when compared with the VA reference design. Because System C is the bounding case for postclosure performance of the repository with a preclosure ventilation rate of 10 m^3/s per emplacement drift, Systems A and B also provide no radiological postclosure advantage when compared with the VA reference design.

The conclusions drawn from this report concerning preclosure operations are as follows:

1. System A appears to demonstrate little difference to the VA reference design other than a slight decrease in temperatures, yet still indicates above boiling drift wall temperatures.

2. System B would maintain the drift wall temperature below the boiling point of water.

3. System C would maintain the drift wall temperature below 61°C.

CONTENTS

CONTENTS (Continued)

FIGURES

TABLES

ACRONYMS

CDA	Control Design Assumptions
CMS	Cubic Meters per Second
CRWMS M&O	Civilian Radioactive Waste Management System Management and Operating Contractor
CSCI	Computer Software Configuration Item
DA	Design Alternative
DBE	Design Basis Event
DF	Design Feature
DOE	Department of Energy
EDA	Enhanced Design Alternative
LA	License Application
LADS	License Application Design Selection
MGR	Mined Geologic Repository
MTU	Metric Tons of Uranium
PA	Performance Assessment
QARD	Quality Assurance Requirement Document
TBM	Tunnel Boring Machine
TBV	To Be Verified
TBD	To Be Determined
VA	Viability Assessment

1. OBJECTIVE AND SCOPE

The purpose and objective of this document is to support License Application Design Selection (LADS). Continuous preclosure ventilation will be evaluated for thermal management and emplacement drift environment. Long term performance evaluation of the VA reference design against evaluation criteria, provided by the LADS team will be completed (CRWMS M&O 1998g).

The scope of this document is to:

- Provide cost estimates for the support of three continuous preclosure ventilation system airflow rates in the emplacement drifts at 1.0 m^3/s, 5 m^3/s and 10 m^3/s.

- Assess the postclosure performance of the repository with a preclosure ventilation rate of 10 m^3/s per emplacement drift.

The three continuous preclosure ventilation systems are based on an emplacement layout designed for an areal mass loading of 85 MTU/acre for commercial spent nuclear fuel and a 100 year preclosure period (Section 4.2.16). The difference in each system is the quantity of airflow in the emplacement drifts: 1.0 m^3/s for System A, 5.0 m^3/s for System B, and 10.0 m^3/s for System C. The description of the systems will include the following topics:

- An assessment of the impact to long term performance for the 10.0 m^3/s system as a conservative bounding limit.

- An estimate of the total repository airflow quantity required.

- A concept of the arrangement and number of intake and exhaust shafts, exhaust drifts, access drifts, and other pertinent systems and features as well as the facilities to support the extra excavation. Surface roads related to the new excavation will not be included, because they are insignificant in terms of the overall design and cost of each system.

- An estimate of the difference in construction and operating costs between the VA reference design and each of the continuous preclosure ventilation systems.

- An evaluation of the systems against a set of criteria provided by the LADS group (CRWMS M&O 1998g).

2. QUALITY ASSURANCE

This activity has been evaluated in accordance with QAP-2-0, *Conduct of Activities*, and has been determined to be quality affecting (CRWMS M&O 1998a); therefore it is subject to the requirements of the *Quality Assurance Requirements and Description* (QARD) (DOE 1998a). The quality assurance controls for this document will be documented in accordance with NLP-3-18, *Documentation of QA Controls on Drawings, Specifications, Design Analyses, and Technical Documents*. This document was prepared in accordance with QAP-3-5, *Development of Technical Documents* and the *Technical Document Preparation Plan* (CRWMS M&O 1999f).

Any applicable permanent items will be classified in accordance with the CRWMS M&O (1999h) document, *Classification of the Preliminary MGDS Repository Design*, which was completed in accordance with QAP-2-3, *Classification of Permanent Items*.

The activity is not a site characterization field activity; therefore, NLP-2-0, *Determination of Importance Evaluations*, is not applicable.

Computer software to be used in the *Design Feature Evaluation 7: Continuous Preclosure Ventilation* document will be documented in accordance with Attachment II of QAP-3-5, *Development of Technical Documents*.

3. BACKGROUND

Continuous preclosure ventilation has been evaluated in previous studies. Some of these studies discussed continuous preclosure ventilation and estimated the air temperature and the drift wall temperatures. Other studies considered the amount of moisture removed from the rock by the ventilation system.

Following is a list of documents, including a brief summary of their contents. (Because the summaries include the entire documents, page numbers in the references are not specified).

Emplacement Drift Air Control System (CRWMS M&O 1997b)

This study describes the air control systems used to control the airflow specifically in the emplacement drifts. The reasoning is established for the VA reference design preclosure air volume of 0.1 m^3/s per emplacement drift and also describes the ventilation tube which carries exhaust from the drift to the shaft.

Overall Development and Emplacement Ventilation Systems (CRWMS M&O 1997c)

This analysis describes the ventilation system for emplacement and development. The description is applicable to the VA reference design. The general ventilation plan outlines engineering parameters specific to the VA reference design

Repository Thermal Loading Management Analysis (CRWMS M&O 1997e)

This analysis describes the selection of thermal loading value for the VA reference design and develops a plan for emplacement to meet the thermal goals in keeping with the repository design. The study also discusses emplacement strategies, waste emplacement schedule, drift spacing, and length. Models used in this analysis considered two heat transfer modes (thermal radiation and conduction heat). Moisture was not considered.

Heating and Cooling Scoping Analysis Report (CRWMS M&O 1995a)

This report evaluates repository heating/cooling and the potential impact on the repository subsystem that may arise. The analysis discusses emplacement drift and waste package spacing. In addition it covers three levels of continuous emplacement drift ventilation (0, 2, and 10 m^3/s per drift). The effects of water vapor on drift temperature are discussed (see pp. 86 through 101).

Repository Subsurface Ventilation Scoping Evaluation Report (CRWMS M&O 1995b)

This report focuses on various airflow quantity and distribution evaluations during various stages of construction and operation of the repository. The effect of moisture is not considered in the development of unit ventilation quantities. Evaluation is made of alternative subsurface ventilation scenarios including configuration of fans, air regulators, and other control devices.

Repository Subsurface Waste Emplacement and Thermal Management Strategy (CRWMS M&O 1998c).

The document discusses the emplacement drift environment and surrounding rock conditions in terms of temperature only. Moisture effects were not included. Because evaporation of water from the walls of the emplacement drifts would lower the air temperature this document is conservative in its temperature estimates. The data from the document is presented at 100 years and 300 years after emplacement.

4. INPUTS

Since this document is conceptual in nature and will not be used for construction, procurement, or fabrication, most of the to be verified (TBVs) will only be identified and not be assigned tracking numbers. TBVs that already have an assigned number will show the tracking number for completeness but will not be registered as an update to the individual TBV.

4.1 DESIGN INPUTS

This section documents those inputs that are used in the document.

4.1.1 Emplacement Drift Environment and Surrounding Rock Conditions

The ventilation system for the Exploratory Studies Facility currently removes significant quantities of water from the host rock. The drying front has extended several meters into the rock, and the effects of the drying is felt, to some degree, tens of meters away from the drift already. Ventilation during the operational phase of the repository would remove considerable water from the system, as well as reduce temperatures (TBV) (CRWMS M&O 1998e, p.2) (Used in Section 8.1, 9.1 and 10.1).

4.1.2 Performance Assessment

Based on input, the stochastic simulation code WAPDEG (waste package degradation) is used to generate waste package failure profiles. WAPDEG inputs include time varying histories of the temperature and relative humidity at the waste package surface, various temperature and relative humidity thresholds for corrosion initiation, corrosion models, and corrosion model parameter distributions. A waste package may fail either through localized corrosion processes (pitting or crevice corrosion), leading to pinhole perforations, or through general corrosion processes leading to much larger patch perforations (CRWMS M&O 1999a, p.4)

Since there is a strong correlation between fraction of waste packages failed, as a function of time and dose as a function of time, there is no need to run the Total System Performance Assessment Repository Integrated Probabilistic (RIP) Simulator calculations as there is not likely to be any noticeable difference from the Total System Performance Assessment-VA base case dose rates (CRWMS M&O 1999d).(TBV) (Used in Section 10.2 and Appendix K).

4.1.3 VA Reference Design Layout

The VA reference design layout is described in Section 7.1 of the *Repository Subsurface Layout Configuration Analysis* (CRWMS M&O 1997d, p.33). Figure 1 shows the VA reference design layout (TBV) (Used in Sections 8.4, 9.4, and 10.4.).

4.1.4 VA Reference Design Continuous Ventilation Airflow

The VA reference design had a continuous ventilation airflow quantity of 0.1 m^3/s for each emplacement drift as is discussed in the Emplacement Drift Air Control System (CRWMS M&O 1997b, p. 44) (TBV) (Used in Section 7 and 8.1).

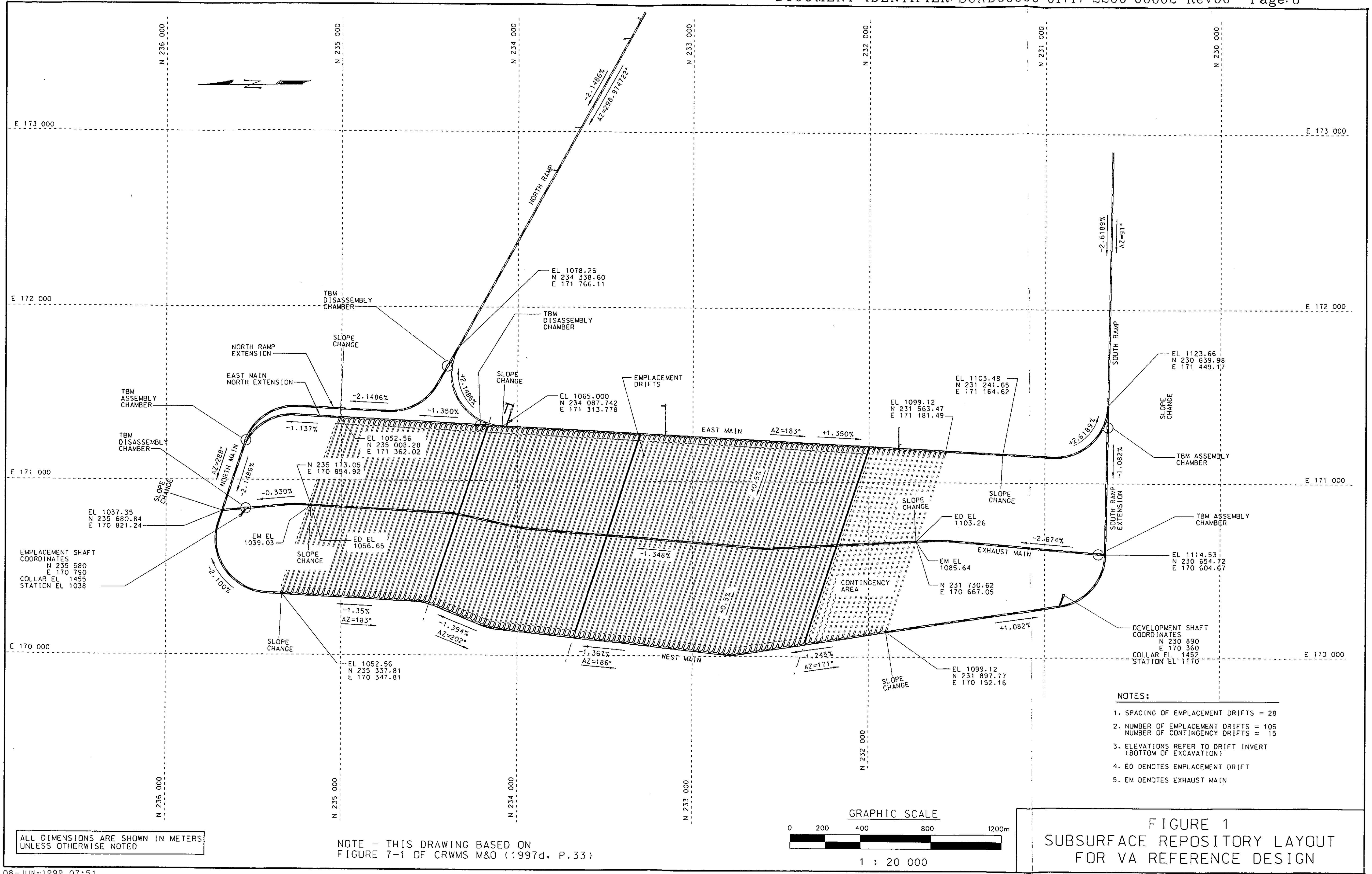


FIGURE 1
SUBSURFACE REPOSITORY LAYOUT FOR VA REFERENCE DESIGN

4.1.5 VA Reference Design Drift Wall Temperatures

The VA document discusses the drift wall temperature being above 150°C at 20 years after emplacement (DOE 1998b, p. 5-32), and how moisture and gases could have an effect on the temperature, however, the effect of moisture and gases on the temperature were not included in VA thermal analyses (TBV) (Used in Section 7 and 8.1).

4.1.6 Emplacement Drift Wall and Air Temperatures

A study of thermal conditions in the emplacement drifts was included in *Repository Subsurface Waste Emplacement and Thermal Management Strategy* and this analysis used 600 meters as the length of an emplacement drift split (half total length of emplacement drift) (CRWMS M&O 1998c, page I-42). For System A, the peak air temperature is 127.83°C and drift wall temperature is 143.85°C and occurs at year 30 (CRWMS M&O 1998c, p. I-42). At year 100, the time of closure, the air temperature is 105.37°C and the drift wall temperature is 120.32°C (CRWMS M&O 1998c, p. I-42) (TBV) (Used in Section 8.1). For System B, the peak air temperature is 66.08°C occurs at year 20 and the peak drift wall temperature is 80.88°C and occurs at year 10 (CRWMS M&O 1998c, p. I-70). At year 100, the time of closure, the air temperature is 45.76°C and the drift wall temperature is 53.57°C (CRWMS M&O 1998c, p. I-70) (TBV) (Used in Section 9.1). For System C, the peak air temperature is 49.20°C occurs at year 10 and the peak drift wall temperature is 60.89°C and occurs at year 10 (CRWMS M&O 1998c, p. I-84). At year 100, the time of closure, the air temperature is 35.40°C and the drift wall temperature is 40.23°C (CRWMS M&O 1998c, p. I-84) (TBV) (Used in Section 10.1).

4.1.7 Fan Efficiency

Fan efficiency is 75 percent (CRWMS M&O 1997c, page I-8) (TBV) (Used in Sections 8.3, 9.3 and 10.3 and in Appendices C, E, and G).

4.1.8 VA Reference Design Shaft Collar Elevations

The Emplacement Shaft and Development Shaft collar elevations in the VA reference design are 1,455 meters and 1,452 meters respectively (CRWMS M&O 1997d, page 33) (TBV) (Used in Section 8.4, 9.4 and 10.4).

4.1.9 Conceptual Layouts

Subsurface Repository Slopes (CRWMS M&O 1997f, pages 21 thru 30) outlining the VA reference design is utilized in the development of Figures H-4, H-5, and H-6 as input data to Vulcan version 3.3 (TBV) (CRWMS M&O 1999b). A list of reference points used for the start of new development headings are outlined in Appendix H, p. H-8.

4.1.10 Primary Fans used in VNETPC Model

A brief explanation and selected fan curves are shown in Appendix A for VNETPC input.

4.2 ASSUMPTIONS

This section contains the assumptions used in the document.

All assumptions listed are used solely for this conceptual study and may be considered as accepted data, existing data and TBV where noted. No assumptions used will require further validation as assumptions utilized are conceptual for this evaluation. Any values derived from this study will not be used to support construction, fabrication or procurement.

4.2.1 Airway Resistances (TBV) (Used in Appendices A, C, D, E, F, and G).

Table 1. Airway Resistance, Effective Area, and Perimeter

Description of Repository Airway	Applicability	Airway Resistance K-Factor		Airway Effective Area (d)		Radius or Dimension (e)		Calc. Perim. (P)	
		kg/m^3	$lbmin^2/ft^4 \times 10^{-10}$	m^2	ft^2	m	ft	m	ft
Waste Ramp	N. Ramp & N. Ramp Ext	0.0056(a)	30	36.17	389.33	r=3.51	11.52	22.05	72.36
Tuff Ramp	S. Ramp & S. Ramp Ext	0.0111(a)	60	36.17	389.33	r=3.51	11.52	22.05	72.36
Service Main Drifts	Perimeter Mains	0.0130(a)	70	36.17	389.33	r=3.51	11.52	22.05	72.36
Exhaust Main	Ex. Mains	0.0111(a)	60	37.30	401.49	r=3.51	11.52	22.05	72.36
Service Drift	PC Main/Drift	0.0130(a)	70	19.63	211.30	r=2.55	8.37	16.02	52.57
Service Drift	ECRB	0.0130(a)	70	16.50	177.60	r=2.35	7.71	14.76	48.44
Emplacement Drift (Typ)	Emplacement Drifts	0.0158(a)	85	15.62	168.13	r=2.55	8.37	16.02	52.57
Service Drift	Cross-block Drift	0.0130(a)	70	19.63	211.30	r=2.55	8.37	16.02	52.57
Service Drift	Stand-by Drift	0.0130(a)	70	18.76	201.93	r=2.55	8.37	16.02	52.57
Emplacement Raise	Vert. Raise Connector	0.0037	20 (b)	2.27	24.43	r=0.85	2.79	5.34	17.52
Service/Vent Raise	Vert. Raise Connector	0.0037	20 (b)	2.27	24.43	r=0.85	2.79	5.34	17.52
Horizontal Raise	Horz. Raise Connector	0.0037	20 (b)	2.27	24.43	r=0.85	2.79	5.34	17.52
Shaft 6.9m LADS-EDA	Emplacement Vent Shaft	0.0046	25 (c)	37.39(f)	402.49(f)	r=3.45(f)	11.32	21.67	71.12
Dev. Shaft 6.9 m LADS-EDA	Dev. Man and Matl Shaft	0.0176(a)	95	37.39(f)	402.49(f)	r=3.45(f)	11.32	21.67	71.12
Access Drift LADS-EDA	Connecting Drift	0.0046	25 (c)	41.48(g)	446.52(g)	w=7.4(g) h=2.7(g) r=3.7(g)	w=24.28(g h=8.86(g) r=12.14(g)	24.42	80.13
Shaft 9.9m LADS-EDA	Intake/Exh. Shaft	0.0046	25 (c)	76.98	828.57(f)	r=4.95(f)	16.24(f)	31.10	102.04
In./Exh. Rse LADS-EDA	Exh. Main to Connector	0.0046	25 (c)	36.17	389.33(f)	r=3.51	11.52(h)	22.05	72.36

Notes:

a) From *Controlled Design Assumptions Document* (CRWMS M&O 1998f, p. 7-16).

b) From Hartman et al (1997, p. 155) for maximum straight, smooth lined, clean airway.

c) From Hartman et al (1997, p. 155) for maximum straight, smooth lined, slightly obstructed airway.

d) Effective areas from *Calculation of Effective Areas of Subsurface Openings During Emplacement Mode* (CRWMS M&O 1999i, p. 50) except LADS-EDA items.

e) Radius or Dimension from (CRWMS M&O 1999i, pp. 27,31,34,37,43,46, and 47) except LADS-EDA items.

f) Assumption for LADS-EDA items is based on engineering judgement and is consistent with airways sized to handle the projected system requirements. Area = πr^2, Perimeter = $2\pi r$

g) The connector drift is 7m high x 8m wide (lined 6.4 m x 7.4 m) and is sized to ensure it does not restrict the airflow from the shaft. Area = 7.4 m x 2.7 m + 1/2 π $(3.7\ m)^2$ = 41.48 m, Perimeter = 7.4 m + 2.7 m + 2.7 m + 1/2 (2π x 3.7m) = 24.42 m = 80.13 ft

h) Nodes between the Exhaust Main and connector have three different sizes of airway (7.62 m dia, 7.5 m dia. and 7 m x 8 m). For VNETPC inputs the area and perimeter is assumed to be based on a 7.62 m dia. for simplication.

Conversion Factors From Hartman et al (1997, p. 680)

1 kg/m^3 = 0.5391 x 10^{-6} $lb.min^2/ft^4$ 1 m = 3.281 ft 1 m^2 = 10.764 ft^2

4.2.2 Location, elevation and pad size (260 m x 130 m) for shaft collars for each System A, B, and C are shown in Figures 2, 3, and 4 respectively. The coordinates and collar elevations are approximate locations where pads can be built based on a reasonably flat topography (CRWMS M&O 1997a, p.22) (TBV) (Used in Sections 8.4, 9.4, 10.4 and Appendix H).

4.2.3 For ventilation simulation, the emplacement drifts were grouped and represented by single branches. This simplifying assumption has no effect on the simulations because they represent parallel ventilation splits that produce very little resistance in the overall ventilation system. All horizontal node to node lengths can be determined from figures included in Appendix H. Vertical node to node lengths are calculated as shown in Appendix H (TBV) (Used in appendices B, D, and F).

4.2.4 All Alcoves for the large raises are 8 meters wide by 7 meters high by 10 meters long to accommodate the raise bore equipment and allow the raises to be pulled without blocking the mains (TBV) (Used in Section 8.4, 9.4, 10.4 and Appendix H).

4.2.5 An additional margin of 18 percent for heat expansion, flexibility and some contingency has been allowed for total exhaust airflow volume (TBV) (Used in Appendix A, p. A-3).

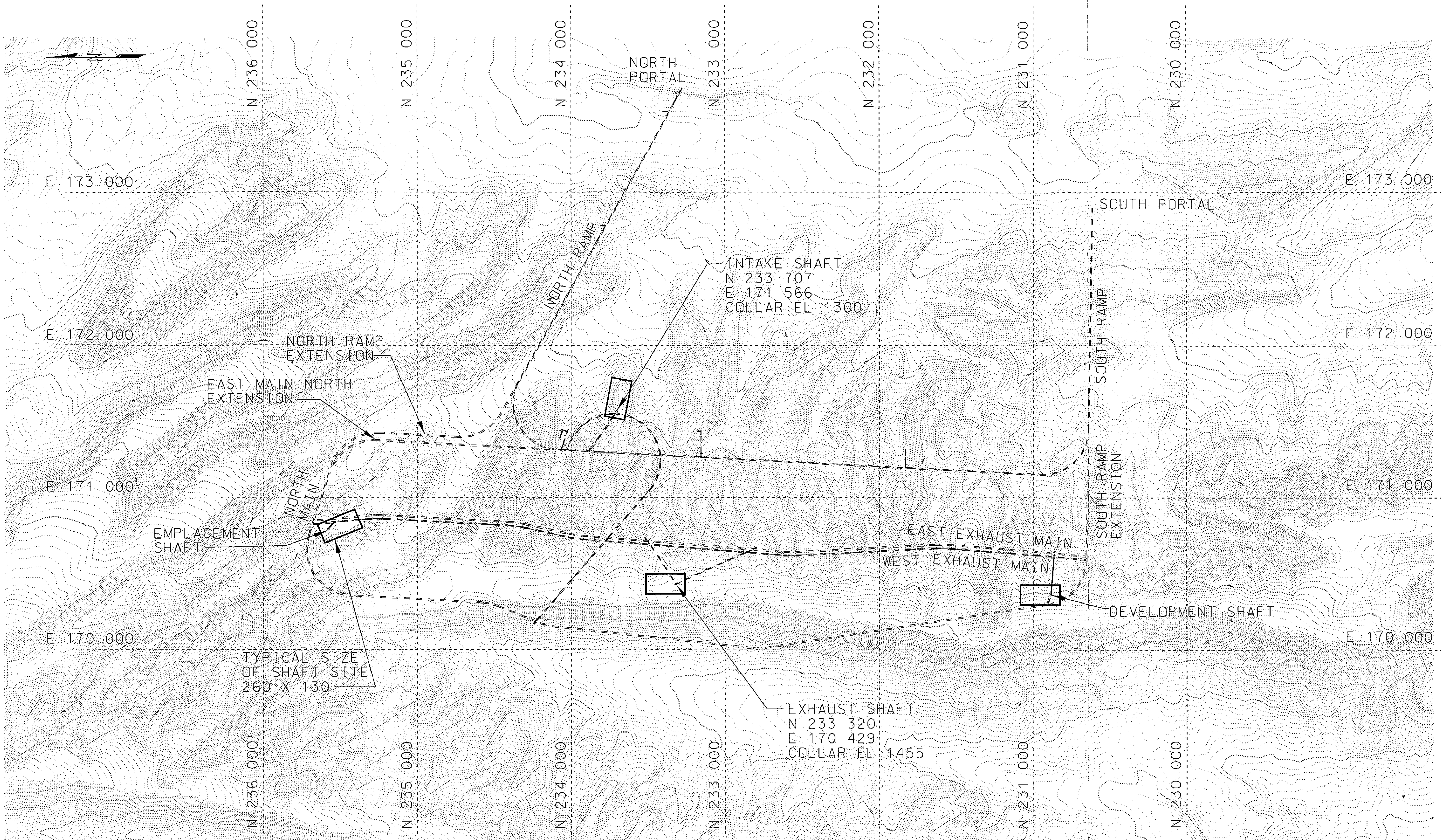
4.2.6 The emplacement raises in the VNETPC (computer software, see Section 11) circuit represents a group of group of raises. The actual length of the raise for the circuit will be the average length of the raises from the block shown in CRWMS M&O (1997f p. 25) (TBV) (Used in Appendix H).

4.2.7 From CRWMS M&O (1997g p. 42) the Performance Confirmation (PC) drifts are to be located a maximum of 20 m above the Emplacement drifts for construction considerations. This is the approximate location of the Enhanced Characterization of the Repository Block (ECRB). To be conservative it is assumed there is a 20 m pillar between the ECRB/PC drifts and the emplacement level. The length for the raises from the mains to the ECRB/PC drifts will be added to the overall length of the drifts to simplify the circuit (TBV) (Used in Appendix H).

4.2.8 The nodes are located at the midpoint of the drift between the crown and invert. All distances are measured from node to node to allow the ventilation circuits to be closed (TBV) (Used in Appendix H).

4.2.9 Dimension of the Drifts (TBV) (Used in Appendix H) are:

ECRB - 5.0 m Dia. (CRWMS M&O 1998h, p. 12)
Emplacement Drifts - 5.5 m Dia. (CRWMS M&O 1997d, p. 73)
Exhaust Mains - 7.62 m Dia. (CRWMS M&O 1997d, p. 62)
Exhaust Connecting Drifts - 7 m H x 8 m W (same as Alcoves) (Section 4.2.4)
PC Drifts - 5.5 m Dia. (CRWMS M&O 1997d, p. 96)
Intake Connectors with TBM 7.62 m (same as Exhaust Mains)



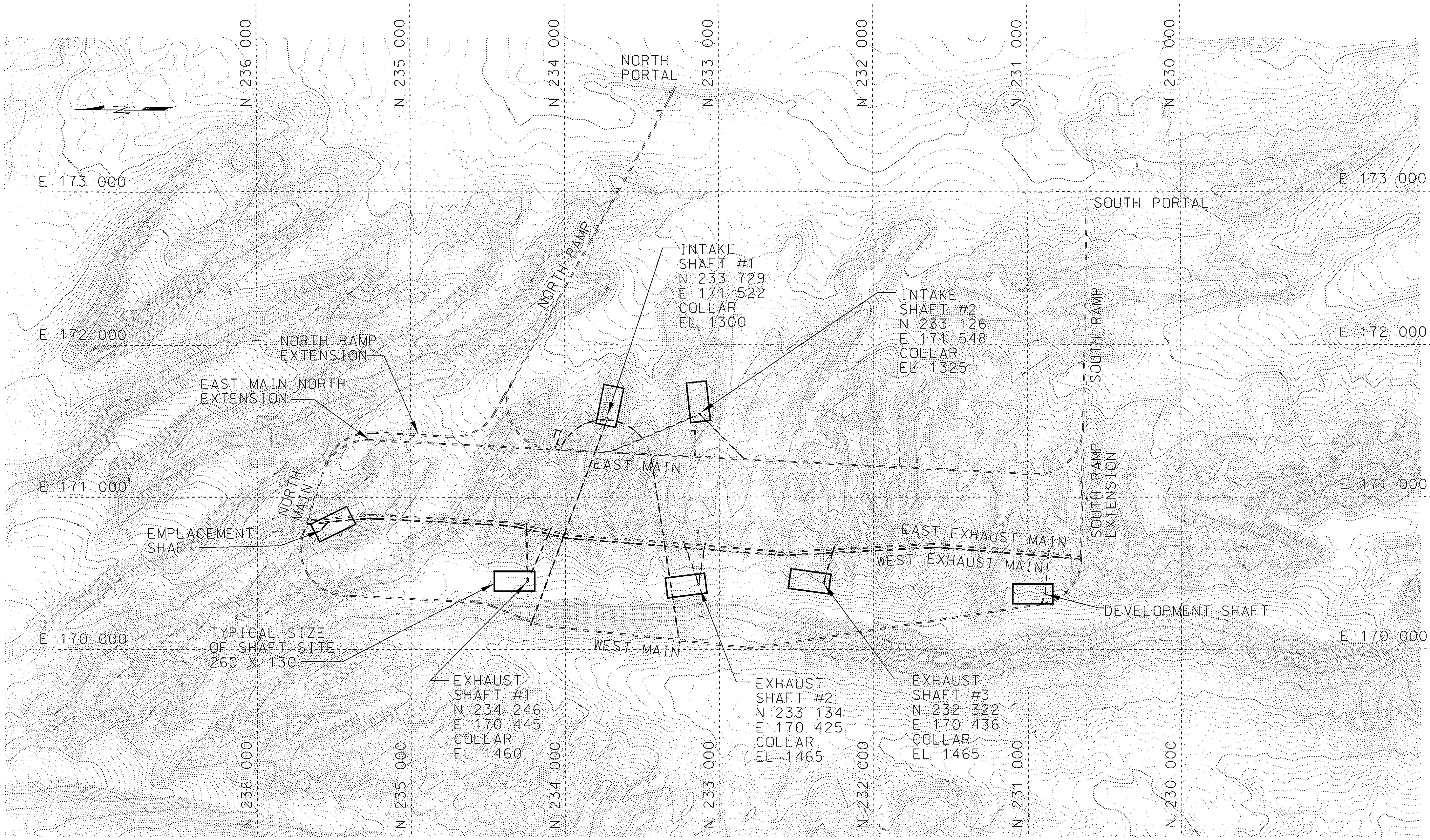
SCALE : NOT TO SCALE

ALL DIMENSIONS ARE SHOWN IN METERS
UNLESS OTHERWISE NOTED

FIGURE 2
SURFACE SHAFT LOCATIONS
FOR SYSTEM A - 1.0 m^3/S

08-JUN-1999 07:53

CAD FILE: t:\repss\fa\fig\ssfa0130a.fig



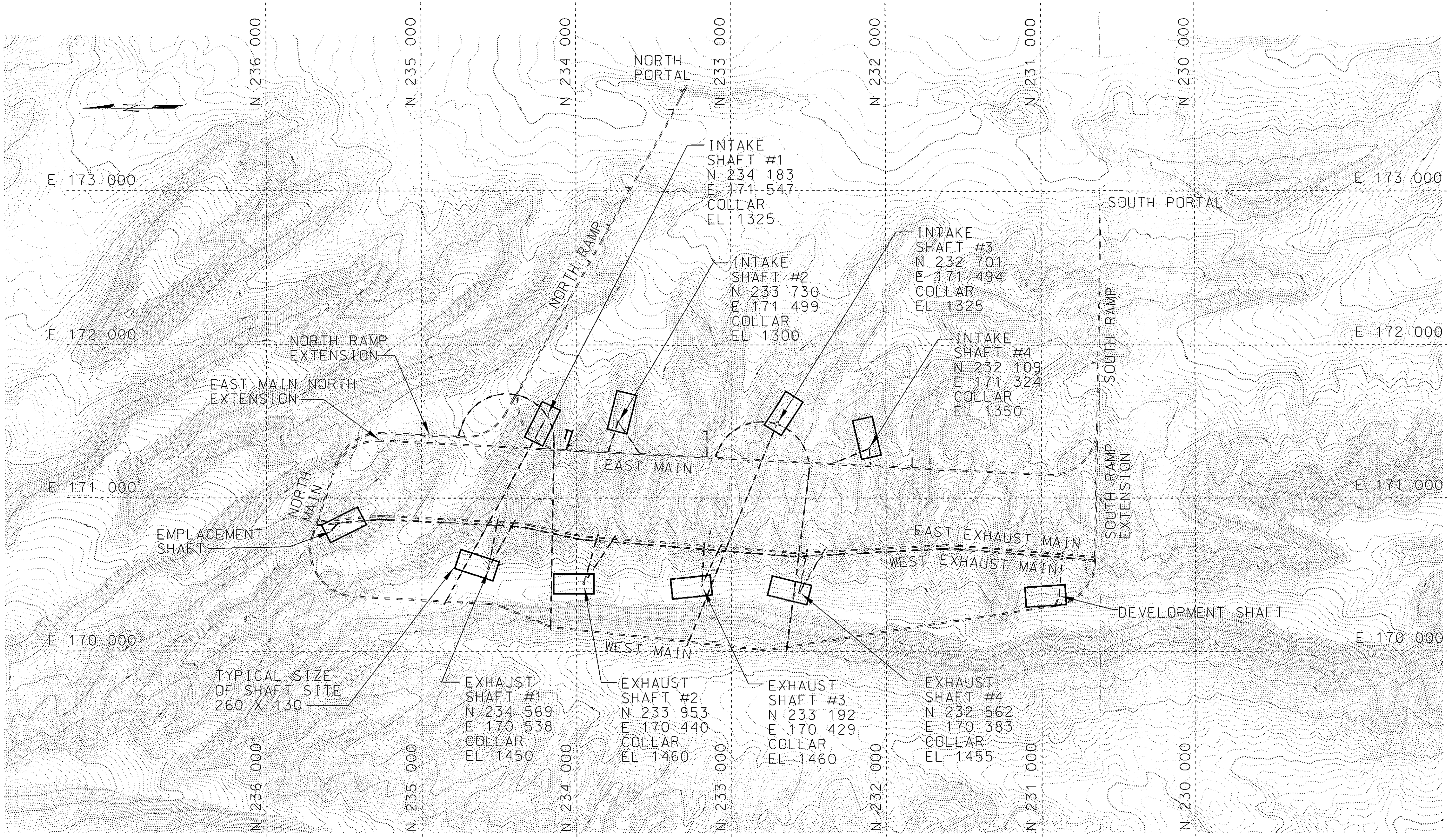
SCALE : NOT TO SCALE

ALL DIMENSIONS ARE SHOWN IN METERS
UNLESS OTHERWISE NOTED

FIGURE 3
SURFACE SHAFT LOCATIONS
FOR SYSTEM B - 5.0 m^3/S

08-JUN-1999 07:55

CAD FILE: t:\repss\fa\fig\ssfa0130b.fig



SCALE : NOT TO SCALE

ALL DIMENSIONS ARE SHOWN IN METERS
UNLESS OTHERWISE NOTED

FIGURE 4
SURFACE SHAFT LOCATIONS
FOR SYSTEM C – 10.0 m^3/S

4.2.10 Drifts crossing underneath one another will have a minimum pillar of 10 m similar to the pillar between the emplacement drifts and the exhaust main (TBV) (Used in Appendix H).

4.2.11 A minimum pillar of 3 diameters (center to center) will be maintained between the exhaust mains for ground stability (TBV) (Used in Appendix H).

4.2.12 The main intake and exhaust raises are located in the center of the alcoves to take into account any deviation of the pilot hole (TBV) (Used in Appendix H).

4.2.13 Minimum radius of TBM drifts set at 305m.(TBV) (Used in Figures H-4, H-5 and H-6, Appendix H).

4.2.14 Maximum allowable air velocity in:

Ramps:	7.6 m/s
Ventilation Shaft:	20.3 m/s
Exhaust Main:	10.2 m/s

(CRWMS M&O 1998f, DCSS 016, p.7-10)

For this report it is assumed that the air velocities for the shafts will be the same as for the exhaust main. Shafts located in the center of the footprint will be designed to accommodate twice the airflow in the main (potential airflow from both directions).

Typical Shaft liner = 0.3 m (CRWMS M&O 1997d, p.57)

Effective area of exhaust main 37.30 m^2 (CRWMS M&O 1999i, p. 32)

Maximum airflow in exhaust main = 37.30 m^2 x 10.2 m/s = 380.46 m^3/s

Maximum airflow in shaft fed by two exhaust mains = 380.46 m^3/s x 2 = 760.92 m^3/s
Min. area required for shaft fed by two exhaust mains = 760.92 m^3/s / 10.2 m/s = 74.6 m^2
Min. radius for shaft fed by two exhaust mains = $(74.6\ m^2 / \pi)^{1/2}$ = 4.87 m
Min. excavated shaft diameter = 4.87 m x 2 + 0.3 m (liner) x 2 = 10.35 m
Shaft sized conservatively to 10.5 m excavated (9.9 m lined)

Min. area required in shaft/raise fed by one exhaust main = Effective area of exhaust main
Min. radius for shaft/raise fed by one exhaust main = $(37.3\ m^2 / \pi)^{1/2}$ = 3.45 m
Min. excavated shaft/raise diameter = 3.45 m x 2 + 0.3 m (liner) x 2 = 7.49 m
Shaft/raise sized conservatively to 7.5 m excavated (6.9 m lined)
(TBV) (Used throughout the analysis)

4.2.15 Intake shaft bottoms accessed by TBM are located 10 meters to 15 meters below the elevation of the access start to maintain the 10 meter pillar and grade constraints (TBV) (Used in Section 8.4, 9.4, 10.4 and Appendix H).

4.2.16 The repository will be designed for a retrievability period of up to 100 years (CRWMS M&O 1998f, Key 016) after initiation of emplacement. The three continuous preclosure ventilation systems are based on an emplacement layout designed for an areal mass loading of 85 MTU/acre for commercial spent nuclear fuel (CRWMS M&O 1997e, p. 53) (TBV) (Used in Section 1, 8.1).

4.2.17 Equivalent length used to account for Head losses due to joints, minor misalignment and obstructions is +10 percent of the total drift length. These are general practice equivalents used for computer simulation (Hartman et al 1997, p.160) (TBV) (Used in Appendices B, D, and F).

4.2.18 The Exhaust Shaft, Development Shaft and the Emplacement Shaft will be drilled and blasted, since bottom access to the shaft is not initially available (TBV) (Used in Section 8.4, 9.4, 10.4).

4.2.19 Power cost is preliminarily estimated at 10 cents per kilowatt-hour (CRWMS M&O 1997c, p. I-8). This input to the VNETPC is used to estimate and to compare the cost of flow in individual airways. Any future change of this cost will not have any significant effect on the outcome of this ventilation analysis (TBV) (Used in VNETPC input, Appendices C, E & G).

4.2.20 Regulator-Door Equivalent Resistance for VNETPC Input

To control the desired airflow distribution in various locations of the subsurface network, the VNETPC ventilation simulation requires resistance input representing doors, barriers, valves/dampers, bulkheads, and other field installed regulating devices. The equivalent resistance input of regulators may vary over a wide range of values depending upon the airflow desired. The field-installed regulators (indicated by RPUb column in Appendices B, D, and F) are used to control and regulate specific airflow in a branch over a certain period and these values are as follows:

Airlock doors	1000 units
Emplacement door regulators (range)	0.0001 to 500 units
Gate valve regulators (range)	0.0001 to 99,000 units
Development /Emplacement Barrier, each	1000 units
Total fan bulkhead (two branches in series @1000 ea.)	2000 units
Fan installation (inlet/outlet adapters + air velocity) range	0.0001 to 0.005 units

A unit is defined as an airway resistance assigned to a regulator converted into VNET PC input as shown in the RPUb column in Appendices B, D, and F.

The assumed values are appropriate and reasonable for repository ventilation design (TBV).

4.2.21 The start of the intake declines have been selected so that the TBM drift intersects with the outside of the shaft. (TBV) (Used in Figures H-4, H-5, and H-6, Appendix H).

4.3 CRITERIA

4.3.1 Maximum grade is ± 3 percent for excavation (CRWMS M&O 1998d, p. 12). (Used in Section 8.4, 9.4, 10.4)

5. REFERENCES

CRWMS M&O 1995a. *Heating and Cooling Scoping Analysis Report.* BC0000000-01717-5705-00007 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19970606.0153.

CRWMS M&O 1995b. *Repository Subsurface Ventilation Scoping Evaluation Report.* BCAD00000-01717-5705-00001 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19960321.0056.

CRWMS M&O 1997a. *Determination of Available Volume for Repository Siting.* BCA000000-01717-0200-00007 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19971009.0699.

CRWMS M&O 1997b. *Emplacement Drift Air Control System.* BCAD00000-01717-0200-00005 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980102.0034.

CRWMS M&O 1997c. *Overall Development and Emplacement Ventilation Systems.* BCA000000-01717-0200-00015 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980123.0661.

CRWMS M&O 1997d. *Repository Subsurface Layout Configuration Analysis.* BCA000000-01717-0200-00008 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19971201.0879.

CRWMS M&O 1997e. *Repository Thermal Loading Management Analysis.* B00000000-01717-0200-00135 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19971201.0601.

CRWMS M&O 1997f. *Subsurface Repository Slopes.* BCAA00000-01717-0200-00007 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19971125.0578.

CRWMS M&O 1997g. *Subsurface Repository Performance Confirmation Facilities* BCA000000-01717-0200-00011 REV 00. Las Vegas, Nevada CRWMS M&O. ACC: MOL.19970723.0142.

CRWMS M&O 1998a. *Activity Evaluation, Design Features for LA Design Selection - Subsurface Repository (*FY99 WP# 12012382M1*).* Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19981130.0400.

CRWMS M&O 1998b. Not used.

CRWMS M&O 1998c. *Repository Subsurface Waste Emplacement and Thermal Management Strategy.* B00000000-01717-0200-00173 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980918.0084.

CRWMS M&O 1998d. *Subsurface Facility System Description Document.* BCA000000-01717-1705-00014 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980826.0161.

CRWMS M&O 1998e. *LA Design Selection-Features List.* Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980909.0038.

CRWMS M&O 1998f. *Controlled Design Assumptions Document.* B00000000-01717-4600-00032 REV 05. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980804.0481.

CRWMS M&O 1998g. *Design Input Request for the Repository Design Selection Process* LAD-XX-99018.R. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19981221.0202.

CRWMS M&O 1998h. *East-West Cross Drift Starter Tunnel Layout Analysis.* BABEAF000-01717-0200-00008 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC. MOL.19980216.0530.

CRWMS M&O 1999a. *Design Input Transmittal for WAPDEG Output for DF7 (Continuous Preclosure Ventilation).* SSR-PA-99046.T Las Vegas, Nevada: CRWMS M&O. ACC. MOL.19990305.0380.

CRWMS M&O 1999b. *Layouts for Design Feature 7, Preclosure Ventilation.* . Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990615.0034.

CRWMS M&O 1999c. *Software Qualification Report for VNETPC for Windows, Version 1.0a.* DI: 30029-2003 Rev 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990105.0206.

CRWMS M&O 1999d. *Design Input Transmittal for WAPDEG results for DF 7 (Continuous Pre-closure Ventilation).* SSR-PA-99046.Ta. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990303.0696.

CRWMS M&O 1999e. *Design Input Transmittal for (DF) 07 - Continuous Preclosure Ventilation.* SSR-PPC-99201.T. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990420.0302.

CRWMS M&O 1999f. *Technical Document Preparation Plan (TDPP) For Design Feature #7: Continuous Preclosure Ventilation.* BCAD00000-01717-4600-00001 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990503.0140.

CRWMS M&O 1999g. *Design Input Request for LADS Phase I Confidence Assessments.* LAD-XX-99018.Ra. Las Vegas, Nevada: CRWMS M&O. ACC: MOL. 19990217.0222.

CRWMS M&O 1999h. *Classification of the Preliminary MGDS Repository Design.* B00000000-01717-0200-00134 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19981103.0546.

CRWMS M&O 1999i. *Calculation of Effective Areas of Subsurface Openings During Emplacement Mode.* BCAA00000-01717-0210-00002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990302.0101.

DOE 1998a. *Quality Assurance Requirements and Description.* DOE/RW-0333P REV 08. Office of Civilian Radioactive Waste Management. Washington, D.C. ACC: MOL.19980601.0022.

DOE 1998b. *Viability Assessment of a Repository at Yucca Mountain, Volume 2: Preliminary Design Concept for the Repository and Waste Package.* DOE/RW-0508/V2. North Las Vegas, Nevada: Yucca Mountain Site Characterization Office. ACC: MOL.19981007.0029.

Hartman, H. L.; Mutmansky, J. M.; Ramani, R.V.; and Wang, Y. J. 1997. *Mine Ventilation and Air Conditioning.* Third Edition. New York, New York: John Wiley & Sons, Inc. TIC: 236391.

Joy Mining Machinery 1982. Joy Axivane Fans Mining Catalog J-670, New Philadelphia, Ohio: Joy Mining Machinery. TIC: 244167.

6. INTERFACES

Organizations that may be affected by this document may include, but not be limited to: Repository Subsurface Design, Repository Surface Design, Engineered Barrier System Performance Modeling, PA Operations, Regulatory and Licensing, LADS, Environmental Impact Statement Support, and System Engineering & Integration.

7. VA REFERENCE DESIGN SYSTEM–0.1 m^3/s

The VA reference design has a continuous ventilation airflow quantity of 0.1 m^3/s as is discussed in the *Emplacement Drift Air Control System* (Section 4.1.4). This document discusses the drift wall temperature being above 150°C at 20 years after emplacement (Section 4.1.5). It also discusses how moisture and gases could have an effect on the temperature. However, the effect of moisture and gases on the temperature were not included in VA thermal analyses

8. CONTINUOUS VENTILATION SYSTEM A–1.0 m^3/s

8.1 EMPLACEMENT DRIFT ENVIRONMENT AND SURROUNDING ROCK CONDITIONS IN SYSTEM A

The ventilation system for the Exploratory Studies Facility currently removes significant quantities of water from the host rock. The drying front has extended several meters into the rock, and the effects of the drying is felt, to some degree, tens of meters away from the drift already. Ventilation during the operational phase of the repository would remove considerable water from the system, as well as reduce temperatures (Section 4.1.1).

System A uses the estimated data for the air temperature and drift wall temperature for continuously ventilated emplacement drifts from the *Repository Subsurface Waste Emplacement and Thermal Management Strategy* document (CRWMS M&O 1998c). This report only uses the data up to 100 years since that is currently the preclosure time period (Section 4.2.16).

The point at which the air temperature and drift wall temperature are the highest in the emplacement drift occurs at the end of the emplacement drift where the air exits through the ventilation raises. An analysis conducted by others used 600 meters as the length of an emplacement drift split (Section 4.1.6). For System A, the peak air temperature is 127.83°C and drift wall temperature is 143.85°C which occurs at 30 years (Section 4.1.6). At year 100, the time of closure, the air temperature is 105.37°C and the drift wall temperature is 120.32°C (Section 4.1.6).

The VA reference design has a continuous ventilation airflow quantity of 0.1 m^3/s as is discussed in the *Emplacement Drift Air Control System* (Section 4.1.4). The VA document discusses the drift wall temperature in the emplacement drifts being above 150°C at 20 years after emplacement (Section 4.1.5). It also discusses how moisture and gases could have an effect on the temperature, however, the effect of moisture and gases on the temperature were not included in VA thermal analyses. This information, however, is enough to compare with the results of System A above and show that the increased continuous ventilation airflow quantity from 0.1 m^3/s to 1.0 m^3/s makes a discernable difference in the drift wall temperature. The VA reference design drift wall temperature is above 150°C at 20 years after emplacement, System A would be a slight improvement as it lowers the temperatures below this, however the temperatures are still above boiling (Department of Energy (DOE) 1998b, Section 5.1.3.2, p. 5-32).

8.2 IMPACT TO LONG TERM PERFORMANCE FOR SYSTEM A

No performance assessment was completed for System A since System C is considered the bounding case (CRWMS M&O 1999d).

8.3 VENTILATION REQUIREMENTS FOR SYSTEM A

System A contains three exhaust fans and by the VNETPC output in Appendix C, the total airflow is 843 m^3/s and the total air power is 1,320 kW (1,770 brake horsepower). This is arrived at by summing up the individual requirements for each fan. Dividing by the fan efficiency, which is 75 percent (Section 4.1.7), the ventilation energy requirement for System A is 1760 kW (2,360 brake horsepower). The power requirements stated is calculated for this report to compare costs for the three systems, it will not be used for fan selection, design or procurement.

8.4 LAYOUT CONFIGURATION FOR SYSTEM A

Figure 1 shows the VA reference design layout. In order to accommodate an increased continuous airflow of 1.0 m^3/s in each emplacement drift, additional openings must be excavated and both existing shafts must increase in size. Figure 5 depicts the layout configuration for System A (This layout, as modeled in CRWMS M&O (1999b) is based on the VA reference design and inputs found in Section 4). Figures 6, 7 and 8 clarify the concept. The Emplacement Shaft Access Drift will remain the same as the VA reference design, and connect the West Exhaust Main with the Emplacement Shaft. The Development Shaft Access Drift will remain the same as the VA reference design, and connect the West Main with the Development Shaft to be used for ventilation intake during construction and development of the repository. As in the VA reference design, the Development Shaft will become an exhaust shaft once construction is complete. For that reason, a connecting drift is shown between the West Exhaust Main and the Development Shaft.

This increased airflow quantity (compared to the VA reference design) will require one additional intake shaft and one additional exhaust shaft to be excavated. The Intake Shaft and Exhaust Shaft will both be 10.5 meters excavated diameter (Section 4.2.14). The Emplacement Shaft and Development Shaft will increase in size to 7.5 meters excavated diameter (Section 4.2.14). All shaft pad sites will be 260 meters by 130 meters (Section 4.2.2) for consistency, which is an increase in size from the VA reference design. The Emplacement Shaft and Development Shaft collar elevations will remain the same as the VA reference design at 1,455 meters and 1,452 meters (Section 4.1.8), even though the shaft site area will increase. However, the lengths of the Emplacement Shaft and Development Shaft will increase to accommodate the exhaust connector drifts.

The shafts are located within the repository so they are available according to the emplacement operations schedule needs. The Development Shaft and the Emplacement Shaft will be constructed during the Construction Phase (pre-emplacement) and will be utilized for ventilation during construction of the Perimeter Loop (South Ramp Extension, West Main, North Main, East Main, North Extension, and North Ramp Extension), East and West Exhaust Main, and the first panel of emplacement drifts. The Intake Shaft will be constructed during the second panel of emplacement drift construction once the Intake Main is sufficiently past the shaft to allow excavation activities in the shaft without interruption of the Intake Main construction. The Exhaust Shaft will be constructed during the third panel of emplacement drift construction.

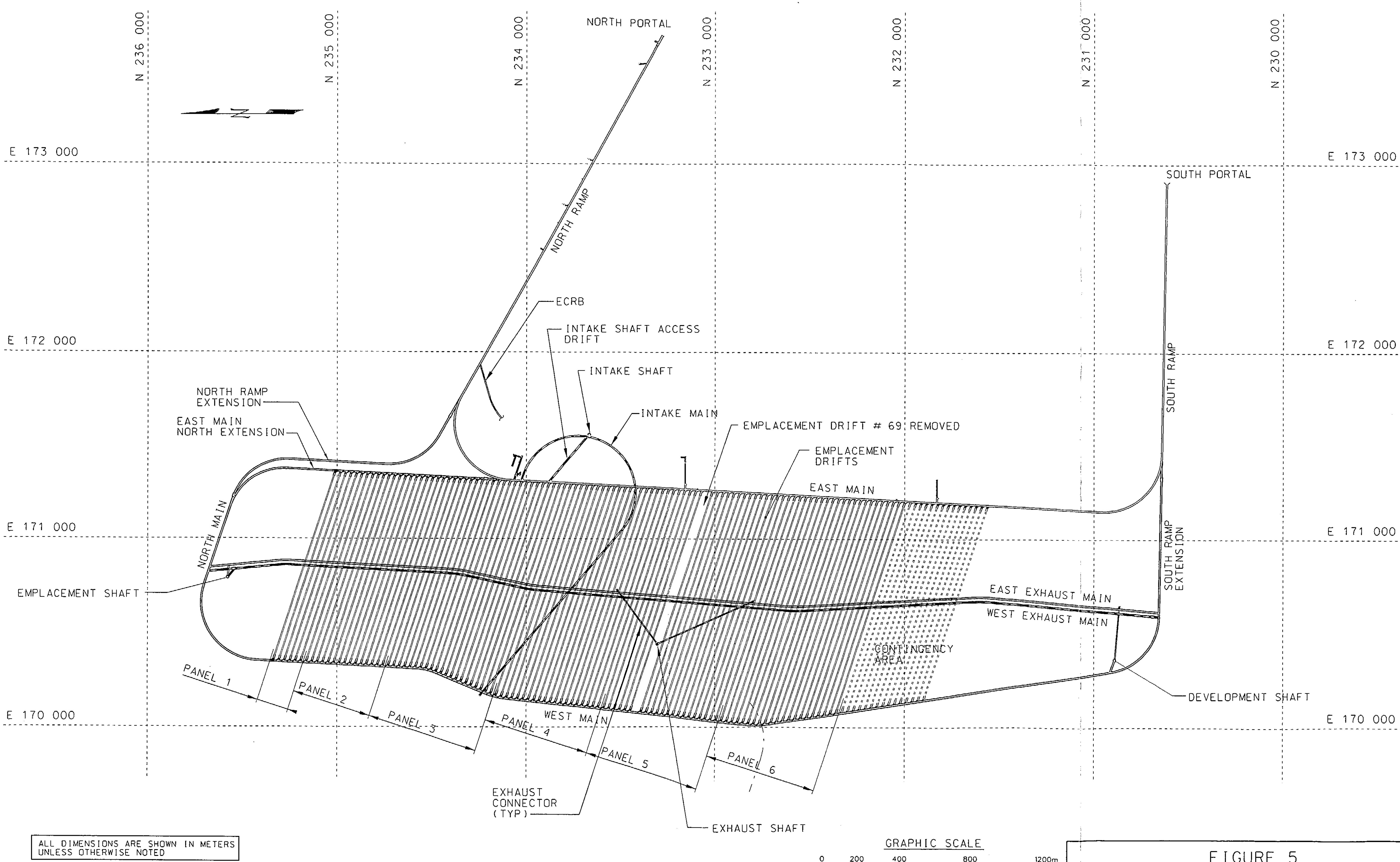


FIGURE 5
VENTILATION SYSTEM A
1.0 m^3/s

08-JUN-1999 09:15

CAD FILE: t:\repss\fa\fig\ssfa0074.fig

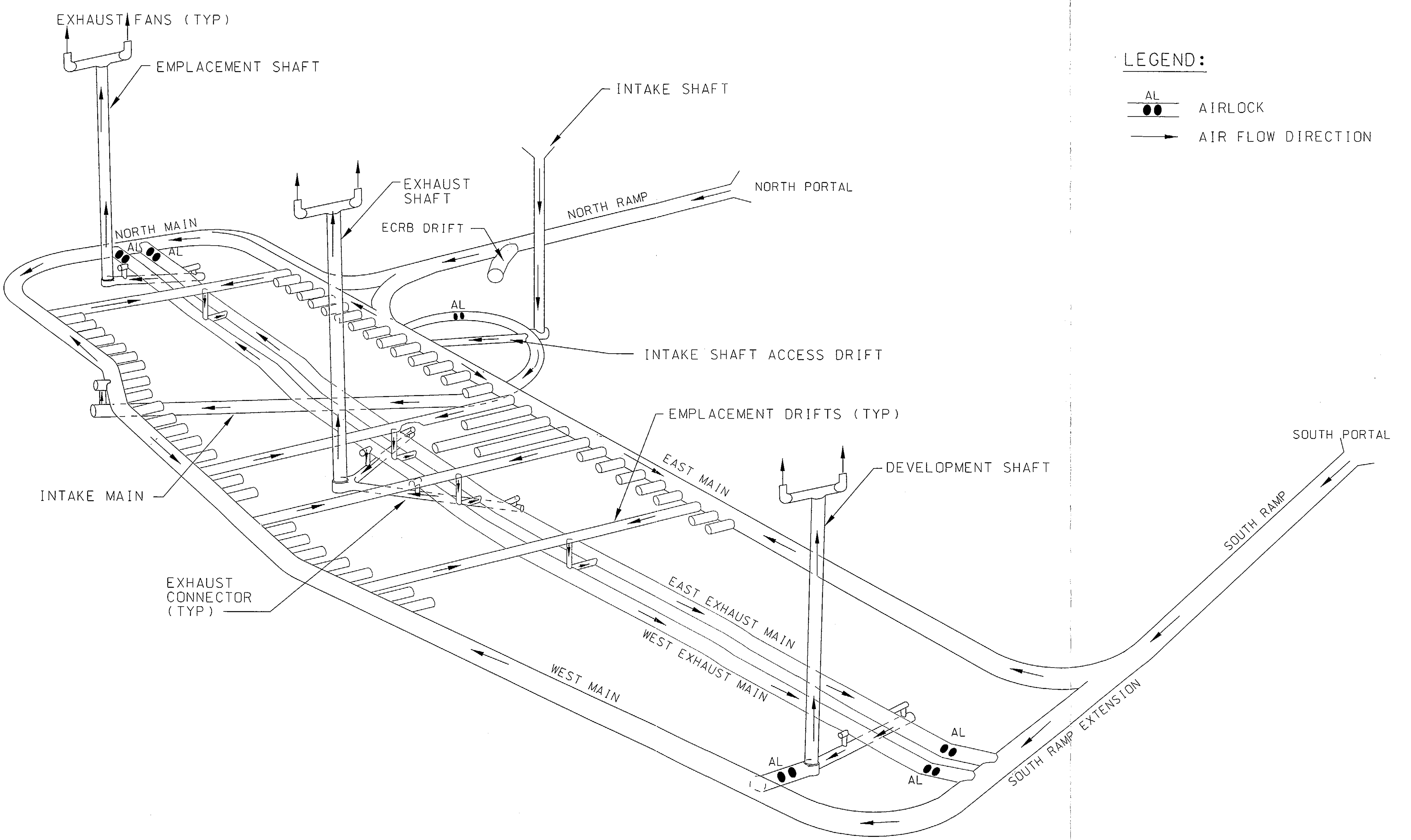


FIGURE 6
VENTILATION PERSPECTIVE
SYSTEM A – 1.0 m³/s

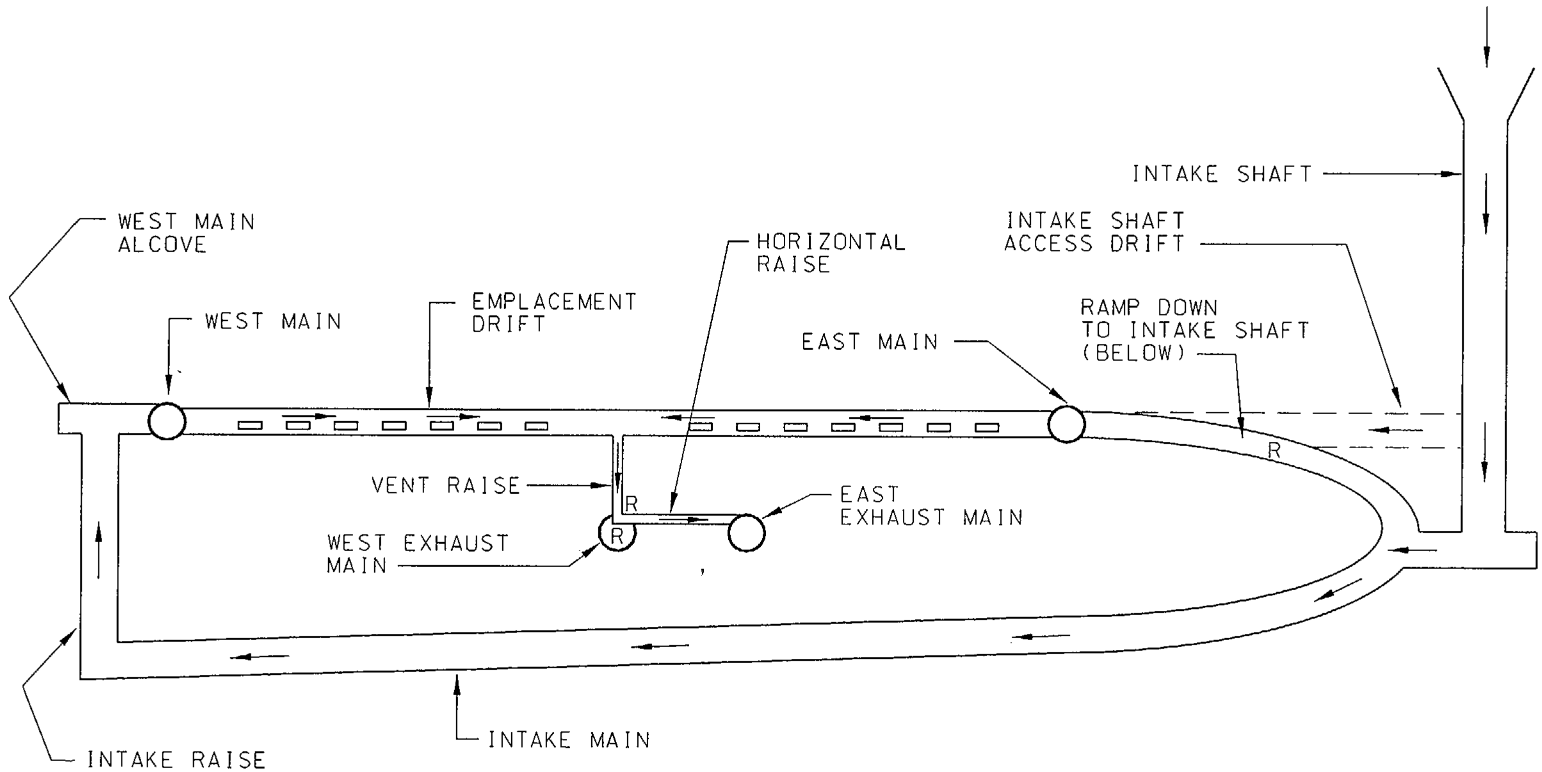
SCALE : NOT TO SCALE

08-JUN-1999 09:17

CAD FILE: f:\repss\fo\fig\ssfo0073.fig

08-JUN-1999 09:19

ALL DIMENSIONS ARE SHOWN IN METERS
UNLESS OTHERWISE NOTED

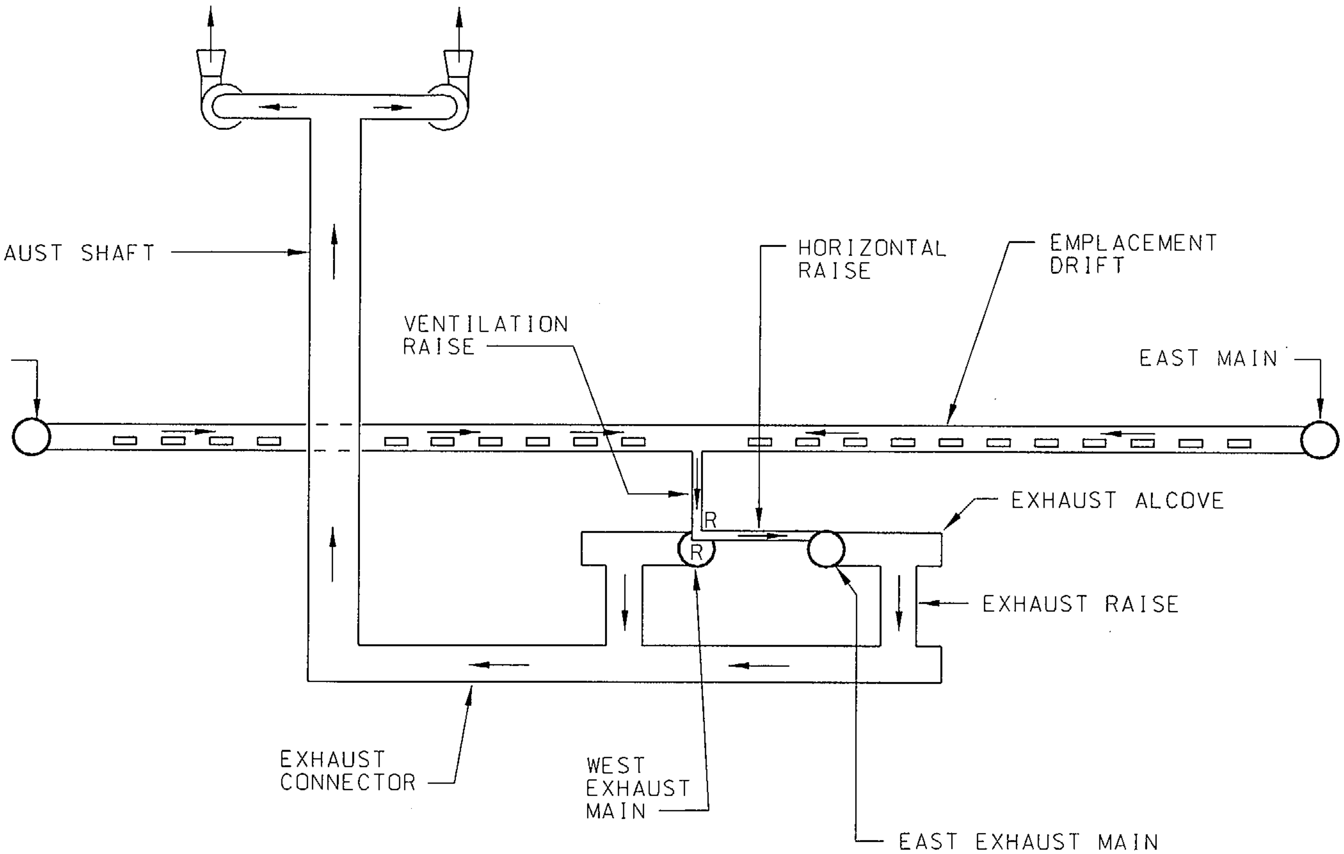


SCALE : NOT TO SCALE

FIGURE 7
CONCEPTUAL INTAKE AIRFLOW
SCHEMATIC SECTION

CAD FILE: t:*repss*fa*fig*ssfa0067.fig

ALL DIMENSIONS ARE SHOWN IN METERS UNLESS OTHERWISE NOTED



SCALE : NOT TO SCALE

FIGURE 8
CONCEPTUAL EXHAUST AIRFLOW SCHEMATIC SECTION

08-JUN-1999 09:21

CAD FILE: t:*repss*fa*fig*ssfa0067.fig

Because the number of flat areas on surface available to locate shafts is limited (Section 4.2.2), the Intake Shaft will be located east of the East Main. The shaft collar will be at elevation 1,300 meters (Section 4.2.2). The Intake Shaft length will correspond with the Intake Main that must be excavated to connect the shaft with the west side of the repository. An access drift will connect the Intake Shaft to the East Main at an elevation higher than the Intake Main. The Intake Shaft Access Drift will be the same size and shape as the emplacement drift turnouts in the VA reference design at 8m wide x 7m high (Section 4.2.4).

The Intake Main will be excavated by a TBM of 7.62 meters diameter. The assembly chamber will be the same size and shape as those for the exhaust mains and will be excavated by a roadheader. The slope of the Intake Main shall not exceed three percent (Section 4.3.1) and a minimum pillar of 10 meters (Section 4.2.15) below the East Exhaust Main shall be maintained. A 7.5 meter excavated diameter (Section 4.2.14) vertical raise will connect the Intake Main to an alcove in the West Main. The Intake Main will not have a disassembly chamber. Once excavation is complete, the TBM will be partially disassembled at the face and backed out of the main to the assembly chamber where it will be completely disassembled and taken to the surface.

The Exhaust Shaft will be located within the repository block where Emplacement Drift 69 (Figure 5) is located. The emplacement drift will be removed and the first drift in the contingency area will replace it. The shaft in this location minimizes the amount of excavation for connection to the exhaust mains. The shaft collar will be at elevation 1,455 meters (Section 4.2.2). The Exhaust Shaft length will correspond to the exhaust connectors that must be excavated to connect the shaft with the two exhaust mains.

The Emplacement Shaft, Development Shaft, and Exhaust Shaft will all be excavated by drill-and-blast methods since bottom access to the shafts is not initially available (Section 4.2.18). However, where access is available to the bottom of the shafts, excavation may be by V-mole methods. There will be four exhaust connectors that must be excavated to connect the exhaust mains to the exhaust shafts. The exhaust connectors will be excavated by a roadheader from the shafts. They will be the same size and shape as the Intake Shaft Access Drift. Exhaust Connector 1 is located at the north end of the repository and connects the East Exhaust Main to the Emplacement Shaft. Exhaust Connectors 2 and 3 are located in the middle of the repository and connect both exhaust mains to the Exhaust Shaft. Exhaust Connector 4 is located at the south end of the repository and connects both exhaust mains to the Development Shaft. Muck from the exhaust connectors will be removed through the shafts similar to the shaft muck. The particular method of muck transportation is out of the scope of this report.

The exhaust connectors are linked to the exhaust mains via a vertical raise. The alcove will be 10 meters in length (Section 4.2.4). A vertical raise will be excavated from the exhaust connector into the alcove. The vertical raise will be 7.5 meters (Section 4.2.14) excavated diameter, the same diameter as the Emplacement and Development Shafts.

The ventilation raises from the emplacement drifts will remain the same size as the VA reference design at two meters excavated diameter and connect to the West Exhaust Main (CRWMS M&O 1997d, p. 70). However, instead of the ventilation raise being in the center at the top of the West Exhaust Main, it will be off to the east side such that the outside of the ventilation raise aligns with the edge of the West Exhaust Main. This will be to accommodate a horizontal raise that will be excavated between the two exhaust mains. The horizontal raise will be the same size as the ventilation raise at two meters excavated diameter, see Figure 8. The top of the horizontal raise will align with the top of the exhaust mains. A cutout will square up the faces where the raises join either of the exhaust mains in order to excavate the raises with a raise-borer. The ventilation controls will be located in the West Exhaust Main and the exhaust air from the emplacement drifts will be directed into the East Exhaust Main. The system will be designed so that the temperature will allow equipment operation in the West Exhaust Main. The East Exhaust Main will be designed for personnel access during maintenance or emergency situations.

8.5 COST ESTIMATE FOR SYSTEM A

The total cost of System A is $1,074 million, an increase in cost of $244 million from the VA reference design. A summary of these costs which are in 1999 dollars are shown in Appendix I.

8.6 DESIGN FEATURE EVALUATION FOR SYSTEM A

The evaluation against the LADS criteria for System A was combined with Systems B and C in Appendix J. The systems vary from each other only in magnitude. Therefore, each criteria is applied to each system the same for questions 2 through 6. Questions 7 and 8 take each system into account when necessary. As indicated in Section 8.2 and Appendix J, only System C was addressed for Question 1.

9. CONTINUOUS VENTILATION SYSTEM B–5.0 m^3/s

9.1 EMPLACEMENT DRIFT ENVIRONMENT AND SURROUNDING ROCK CONDITIONS IN SYSTEM B

The ventilation system for the Exploratory Studies Facility currently removes significant quantities of water from the host rock. The drying front has extended several meters into the rock, and the effects of the drying is felt, to some degree, tens of meters away from the drift already. Ventilation during the operational phase of the repository would remove considerable water from the system, as well as reduce temperatures (Section 4.1.1)

As in the analysis of System A (Section 8), System B will use the estimated data for the air temperature and drift wall temperature for continuously ventilated emplacement drifts from the *Repository Subsurface Waste Emplacement and Thermal Management Strategy* document (CRWMS M&O 1998c).

For System B, the peak air temperature is 66.08°C occurs at year 20 and the peak drift wall temperature is 80.88°C occurs at year 10 (Section 4.1.6). At year 100, the time of closure, the air temperature is 45.76°C and the drift wall temperature is 53.57°C (Section 4.1.6).

As in System A, a comparison of the VA reference design and the results of System B above show that the increased continuous ventilation airflow quantity from 0.1 m^3/s to 5.0 m^3/s makes a significant difference in the drift wall temperature The results of System B illustrate that both the air temperature and the drift wall temperature can be kept below the boiling point of water during the preclosure period.

9.2 IMPACT TO LONG TERM PERFORMANCE FOR SYSTEM B

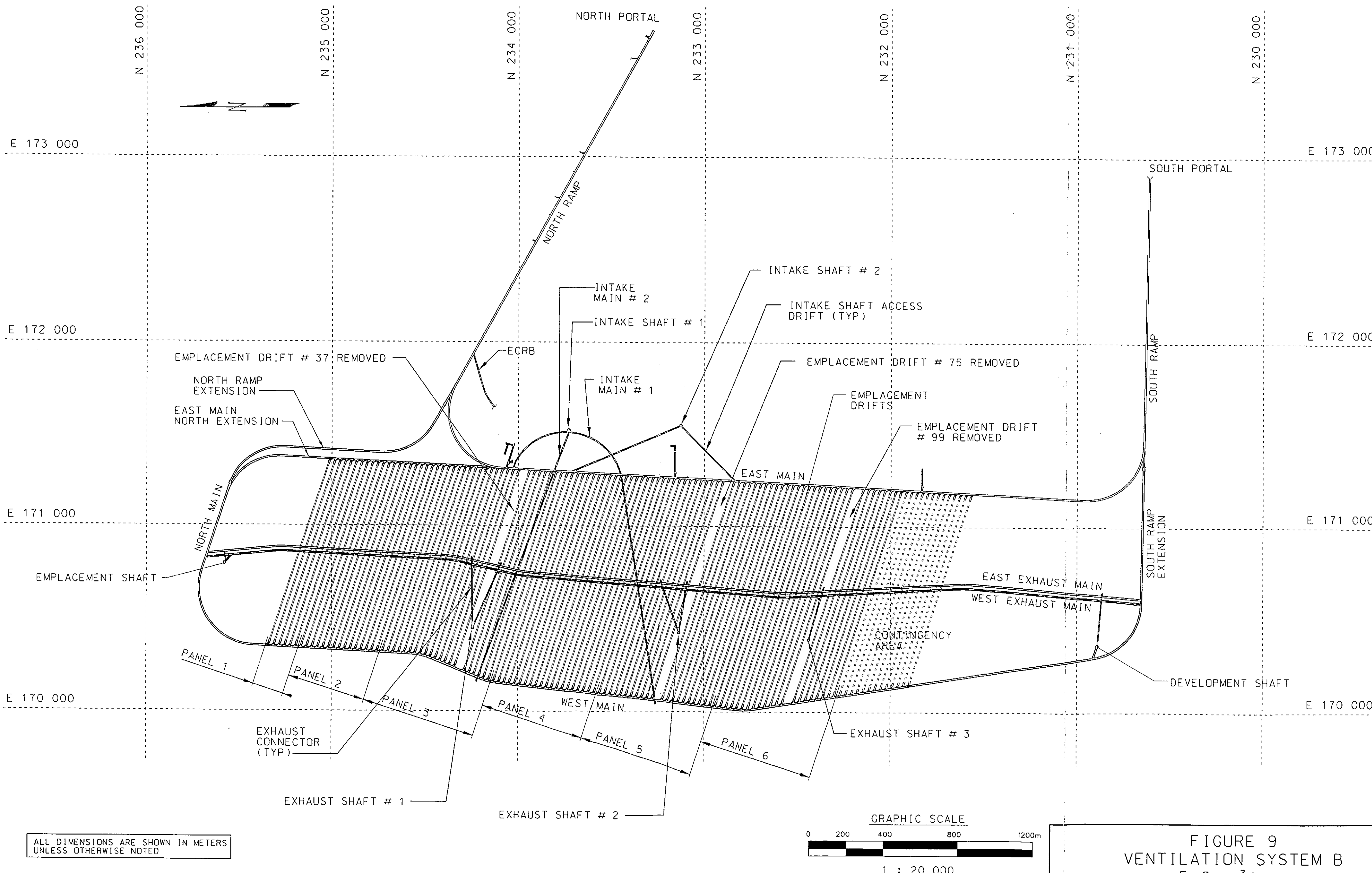
No performance assessment was completed for System B since System C is considered the bounding case. (CRWMS M&O 1999d)

9.3 VENTILATION REQUIREMENTS FOR SYSTEM B

System B contains five exhaust fans. From the VNETPC output shown in Appendix E, the total airflow is 2,171 m^3/s and the total air power is 7,267 horsepower which is calculated by summing up the individual requirements for each fan. Dividing by the fan efficiency, which is 75 percent (Section 4.1.7), the ventilation energy requirement for System B is 7228 kW (9,689 brake horsepower). The power is calculated for this report to compare costs. The horsepower cited will not be used for Fan selection or procurement.

9.4 LAYOUT CONFIGURATION FOR SYSTEM B

Similar to System A in Section 8.4, a continuous airflow of 5.0 m^3/s in each emplacement drift (up from the 0.1 m^3/s in the VA reference design), requires that additional openings be excavated and that both existing shafts be increased in size. The existing shafts will be the same size as in System A (Existing shafts means shafts in the existing VA reference design). Figure 9 depicts



ALL DIMENSIONS ARE SHOWN IN METERS UNLESS OTHERWISE NOTED

FIGURE 9
VENTILATION SYSTEM B
5.0 m^3/s

08-JUN-1999 09:22

CAD FILE: t:\repss\fa\fig\ssfa0074.fig

the layout configuration for System B (This layout, as modeled in CRWMS M&O (1999b) is based on the VA reference design and inputs found in Section 4). The East and West Exhaust Mains will be the same as in System A. The Emplacement and Development Shaft Access Drifts will remain the same as in System A.

In order to accommodate the increased airflow quantity (compared with the VA reference design), two additional intake shafts and three additional exhaust shafts will be excavated. All the new shafts will be 10.5 meters excavated diameter, except for Exhaust Shaft 3 (Section 4.2.14). All excavations are sized to maintain air velocity constraints. Exhaust Shaft 3 will be 7.5 meters excavated diameter (Section 4.2.14). The Emplacement Shaft and Development Shaft will both be 7.5 meters excavated diameter as in System A. The shaft pad sites for all shafts will be 260 meters by 130 meters (Section 4.2.2) for consistency as in System A. The Emplacement Shaft and Development Shaft collar elevations will be 1,455 meters and 1,452 meters as in VA reference design (Section 4.1.8).

The shafts are located within the repository such that they are available when needed by the emplacement operations schedule. The Development Shaft and the Emplacement Shaft will be constructed during the Construction Phase (pre-emplacement) and will be utilized for construction of the Perimeter Loop, East and West Exhaust Main, and the first panel of emplacement drifts.

Intake Shaft 1 will be constructed during the third panel (panels are shown on Figure 9 and are based on a phased turnover schedule to operations for VA reference design waste emplacement) of emplacement drift construction. However, the two intake mains need to be constructed during the second panel because of muck handling logistics. Intake Shaft 2 will be constructed during the third panel of emplacement drift construction. Exhaust Shaft 1 will be constructed during the third panel of emplacement drift construction. Exhaust Shaft 2 will be constructed during the fourth panel of emplacement drift construction. Exhaust Shaft 3 will be constructed during the fifth panel of emplacement drift construction. This particular shaft is only needed to supplement the emplacement ventilation system until the Development Shaft is released for emplacement system exhaust.

The intake shafts will be located east of the East Main. Similar to System A, this is due to limited shaft siting locations (Section 4.2.2). The shaft collar of Intake Shaft 1 will be at elevation 1,300 meters and for Intake Shaft 2 will be at elevation 1,325 meters (Section 4.2.2); both can accommodate the large site sizes. Intake Shaft 1 length will correspond with the intake mains that must be excavated to connect the shaft with the west side of the repository. Intake Shaft 1 will supply intake air for the west side only. Intake Shaft 2 length will correspond with the intake shaft access drifts that must be excavated to connect the shaft with the east side of the repository. Intake Shaft 2 will supply intake air for the east side only. The two intake shaft access drifts will be the same size and shape as those in System A at eight meters wide by seven meters high (Section 4.2.4).

The two intake mains will be excavated by a TBM and will be 7.62 meters excavated diameter as in System A. The assembly chambers will be the same size and shape as the ones in System A and will be excavated by a roadheader. The slope of the Intake Main 1 and 2 shall not exceed 3 percent (Section 4.3.1) and a minimum pillar of 10 meters (Section 4.2.15) below the East

Exhaust Main shall be maintained. A 7.5 meters excavated diameter vertical raise (Section 4.2.14) will connect each intake main to alcoves in the West Main. Intake Main 1 will be excavated from an assembly chamber in the East Main and once excavation is complete, the TBM will be partially disassembled at the face and backed out of the main to the assembly chamber of Intake Main 2. The TBM will be reassembled and launched into Intake Main 2. Intake Main 2 will not have a disassembly chamber. Once excavation is complete, the TBM will be partially disassembled at the face and backed out of the main to the assembly chamber where it will be completely disassembled and taken to the surface.(Assembly chambers not shown in Figures)

The exhaust shafts will be located within the repository block where Emplacement Drifts 37, 75, and 99 are located shown in Figure 9. The emplacement drifts will be removed and the first three in the contingency area will replace them. As in System A, the shafts in these locations minimize the amount of excavation required to connect to the exhaust mains. The shaft collar of Exhaust Shaft 1 will be at elevation 1,460 meters Exhaust Shaft 2 will be at elevation 1,465 meters, and Exhaust Shaft 3 will be at elevation 1,465 meters (Section 4.2.2). All will accommodate the large site sizes. Exhaust Shaft 1, Exhaust Shaft 2, and Exhaust Shaft 3 will be long enough to connect with the drifts that connect the shafts and the two exhaust mains.

The Emplacement Shaft, Development Shaft, and all exhaust shafts will be excavated by drill-and-blast methods since there is no access to the bottom of the shafts prior to excavation (Section 4.2.18). As in System A, the muck will be hauled out the shaft and transported to the main muck pile by either overland conveyor or by trucking. Since Intake Main 1 and the intake shaft access drifts will be excavated before the intake shafts, the shafts can be excavated by V-mole methods as access is available to the bottom of these shafts. The muck will be hauled to the East Main conveyor by rail car.

There will be seven exhaust connectors excavated to connect the exhaust mains to the exhaust shafts. The exhaust connectors will be excavated by a roadheader from the shafts. They will be the same size and shape as the intake shaft access drifts. Exhaust Connector 1 is located at the north end of the repository and connects the East Exhaust Main to the Emplacement Shaft. Exhaust Connectors 2 and 3 are located in about the first third of the repository and connect both exhaust mains to Exhaust Shaft 1. Exhaust Connectors 4 and 5 are located in about the second third of the repository and connect both exhaust mains to Exhaust Shaft 2. Exhaust Connector 6 is located in about the last third of the repository and connects both exhaust mains to Exhaust Shaft 3. Exhaust Connector 7 is located at the south end of the repository and connects both exhaust mains to the Development Shaft. Muck from the exhaust connectors will be removed through the shafts similar to the shaft muck.

The exhaust connectors are linked to the exhaust mains via a vertical raise. An exhaust alcove that is the same size and shape as the exhaust connectors will be excavated from the exhaust mains. The alcove will be 10 meters in length (Section 4.2.4). A vertical raise will be excavated from the exhaust connector into the alcove. The vertical raise will be 7.5 meters (Section 4.2.14) excavated diameter.

The ventilation raises from the emplacement drifts will be the same as in System A. The horizontal raise excavated between the two exhaust mains will be the same as in System A. The cutouts that will square up the raise faces will also be the same as in System A.

9.5 COST ESTIMATE FOR SYSTEM B

The total cost of System B is $1,738 million which is a cost increase of $907 million from the VA reference design. A summary of these costs in 1999 dollars are shown in Appendix I.

9.6 DESIGN FEATURE EVALUATION FOR SYSTEM B

The evaluation against the LADS criteria for System B was combined with Systems A and C in Appendix J. The systems vary from each other only in magnitude. Therefore, each criteria is applied to each system the same for questions 2 through 6. Questions 7 and 8 take each system into account when necessary. As indicated in Section 9.2 and Appendix J, question 1 was only addressed for System C.

10. CONTINUOUS VENTILATION SYSTEM C–10.0 m^3/s

10.1 EMPLACEMENT DRIFT ENVIRONMENT AND SURROUNDING ROCK CONDITIONS IN SYSTEM C

The ventilation system for the Exploratory Studies Facility currently removes significant quantities of water from the host rock. The drying front has extended several meters into the rock, and the effects of the drying is felt, to some degree, tens of meters away from the drift already. Ventilation during the operational phase of the repository would remove considerable water from the system, as well as reduce temperatures (Section 4.1.1).

This section will determine the design impacts and evaluation of the $10.0m^3/s$ continuous preclosure ventilation airflow quantity in the emplacement drifts, air temperature, waste package surface temperature, humidity, amount of moisture removed, and drying front location.

10.2 IMPACT TO LONG TERM PERFORMANCE FOR SYSTEM C

The WAPDEG software was used to determine corrosion performance of the waste packages. PA has completed WAPDEG computer simulations for the 100 year preclosure ventilation rate of 10 m^3/s. The conclusion is that there is little discernable difference in the fraction of waste packages breached versus time curves between the ventilation case and the Total System Performance Assessment. Since there is a strong correlation between fraction of waste packages failed as a function of time and dose as a function of time, there is no need to run the Total System Performance Assessment Repository Integrated Probabilistic Simulator calculations as there is not likely to be any noticeable difference from the Total System Performance Assessment-VA base case dose rates. (Section 4.1.2) A preclosure ventilation rate of 10 m^3/s per emplacement drift was assumed to be bounding, therefore only the 10 m^3/s case was examined using WAPDEG. Of the cases examined by Dr. Danko (1.0, 5.0, and 10.0 m^3/s), 10 m^3/s would provide the most extreme postclosure conditions by removing the most water and providing the lowest emplacement drift temperature at the time of closure (CRWMS M&O 1999d).

For System C, the peak air temperature reported by *Repository Subsurface Waste Emplacement and Thermal Management Strategy* CRWMS M&O 1998c document is 49.20°C occurs at year 10 and the peak drift wall temperature is 60.89°C occurs at year 10 (Section 4.1.6). At year 100, the time of closure, the air temperature is 35.40°C and the drift wall temperature is 40.23°C (Section 4.1.6).

10.3 VENTILATION REQUIREMENTS FOR SYSTEM C

This section shows the total repository airflow quantity requirements for System C which will include the air power and brake horsepower requirements. The opening sizes will also be determined from these values.

System C contains six exhaust fans and by the VNETPC output in Appendix G, the total airflow is 3,563 m^3/s and the air power is 11,213 horsepower. This is arrived at by summing up the individual requirements for each fan. Dividing by the fan efficiency, which is 75 percent (Section 4.1.7), the ventilation energy requirement for System C is 11,153 kW (14,951 brake horsepower). The power is calculated for this report to compare costs. and will not be used for fan selection or procurement.

10.4 LAYOUT CONFIGURATION FOR SYSTEM C

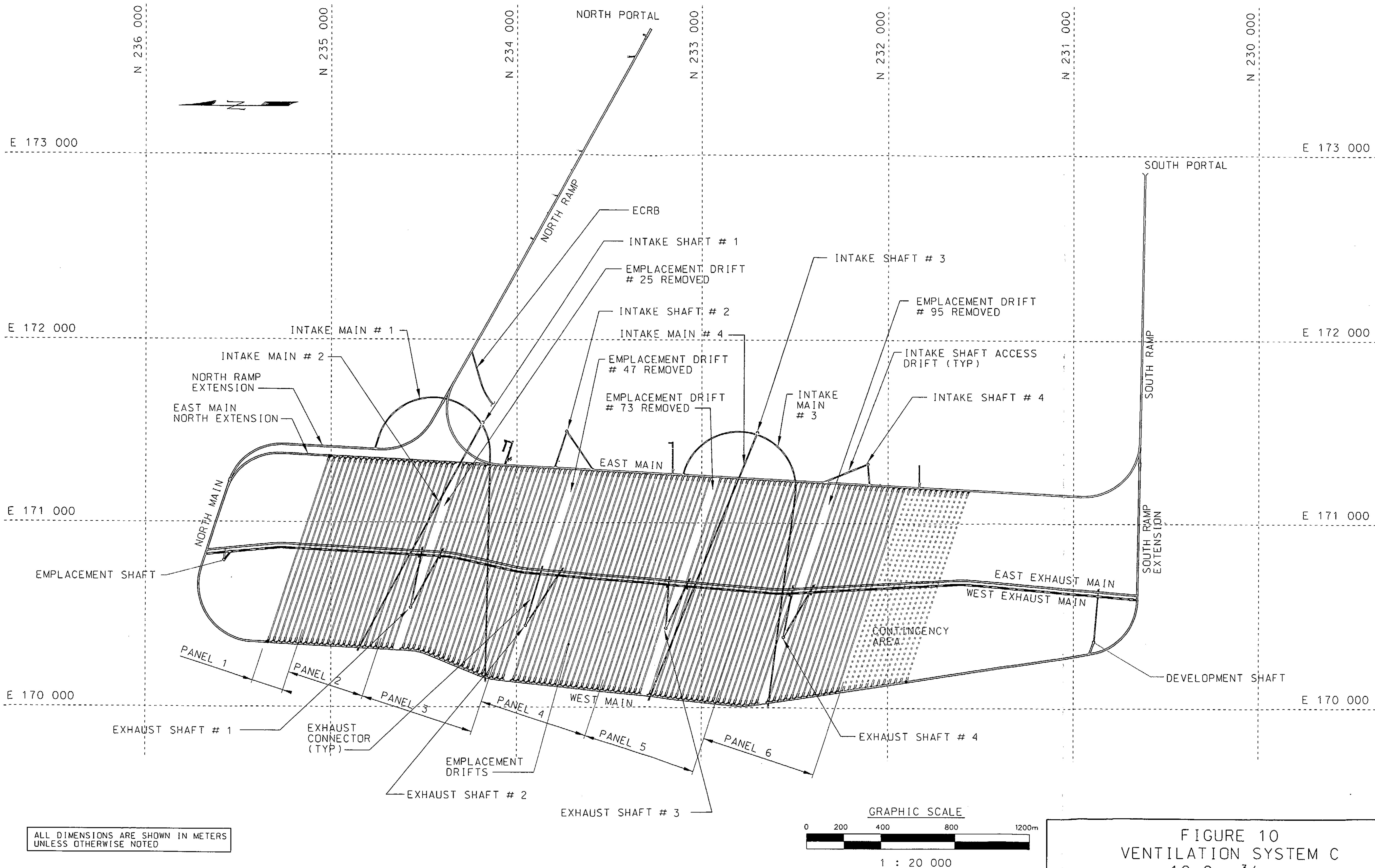
Similar to System A (Section 8) and System B (Section 9) a continuous airflow of 10.0 m^3/s in each emplacement drift compared to the 0.1 m^3/s in the VA reference design, require additional openings to be excavated and both existing shafts to be increased in size. The existing shafts (existing shafts means shafts in the existing VA reference design) will be the same size as in System A at 7.5 m diameter (Section 4.2.14). Figure 10 depicts the layout configuration for System C (This layout, as modeled in CRWMS M&O (1999b) is based on the VA reference design and inputs found in Section 4). The East and West Exhaust Mains will be the same as in System A (Section 8). The Emplacement and Development Shaft Access Drifts will remain the same as in System A.

The increased airflow quantity will require four additional intake shafts and four additional exhaust shafts to be excavated. All the new shafts will be 10.5 meters excavated diameter (Section 4.2.14). The Emplacement Shaft and Development Shaft will both be 7.5 meters (Section 4.2.14) excavated diameter. The shaft pad sites for all shafts will be 260 meters by 130 meters (Section 4.2.2) for consistency. The Emplacement Shaft and Development Shaft collar elevations will be 1,455 meters and 1,452 meters (Section 4.1.8).

The shafts are located relative to the repository such that they are available according to the emplacement operations schedule needs. As in System A, the Development Shaft and the Emplacement Shaft will be constructed during the Construction Phase (pre-emplacement) and will be utilized for construction of the Perimeter Loop, East and West Exhaust Main, and the first panel of emplacement drifts.

Intake Shaft 1 needs also to be constructed during the Construction Phase because of muck handling logistics. Intake Shaft 2 will be constructed during the third panel (panels are shown on Figure 10) of emplacement drift construction once the Intake Main is sufficiently past the shaft to allow excavation activities in the shaft without interruption of the Intake Main construction. Intake Shaft 3 will be constructed during the fourth panel of emplacement drift construction but the two intake mains need to be constructed during the third panel for efficient muck handling. Intake Shaft 4 will be constructed during the fifth panel of emplacement drift construction. Exhaust Shaft 1 will be constructed during the second panel of emplacement drift construction. Exhaust Shaft 2 will be constructed during the third panel of emplacement drift construction. Exhaust Shaft 3 will be constructed during the fourth panel of emplacement drift construction and finally exhaust Shaft 4 will be constructed during the fifth panel of emplacement drift construction.

The intake shafts will be located east of the East Main as in systems A & B. The shaft collar of Intake Shaft 1 will be at elevation 1,325 meters, Intake Shaft 2 will be at elevation 1,300 meters, Intake Shaft 3 will be at elevation 1,325 meters, and for Intake Shaft 4 will be at elevation 1,350 meters (Section 4.22). The lengths of Intake Shaft 1 and Intake Shaft 3 will correspond with the intake mains required to connect the shafts with the west side of the repository. Intake Shaft 2 and



ALL DIMENSIONS ARE SHOWN IN METERS UNLESS OTHERWISE NOTED

FIGURE 10
VENTILATION SYSTEM C
10.0 m^3/s

08-JUN-1999 09:41

CAD FILE: t:\repss\fo\fig\ssfo0074.fig

Intake Shaft 4 lengths will correspond with the intake shaft access drifts to connect the shaft with the east side of the repository. Intake Shaft 1 and Intake Shaft 3 will supply intake air for the west side only. Intake Shaft 2 and Intake Shaft 4 will supply intake air for the east side only. The four intake shaft access drifts will be the same size and shape as those in System A at eight meters wide by seven meters high (Section 4.2.4)

The four intake mains will be excavated by a TBM and will be 7.62 meters excavated diameter as in System A. The assembly chambers will be the same size and shape as the ones in System A and will be excavated by a roadheader. The slope of Intake Main 1, Intake Main 2, Intake Main 3, and Intake Main 4 shall not exceed 3 percent (Section 4.3.1) and a minimum pillar of 10 meters below the East Exhaust Main shall be maintained (Section 4.2.15). A 7.5 meters (Section 4.2.14) excavated diameter vertical raise will connect each intake main to alcoves in the West Main. Intake Main 1 will be excavated from an assembly chamber in the North Ramp Extension and once excavation is complete, the TBM will be partially disassembled at the face and backed out of the main to the assembly chamber of Intake Main 2. The TBM will be reassembled and launched into Intake Main 2. Intake Main 2 will not have a disassembly chamber. Once excavation is complete, the TBM will be partially disassembled at the face and backed out of the main to the North Ramp Extension and moved into the assembly chamber of Intake Main 3 off the East Main. The excavation process for Intake Main 3 and Intake Main 4 will be the same as it was for Intake Main 1 and Intake Main 2. When excavation of Intake Main 4 is complete and the TBM is partially assembled, it will be backed out to the assembly chamber where it will be completely disassembled and taken to the surface (Assembly chambers not shown in Figures). Intake Mains 1 and 2 must be excavated during the pre-emplacement construction period. This means that part of the North Ramp Extension will have to be excavated by a roadheader to gain access.

The exhaust shafts will be located within the repository block where Emplacement Drifts 25, 47, 73, and 95 (Figure 10) are located. The emplacement drifts will be removed and the first four in the contingency area will replace them. Shafts in these locations minimize the amount of excavation to connect them to the exhaust mains. The shaft collar of Exhaust Shaft 1 will be at elevation 1,450 meters, Exhaust Shaft 2 will be at elevation 1,460 meters, Exhaust Shaft 3 will be at elevation 1,460 meters, and Exhaust Shaft 4 will be at elevation 1,455 meters (Section 4.2.2). All shafts will accommodate the large site sizes. The lengths of Exhaust Shaft 1, Exhaust Shaft 2, Exhaust Shaft 3, and Exhaust Shaft 4 will correspond to the exhaust connectors that are required to be excavated to connect the shafts with the exhaust mains.

The Emplacement Shaft, Development Shaft, and all exhaust shafts will be excavated by drill-and-blast methods since there is no access to the bottom of the shafts. (Section 4.2.18). As in System A, the muck will be hauled out the shaft and transported to the main muck pile. Since Intake Main 1, Intake Main 3, and the intake shaft access drifts for Intake Shafts 2 and 4 will be excavated before their respective intake shaft, these shafts can be considered for excavation by V-mole methods since there will be access to the bottom of the shafts prior to excavation.

There will be ten exhaust connectors (see Figure 10) that are required to be excavated to connect the exhaust mains to the exhaust shafts. The exhaust connectors will be excavated by a roadheader from the shafts. They will be the same size and shape as the intake shaft access drifts. Exhaust Connector 1 is located at the north end of the repository and connects the East

Exhaust Main to the Emplacement Shaft. Exhaust Connectors 2 and 3 are located in about the first quarter of the repository and connect both exhaust mains to Exhaust Shaft 1. Exhaust Connectors 4 and 5 are located in about the second quarter of the repository and connect both exhaust mains to Exhaust Shaft 2. Exhaust Connectors 6 and 7 are located in about the third quarter of the repository and connect both exhaust mains to Exhaust Shaft 3. Exhaust Connectors 8 and 9 are located in about the fourth quarter of the repository and connect both exhaust mains to Exhaust Shaft 4. Exhaust Connector 10 is located at the south end of the repository and connects both exhaust mains to the Development Shaft. Muck from the exhaust connectors will be removed through the shafts similar to the shaft muck.

The exhaust connectors are linked to the exhaust mains via a vertical raise. An exhaust alcove that is the same size and shape as the exhaust connectors will be excavated from the exhaust mains. The alcove will be 10 meters in length (Section 4.2.4). A vertical raise will be excavated from the exhaust connector into the alcove. The vertical raise will be 7.5 meters (Section 4.2.14) excavated diameter.

The ventilation raises from the emplacement drifts will be the same as in System A. The horizontal raise excavated between the two exhaust mains will be the same as in System A. The cutouts that will square up the raise faces will also be the same as in System A.

10.5 COST ESTIMATE FOR SYSTEM C

The total cost of System C is $2,695 million which is a cost increase of $1,864 million from the VA reference design. Summaries of these costs in 1999 dollars are shown in Appendix I.

10.6 DESIGN FEATURE EVALUATION FOR SYSTEM C

The evaluation against the LADS criteria for system C was combined with systems A and B in Appendix J. The systems vary from each other only in magnitude. Therefore, each criteria is applied to each system the same for questions 2 through 6. Questions 7 and 8 take each system into account when necessary. Only System C was addressed for question 1, as indicated in Appendix J.

11. COMPUTER SOFTWARE

The following is a list of the computer software used:

1) VNETPC, Version 1.0a
2) Lotus 123 Release 5
3) Microsoft Excel 97
4) Vulcan Version 3.3 (TBV)

The ventilation calculations to determine the airflow quantity, pressure differential, air power loss (horsepower), and operating cost of the subsurface openings used VNETPC, Version 1.Oa. This software is developed by Mine Ventilation Services. VNETPC was qualified in 1999 and carries the Computer Software Configuration Item (CSCI) number 30029 V1.0W (CRWMS M&O 1999c). The software is installed on a Gateway 2000 computer, Model P5-166 located in the Repository Subsurface Design Group and has the CRWMS M&O tag #110957. The software was obtained to specifically perform this type of work and was qualified with that intent in mind. The software is appropriate for the application used in this report, was not used outside the range of qualification, and was obtained from Software Configuration Management according to the QAP-SI-0 series procedures. The input data for the ventilation calculations, which is the resistances of the individual branches, are provided in Appendices B, D & F. The output data from VNETPC for each branch simulation is provided in Appendices C, E & G.

The calculations for the resistances that were the input data for VNETPC used Lotus 123 version release 5 and later converted to Microsoft Excel 97. Both are commercial-off-the-shelf spreadsheet software and were installed on a Gateway 2000 computer, Model P5-166. No software routines were used in the calculations; therefore, the software does not have TBV and validated per QAP-SI-0.

The conceptual layouts (CRWMS M&O 1999b) were developed on the Vulcan Software. Vulcan Version 3.3 (TBV) is an unqualified software program. This software was run on a Silicon Graphics Indigo 2 computer system (CPU# 700592) with a Unix operating system. Since this software is unqualified, the layouts are considered TBV and are not to be used to support construction, fabrication, or procurement. The software was originally acquired to specifically perform this type of work and the software is appropriate for its application to this engineering calculation.

12. CONCLUSIONS

The report examined the effect of preclosure ventilation in the emplacement drifts on preclosure operations and upon postclosure radiological performance. Where applicable, comparisons are made with the VA reference design (ventilation rate of 0.1 m^3/s in the emplacement drifts). Three preclosure systems at the ventilation rates stated were investigated as follows:

- System A (1.0 m^3/s)
- System B (5.0 m^3/s)
- System C (10.0 m^3/s)

These three preclosure systems are discussed in Sections 8, 9 and 10 respectively.

System C was chosen as a bounding case for postclosure evaluation because it has the greatest potential for removing water and heat from the repository prior to closure.

Appendix J provides DF evaluation based on the LADS evaluation criteria (CRWMS M&O 1998g).

The conclusion drawn from this report concerning postclosure performance of the three preclosure systems is that System C provides no postclosure radiological advantage when compared with the VA reference design. Because System C is the bounding case, Systems A and B also provide no radiological postclosure advantage when compared with the VA reference design.

The conclusions drawn from this report concerning preclosure operations are as follows:

1. System A appears to demonstrate little difference to the VA reference design other than a slight decrease in temperatures, yet still indicates above boiling drift wall temperatures (Section 8.1).

2. System B would maintain the drift wall temperature below the boiling point of water (Section 9.1).

3. System C would maintain the drift wall temperature below 61°C (Section 10.2).

The choice of system would depend on the particular design goals for the overall repository. For example, if continuous access to emplacement drifts were a design goal, then System C should be seriously considered.

Costs vary between Systems A, B, and C. The same fundamental layout and ventilation system proposed in the VA reference design is used. However, the number of shafts and ventilation drifts increase with an increase in air volume in the emplacement drifts. This is reflected in the costs as follows:

- The cost differential between System A and the VA reference design is +$244 million (Section 8.5).
- The cost differential between System B and the VA reference design is +$907 million (Section 9.5).
- The cost differential between System C and the VA reference design is +$1,864 million (Section 10.5).

Results and conclusions discussed in this evaluation are based on the input data presented in Section 4. As indicated in Sections 4, and 11, some of the input data and computer software used in this evaluation are considered preliminary and unqualified. Therefore, all results and conclusions must be considered TBV.

APPENDIX A

VENTILATION AIRFLOW QUANTITY REQUIREMENTS

APPENDIX A

VENTILATION AIRFLOW QUANTITY REQUIREMENTS

A brief explanatory outline is given for airway resistance tables developed for the Monitoring Phase for System A, System B and System C (Tables are in Appendices B, D, F respectively).

Line No.	Branch		Resistance in PU VNETPC Input RPUa+RPUb	Regulator Resistance in PU (Field Installed) RPUb	Resistance in PU From R RPUa = R/10	Airway Resistance R = KPL/(5.2A^3) in.min^2/ft^6	Friction Factor K (x10^-10)	Cross Area A (Ft)	Perimeter P (Ft)	Actual Length meter (m)	Actual Length L' (Ft)	Equiv. Length L=L'+10% (Ft)
	From	To										

Line No. identifies all branch lines in the VNETPC simulation .

Branch indicates node points for that Line No. and the From/To represents airflow direction (see Figures B-1, D-1 and F-1).

Airway Resistance = R, as defined in Hartman et al. (1997 pp. 168-169). However the VNETPC input requires resistance to be denoted by RPUa, which equals R divided by 10. In addition RPUb is an installed field regulator which can be adjusted to attain desired airflow. VNETPC computer program was qualified in 1999 (CRWMS M&O 1999c). The sum of RPUa and RPUb is the input to VNETPC.

The K factor represents the frictional roughness of the airway. (Section 4.2.1)

Cross sectional area A is the net calculated area based on the excavated area minus any obstructed area as defined in Appendix Tables B-1, D-1 and F-1 for the three systems. The Perimeter is the total length in feet of lined airway in section (e.g., circumference of circle). The perimeters and areas are found in Section 4.2.1.

Equivalent length is Actual Length in feet plus 10 percent and is used to account for joints/minor misalignment of the total duct length or drift length under consideration (Section 4.2.17).

For this analysis the lengths between the nodes for input into VNETPC 1.0a are located in Appendix H.

Table A-1 develops the total volume for each system. These volumes are used in VNETPC.

Table A-1. Repository Ventilation Airflow Quantities

Line				
1				
2	**Estimated Monitoring Ventilation Using VA Reference Design Layout with 115 Emplacement Drifts**			
3	File: RSJurani\repvola-lad 3/24/99	SYSTEM A	SYSTEM B	SYSTEM C
4	**Case, Air Quantity per Emplacement Drift Split (cfm) 1 cu ft.= .000472m^3/s**	**2,119**	**10,593**	**21,186**
5	**Case, Air Quantity per Emplacement Drift Split (m^3/s)**	**1**	**5**	**10**
6				
7	No. of PC drifts (CRWMS M & O 1997d, Attachment V, page 1)	5	5	5
8	No. of Cross Block Drifts (CRWMS M & O 1997d, Attachment I, page 1)	3	3	3
9	No. of Empl Standby Drifts (CRWMS M & O 1997d, Attachment I, page 1)	2	2	2
10				
11	**Airflow Allocation (cfm)**			
12	PC drift @ 40300 cfm each (Line 7 x 40300) (CRWMS M & O 1997c, page 40)	201,500	201,500	201,500
13	Cross Block drift@ 40300 cfm each (Line 8 x 40300) (CRWMS M & O 1997c, page 40)	120,900	120,900	120,900
14	Standby Empl Drift @ 40300 cfm each(Line 9 x 40300) (CRWMS M & O 1997c, page 40)	80,600	80,600	80,600
15				
16	Loaded Empl Drifts with *115 drifts (230 drift splits) (Line 4 x 230)	487,288	2,436,441	4,872,881
17	*105 drifts + 15 contingency drift (CRWMS M & O 1997d, p.33) - 5 cross block/ standby = 115 drifts			
18	Approx. Blast Cooling & Flushing Functions (CRWMS 1995a, p 95) (100m^3/s divided by .000472)	212,000	212,000	212,000
19				
20	Subtotal (Lines 12 to 18)	1,102,288	3,051,441	5,487,881
21				
22	15% Contingency (Line 20 x 0.15)	165,343	457,716	823,182
23				
24	Total Intake System (Line 22 + Line 20)	**1,267,631**	**3,509,157**	**6,311,064**
25				
26				
27	**Exhaust Air Quantity**			
28				
29	Airflow quantity allowance of 18 percent (Section 4.2.5) (Line 24 x 0.18)	228,174	631,648	1,135,991
30				
31	Total exhaust airflow quantity (Line 24 + Line 29)	1,495,805	4,140,805	7,447,055
32				
33				
34				
35				
36				
37				
38	**Approx. Total Exhaust Design Volume (cfm)**	**1,500,000**	**4,100,000**	**7,500,000**

Primary Fans used in VNETPC Model

Total quantity of air shown in Table A-1 is distributed throughout the system. Therefore, primary airways such as the shafts or ramps are pre-assigned airflows. The ventilation simulation is provided with primary fans, chosen from a fan catalog. "Joy Axivane Fans Mining Catalog, J 670" Joy Mining Machinery (1982). was used to perform the specified general air quantity requirements at an initial pressure of 1.49 kPa (6" water gauge) however, the fan curve may range from 1.24 to 2.99 kPa (5 to 12 inches water gauge). Each fan is a variable pitch, axial flow fan. A blade tip angle setting was selected for the simulations. The settings are used to provide the simulation with a starting point for fan operation.

In addition, the catalog fan curves (pp. A-9-A-13, Appendix A) have been modified to show potential stall points. The stall points are selected and follow the basic shape of curves for axial flow fans as shown in Hartman et. al (Figure 9.13, p. 347).

The following fans were selected with the corresponding approximate blade tip angle setting shown in the curve (4.1.10):

System A

Fan Curve # C-8242, (p.A-9, Appendix A). Three (3) Joy Axivane Fan Model M132-79-710, Blade Tip Angle 25°.
(Used in Appendix C)

System B

Fan Curve # C-8247, (p.A-10, Appendix A). One Joy Axivane Fan Model M144-79-590, Blade Tip Angle 24°
Fan Curve # C-8211, (p.A-11, Appendix A). One Joy Axivane Fan Model M84-58-880, Blade Tip Angle 31°
Fan Curve # C-9804, (p.A-12, Appendix A). Three (3) Joy Axivane Fan Model M144-79-880, Blade Tip Angle 31.5°.
(Used in Appendix E)

System C

Fan Curve # C-8247, (p.A-10, Appendix A). One Joy Axivane Fan Model M144-79-590, Blade Tip Angle 24°
Fan Curve # C-8211, (p.A-11, Appendix A). One Joy Axivane Fan Model M84-58-880, Blade Tip Angle 31°
Fan Curve # C-8248, (p.A-13, Appendix A). Eight (8) Joy Axivane Fan Model M144-79-710, Blade Tip Angle 26.5° arranged in four parallel sets.
(Used in Appendix G)

Pages A-5-A8 document the copyright permission obtained from Joy Technologies for the use of the fan curves.

To →

FACSIMILE MESSAGE

From the
The Desk of Karen Andrews
1261 TOWN CENTER DRIVE
LAS VEGAS, NV 89134-6352
MAIL STOP 423/1127C

Phone: 702-295-7126	FAX: 702-295-6475
To: Mr. David Johnston - Manager International Sales	
Fax: (~~216~~ 330) 339-8210	
Date: June 16, 1999	
Number of pages including this page: 4	

MESSAGE

Please forward to the appropriate individual. Thank you.

Respectfully,

Karen M. Andrews

Karen Andrews

TRW Environmental Safety Systems Inc.
1261 Town Center Drive
Las Vegas, NV 89134
702.295.5400

Ms. Karen Andrews
TRW Environmental Safety Systems, Inc.
Acting Supervisor, Cited Information Management
MS 423/1127C
1261 Town Center Drive
Las Vegas, NV 89134-6352
Phone number (702) 295-7126
Fax number (702) 295-6475

June 16, 1999

Mr. David Johnston
Manager
International Sales
Joy Technologies, Inc.
Joy/Green Fan Division
338 South Broadway
P.O. Box 5000
New Philadelphia, OH 44663

Dear Mr. Johnston:

We are requesting copyright clearance for documents to be included in reports or analysesto the United States Department of Energy (DOE) discussing issues, technology, and concerns for the Yucca Mountain Project. In December 1995, Mr. Romeo Jurani of Morrison Knudsen received approximately sixty fan curves from you, along with a letter granting him permission to use them in his reports. Our engineers would like permission to place copies of some or all of those fan curves in the bodies of their reports. The reports will be used by project participants and could be part of DOE's basis for deciding what actions will be taken in the future regarding a potential underground nuclear waste repository at Yucca Mountain, Nevada. The reports would also be available to the United States Congress, the DOE, the United States Nuclear Regulatory Commission, and the general public.

May we have permission to insert copies of the fan curves on the attached list into our reports and to distribute as many copies of those reports as needed for the Yucca Mountain M&O, and the entities mentioned earlier?

We would very much like to see your company's product information utilized by our scientists and engineers and represented in our project reports. Your response before June 18, 1999, would

TRW Inc.

be most appreciated. Please e-mail your response to Karen_Andrews@ymp.gov, or fax it to "Attention: Karen Andrews" at (702) 295-6475. If you have any further questions, please feel free to contact Karen Andrews at (702) 295-7126.

Sincerely,

Karen Andrews

Karen Andrews
Acting Supervisor, Cited Information Management
TRW Environmental Safety Systems

I (We) grant permission to project participants working for the Office of Civilian Radioactive Waste Management, Management and Operating Contractor to include the Joy Mining Machinery documents from the attached list in their documents, and to maintain and distribute hard copies of the documents as previously described.

_____________________ 6-18-99
Signature **Date**

JOY TYPICAL MINE FAN CURVES

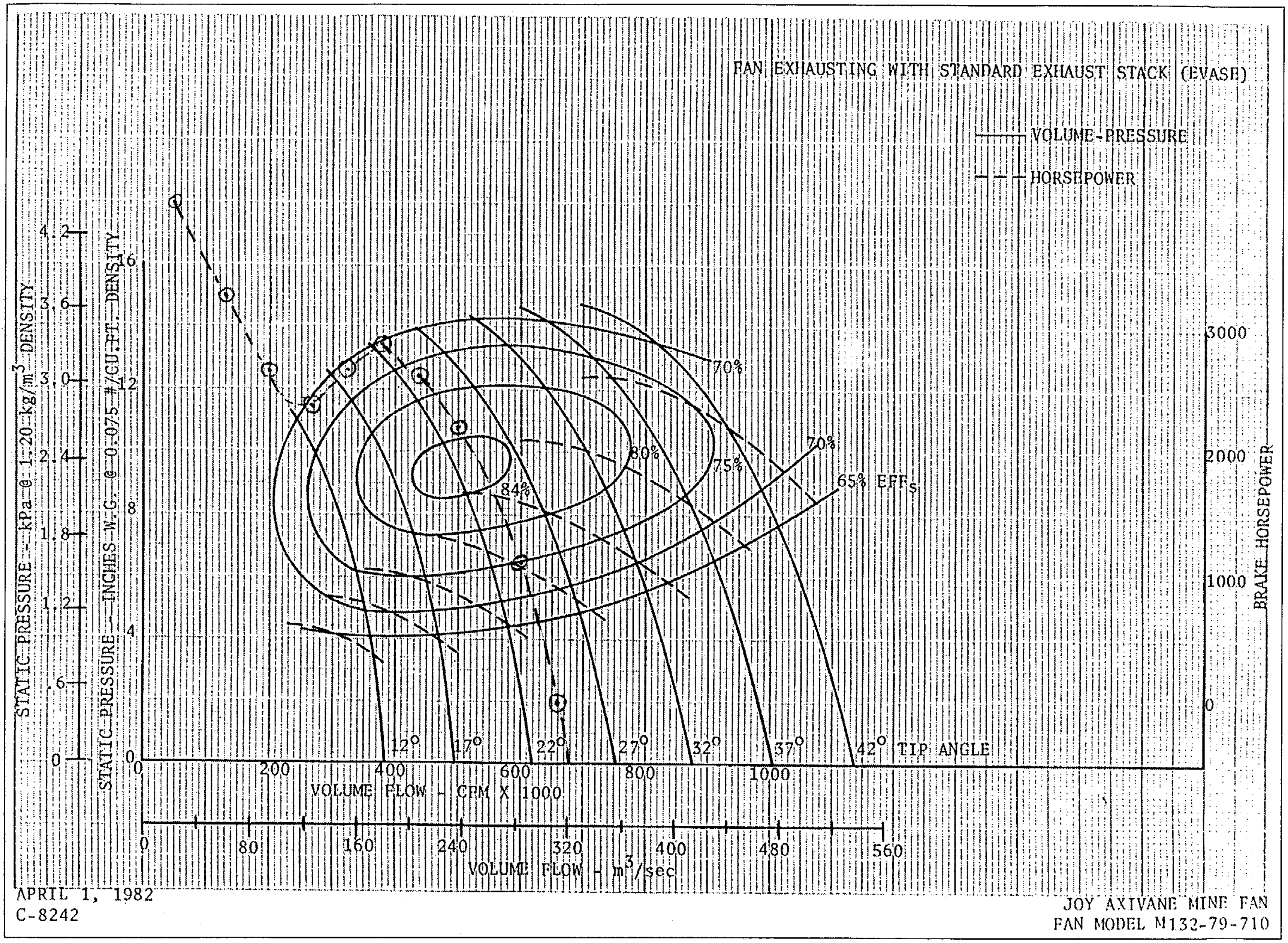
FAN MODEL NUMBER	FAN CURVE NUMBER
M60-29-1180	C-8194
M60-29-1780	C-8195
M60-36-1180	C-8196
M60-36-1780	C-8197
M60-43-1180	C-8198
M72-36-1180	C-8199
M72-36-1780	C-8200
M72-43-880	C-8201
M72-43-1180	C-8202
M72-50-880	C-8203
M72-50-1180	C-8204
M84-36-880	C-8205
M84-36-1180	C-8206
M84-43-880	C-8207
M84-43-1180	C-8208
M84-50-880	C-8209
M84-50-1180	C-8210
M84-58-880	C-8211
M84-58-1180	C-8212
M96-43-880	C-8213
M96-43-1180	C-8214
M96-50-880	C-8215
M96-50-1180	C-8216
M96-58-880	C-8217
M96-58-1180	C-8218
M96-65-880	C-8219
M108-50-710	C-8220
M108-50-880	C-8221
M108-58-710	C-8222
M108-58-880	C-8223
M108-65-710	C-8224
M108-65-880	C-8225
M108-72-710	C-8226
M108-72-880	C-8227

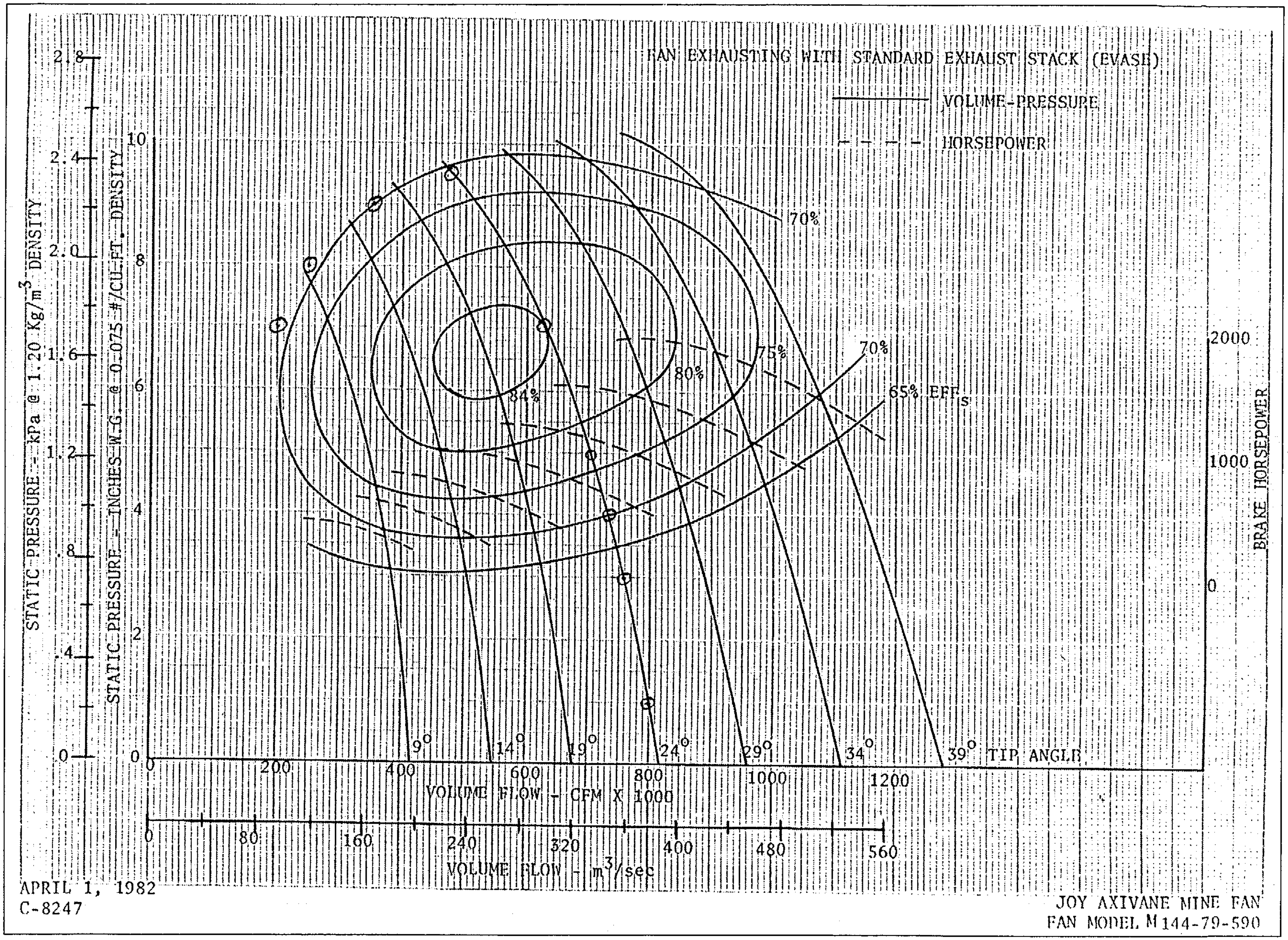
NTS.P. ←

FAN MODEL NUMBER	FAN CURVE NUMBER
M120-58-710	C-8228
M120-58-880	C-8229
M120-65-590	C-8251
M120-65-710	C-8230
M120-65-880	C-8231
M120-72-590	C-8232
M120-72-710	C-8233
M120-72-880	C-8234
M120-79-590	C-8235
M120-79-710	C-8236
M120-79-880	C-8250
M132-65-590	C-8237
M132-65-710	C-8238
M132-72-590	C-8239
M132-72-710	C-8240
M132-72-900	C-9079
M132-79-590	C-8241
M132-79-710	C-8242
M132-79-880	C-8249
M144-65-590	C-8243
M144-65-710	C-8244
M144-72-590	C-8245
M144-72-710	C-8246
M144-79-590	C-8247
M144-79-710	C-8248
M144-79-880	C-9804

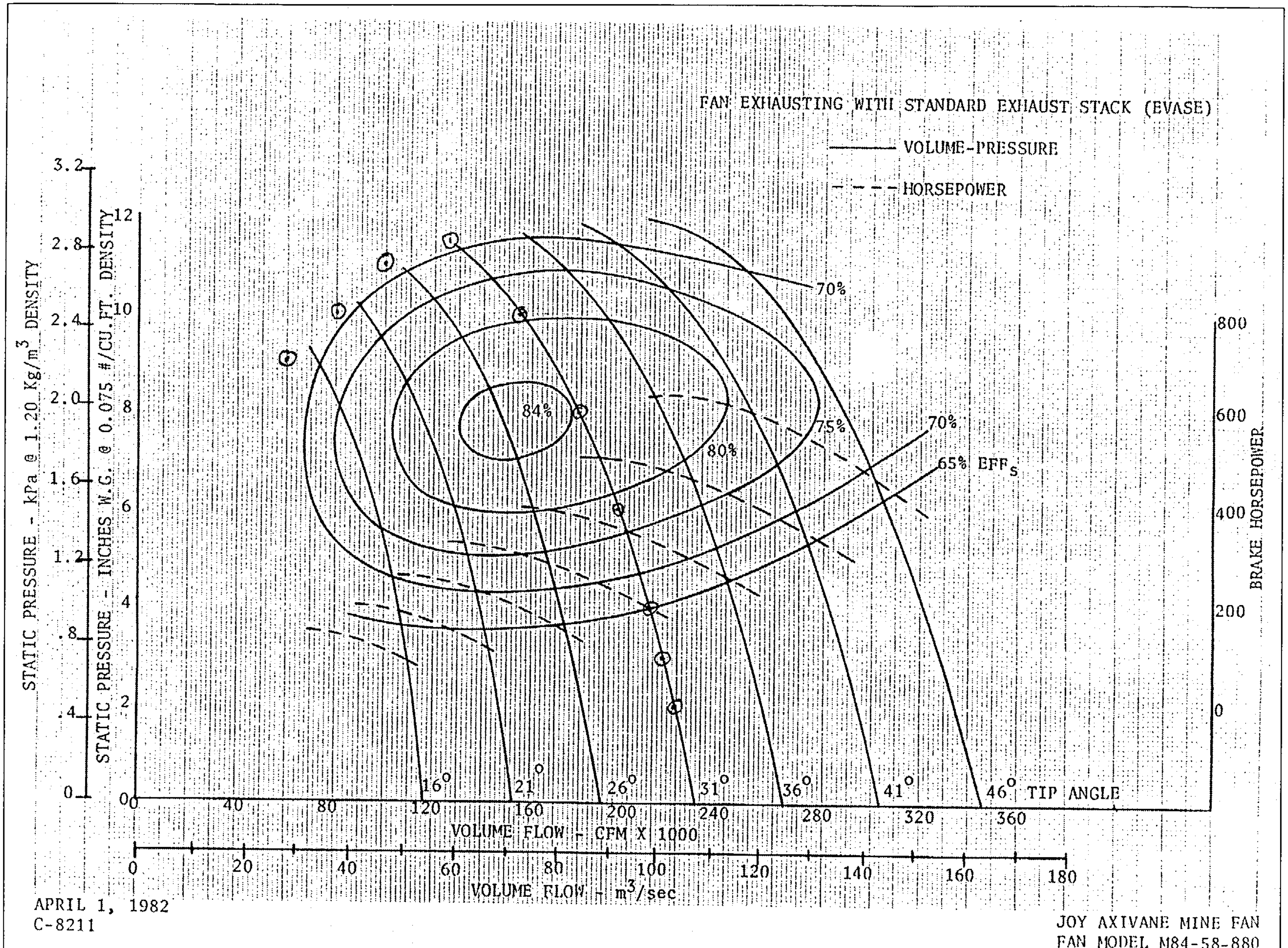
While these are typical representations of Joy Mine Fan curves, they are by no means a complete compilation. Contact the Factory for additional, specific requirements.

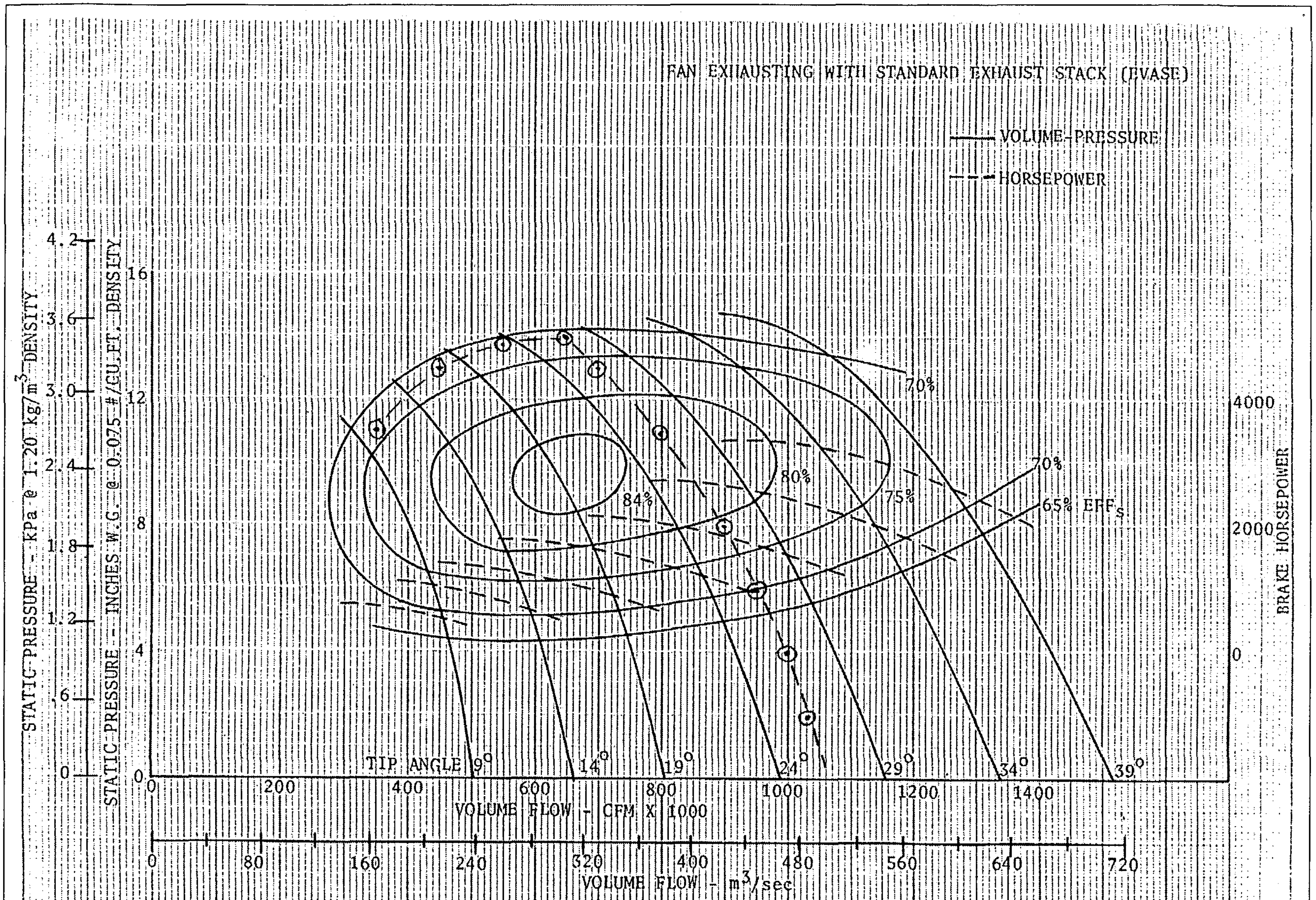
Joy Technologies, Inc.
Joy/Green Fan Division
New Philadelphia, Ohio


FAN EXHAUSTING WITH STANDARD EXHAUST STACK (EVASE)
VOLUME-PRESSURE
HORSEPOWER
STATIC PRESSURE - kPa @ 1.20 kg/m3 DENSITY
STATIC PRESSURE - INCHES W.G. @ 0.075 #/CU.FT. DENSITY
BRAKE HORSEPOWER
70%
70%
75%
80%
84%
65% EFFs
12°
17°
22°
27°
32°
37°
42° TIP ANGLE
VOLUME FLOW - CFM X 1000
VOLUME FLOW - m3/sec
APRIL 1, 1982
C-8242
JOY AXIVANE MINE FAN
FAN MODEL M132-79-710



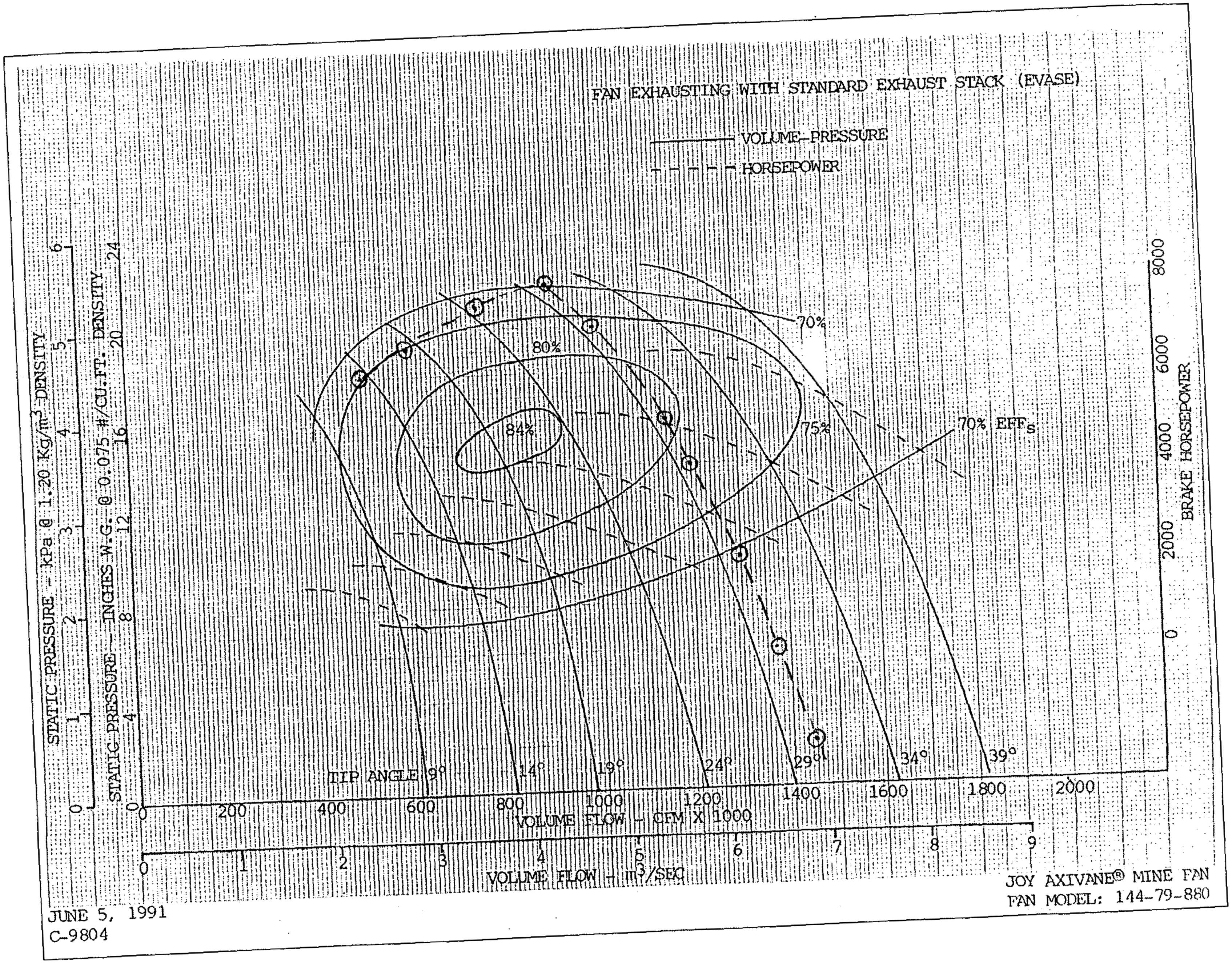
FAN EXHAUSTING WITH STANDARD EXHAUST STACK (EVASE)
VOLUME-PRESSURE
HORSEPOWER
STATIC PRESSURE - kPa @ 1.20 Kg/m3 DENSITY
STATIC PRESSURE - INCHES W.G. @ 0.075 #/CU.FT. DENSITY
BRAKE HORSEPOWER
2000
1000
0
70%
75%
80%
84%
70%
65% EFFs
9°
14°
19°
24°
29°
34°
39° TIP ANGLE
0
200
400
600
800
1000
1200
VOLUME FLOW - CFM X 1000
0
80
160
240
320
400
480
560
VOLUME FLOW - m3/sec
APRIL 1, 1982
C-8247
JOY AXIVANE MINE FAN
FAN MODEL M 144-79-590


FAN EXHAUSTING WITH STANDARD EXHAUST STACK (EVASE)
VOLUME-PRESSURE
HORSEPOWER
70%
84%
80%
75%
70%
65% EFFs
16°
21°
26°
31°
36°
41°
46° TIP ANGLE
STATIC PRESSURE - kPa @ 1.20 Kg/m3 DENSITY
STATIC PRESSURE - INCHES W.G. @ 0.075 #/CU.FT. DENSITY
BRAKE HORSEPOWER
VOLUME FLOW - CFM X 1000
VOLUME FLOW - m3/sec
3.2
2.8
2.4
2.0
1.6
1.2
.8
.4
0
12
10
8
6
4
2
0
800
600
400
200
0
0
40
80
120
160
200
240
280
320
360
0
20
40
60
80
100
120
140
160
180
APRIL 1, 1982
C-8211
JOY AXIVANE MINE FAN
FAN MODEL M84-58-880



APRIL 1, 1982
C-8248

JOY AXIVANE MINE FAN
FAN MODEL M144-79-710


FAN EXHAUSTING WITH STANDARD EXHAUST STACK (EVASE)
VOLUME-PRESSURE
HORSEPOWER
70%
80%
84%
75%
70% EFFs
STATIC PRESSURE - kPa @ 1.20 Kg/m3 DENSITY
STATIC PRESSURE - INCHES W.G. @ 0.075 #/CU.FT. DENSITY
BRAKE HORSEPOWER
TIP ANGLE 9°
14°
19°
24°
29°
34°
39°
VOLUME FLOW - CFM X 1000
VOLUME FLOW - m3/SEC
JOY AXIVANE® MINE FAN
FAN MODEL: 144-79-880
JUNE 5, 1991
C-9804

APPENDIX B

CALCULATION OF AIRWAY RESISTANCES FOR SYSTEM A–1.0 cms

APPENDIX B

CALCULATION OF AIRWAY RESISTANCES FOR SYSTEM A–1.0 cms

This table develops the input file for VNETPC for this system. The descriptions for the inputs for this table are located in Appendix A and Section 4.2.

The input values for K, A and P can be found in Section 4.2.1. The actual length are from Appendix H (as indicated by reference column). The regulator resistance (RPU_b) can be found in Section 4.2.20.

Fan locations, nodes and branches are shown in Figure B-1

Table B-1. Calculation of Airway Resistances During Monitoring Phase for System A-1.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad01: VNETPC INPUT, Design Feature Development, Case 1 m^3/s per emplacement drift. (Data by RSJurani & A Linden)														
Line No.	BRANCH		RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
	FROM	TO												
1	1	2	0.0051		0.0051	0.0509	30	389.33	72.36	1992.0	6535	7189	North Ramp	Figure H-2
2	2	3	0.0001		0.0001	0.0011	30	389.33	72.36	43.6	143	157	North Ramp	Figure H-2
3	3	111	0.0004		0.0004	0.0039	30	389.33	72.36	151.4	497	546	North Ramp	Figure H-2
4	111	100	0.0039		0.0039	0.0394	30	389.33	72.36	1543.0	5062	5569	North Ramp Ext	Figure H-2
5	100	102	0.0039		0.0039	0.0390	70	389.33	72.36	654.6	2148	2362	East Main Drift Ext.	Figure H-2
6	102	103	0.0003		0.0003	0.0026	70	389.33	72.36	43.5	143	157	East Main Drift	Figure H-2
7	103	110	0.0013		0.0013	0.0130	70	389.33	72.36	217.4	713	785	East Main Drift	Figure H-2
8	110	115	0.0009		0.0009	0.0086	70	389.33	72.36	144.9	475	523	East Main Drift	Figure H-2
9	115	122	0.0012		0.0012	0.0121	70	389.33	72.36	202.9	666	732	East Main Drift	Figure H-2
10	122	130	0.0014		0.0014	0.0138	70	389.33	72.36	231.9	761	837	East Main Drift	Figure H-2
11	111	130	0.0018		0.0018	0.0178	30	389.33	72.36	698.5	2292	2521	North Ramp Curve	Figure H-2
12	601	605	0.1001	0.1000	0.0001	0.0010	25	446.53	80.13	67.0	220	242	East Exhaust Main to Empl Shaft	Figure H-2
13	701	605	0.0001		0.0001	0.0009	25	446.53	80.13	57.5	189	208	West Exhaust Main Connector to Empl Shaf	Figure H-2
14	605	17	0.0008		0.0008	0.0082	25	402.49	71.12	431.2	1415	1556	Emplacement Shaft (6.9 m dia.)	Fig. H-4, Appendix H
15	17	18	0.0020	0.0020	0.0000	0.0000	0	0	0	0.0	0	0	Primary Fan- Emplacement Shaft	
16	18	19	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage Loop-1st leg	
17	19	17	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage Loop-2nd leg	
18	18	20	0.0030	0.0030	0.0000	0.0000	0	0	0	0.0	0	0	Surface Discharge - Evase (Outlet Cone)	
19	4	5	0.0072		0.0072	0.0716	60	389.33	72.36	1402.6	4602	5062	South Ramp to PC	Figure H-2
20	5	6	0.0003		0.0003	0.0025	60	389.33	72.36	49.2	161	178	South Ramp	Figure H-2
21	6	7	0.0043		0.0043	0.0427	60	389.33	72.36	835.8	2742	3016	South Ramp	Figure H-2
22	7	8	0.0001		0.0001	0.0012	60	389.33	72.36	23.1	76	83	South Ramp	Figure H-2
23	8	9	0.0012		0.0012	0.0116	60	389.33	72.36	227.2	745	820	South Ramp	Figure H-2
24	9	10	0.0010		0.0010	0.0102	60	389.33	72.36	200.0	656	722	South Ramp Ext Curve	Figure H-2
25	10	16	15.0001	15.0000	0.0001	0.0011	25	446.53	80.13	69.7	229	252	West Main to Development Shaft Drift	Figure H-2
26	23	21	0.0001		0.0001	0.0010	25	446.53	80.13	66.6	219	240	East Exhaust Main to Connector	Appendix H
27	22	21	0.0000		0.0000	0.0004	25	446.53	80.13	26.1	86	94	West Exhaust Main to Connector	Appendix H
28	21	16	0.0004		0.0004	0.0039	25	446.53	80.13	249.3	818	900	Exhaust Main Connecting Drift to Dev Shaft	Figure H-2
29	16	14	0.0026		0.0026	0.0258	95	402.49	71.12	358.8	1177	1295	Dev Shaft (Man/material - 6.9 m dia)	Fig. H-4, Appendix H
30	14	13	0.0020	0.0020	0.0000	0.0000	0	0	0	0.0	0	0	Primary Fan- Development Shaft	
31	13	15	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage 1st leg	
32	15	14	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage 2nd leg	
33	13	12	0.0050	0.0050	0.0000	0.0000	0	0	0	0.0	0	0	Surface Outlet - Evase	
34	12	11	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Dummy Connector	
35	11	14	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Dummy Connector	
36	4	1	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Dummy Connector	
37	20	1	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Dummy Connector	
38	100	600	0.0020		0.0020	0.0200	70	389.33	72.36	336.5	1104	1214	North Main	Figure H-2
39	600	700	0.0001		0.0001	0.0015	70	389.33	72.36	25.1	82	91	North Main	Figure H-2
40	700	200	0.0014		0.0014	0.0144	70	389.33	72.36	241.7	793	872	North Main	Figure H-2

Table B-1. Calculation of Airway Resistances During Monitoring Phase for System A-1.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad01: VNETPC INPUT, Design Feature Development, Case 1 m^3/s per emplacement drift. (Data by RSJurani & A Linden)														
Line No.	BRANCH		RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
	FROM	TO												
41	200	201	0.0014		0.0014	0.0141	70	389.33	72.36	236.1	775	852	West Main	Figure H-2
42	201	202	0.0015		0.0015	0.0147	70	389.33	72.36	246.5	809	890	West main	Figure H-2
43	202	203	0.0003		0.0003	0.0026	70	389.33	72.36	43.5	143	157	West main	Figure H-2
44	203	210	0.0013		0.0013	0.0130	70	389.33	72.36	217.4	713	785	West main	Figure H-2
45	210	215	0.0009		0.0009	0.0086	70	389.33	72.36	144.9	475	523	West main	Figure H-2
46	215	222	0.0012		0.0012	0.0121	70	389.33	72.36	202.9	666	732	West main	Figure H-2
47	222	230	0.0014		0.0014	0.0137	70	389.33	72.36	230.1	755	830	West main	Figure H-2
48	230	233	0.0004		0.0004	0.0042	70	389.33	72.36	70.1	230	253	West main	Figure H-2
49	233	238	0.0009		0.0009	0.0092	70	389.33	72.36	154.5	507	558	West main	Figure H-2
50	238	245	0.0012		0.0012	0.0117	70	389.33	72.36	197.1	647	711	West main	Figure H-2
51	245	253	0.0014		0.0014	0.0136	70	389.33	72.36	228.9	751	826	West main	Figure H-2
52	253	256	0.0004		0.0004	0.0043	70	389.33	72.36	71.5	235	258	West main	Figure H-2
53	256	260	0.0008		0.0008	0.0077	70	389.33	72.36	128.7	422	464	West main	Figure H-2
54	260	266	0.0010		0.0010	0.0102	70	389.33	72.36	171.7	563	620	West main	Figure H-2
55	10	2120	0.0060		0.0060	0.0595	70	389.33	72.36	999.2	3278	3606	West main	Figure H-2
56	2120	2105	0.0028		0.0028	0.0280	70	389.33	72.36	470.3	1543	1697	West main	Figure H-2
57	2105	2103	0.0005		0.0005	0.0047	70	389.33	72.36	78.4	257	283	West main	Figure H-2
58	2103	295	0.0014		0.0014	0.0140	70	389.33	72.36	235.2	772	849	West main	Figure H-2
59	295	292	0.0005		0.0005	0.0045	70	389.33	72.36	75.9	249	274	West main	Figure H-2
60	292	280	0.0022		0.0022	0.0224	70	389.33	72.36	376.2	1234	1358	West main	Figure H-2
61	280	275	0.0008		0.0008	0.0077	70	389.33	72.36	128.7	422	464	West main	Figure H-2
62	275	266	0.0015		0.0015	0.0153	70	389.33	72.36	257.5	845	929	West main	Figure H-2
63	130	133	0.0004		0.0004	0.0043	70	389.33	72.36	72.5	238	262	East Main	Figure H-2
64	133	138	0.0009		0.0009	0.0095	70	389.33	72.36	159.4	523	575	East Main	Figure H-2
65	138	145	0.0012		0.0012	0.0121	70	389.33	72.36	202.9	666	732	East Main	Figure H-2
66	145	153	0.0014		0.0014	0.0138	70	389.33	72.36	231.9	761	837	East Main	Figure H-2
67	153	156	0.0004		0.0004	0.0043	70	389.33	72.36	72.5	238	262	East Main	Figure H-2
68	156	160	0.0008		0.0008	0.0078	70	389.33	72.36	130.4	428	471	East Main	Figure H-2
69	160	166	0.0010		0.0010	0.0104	70	389.33	72.36	173.9	571	628	East Main	Figure H-2
70	6	1120	0.0065		0.0065	0.0651	70	389.33	72.36	1093.1	3586	3945	East Main	Figure H-2
71	1120	1105	0.0026		0.0026	0.0259	70	389.33	72.36	434.8	1427	1569	East Main	Figure H-2
72	1105	1103	0.0004		0.0004	0.0043	70	389.33	72.36	72.5	238	262	East Main	Figure H-2
73	1103	195	0.0013		0.0013	0.0130	70	389.33	72.36	217.4	713	785	East Main	Figure H-2
74	195	180	0.0027		0.0027	0.0268	70	389.33	72.36	449.3	1474	1621	East Main	Figure H-2
75	180	175	0.0008		0.0008	0.0078	70	389.33	72.36	130.4	428	471	East Main	Figure H-2
76	175	166	0.0016		0.0016	0.0155	70	389.33	72.36	260.9	856	942	East Main	Figure H-2
77	2	131	0.0313		0.0313	0.3130	70	177.60	48.44	745.0	2444	2689	ECRB	Figure H-2
78	131	155	0.0119		0.0119	0.1193	70	211.30	52.57	440.8	1446	1591	PC Main	Figure H-2
79	5	1102	0.0395		0.0395	0.3946	70	211.30	52.57	1457.6	4782	5260	PC Main	Figure H-2
80	1102	179	0.0180		0.0180	0.1805	70	211.30	52.57	666.7	2187	2406	PC Main	Figure H-2

Table B-1. Calculation of Airway Resistances During Monitoring Phase for System A-1.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad01: VNETPC INPUT, Design Feature Development, Case 1 m^3/s per emplacement drift. (Data by RSJurani & A Linden)

Line No.	BRANCH FROM	BRANCH TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
81	179	155	0.0188		0.0188	0.1883	70	211.30	52.57	695.7	2282	2511	PC Main	Figure H-2
82	131	132	0.0061		0.0061	0.0612	70	211.30	52.57	225.9	741	815	PC Main	Figure H-2
83	132	133	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 2	Figure H-2
84	131	157	0.5201	0.5000	0.0201	0.2014	70	177.60	48.44	479.4	1573	1730	ECRB	Figure H-2
85	155	156	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 3	Figure H-2
86	179	180	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 4	Figure H-2
87	1102	1103	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 5	Figure H-2
88	666	660	0.0008		0.0008	0.0080	60	401.49	72.36	172.7	567	623	East Exhaust Main	Figure H-2
89	660	656	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	East Exhaust Main	Figure H-2
90	656	653	0.0003		0.0003	0.0034	60	401.49	72.36	72.0	236	260	East Exhaust Main	Figure H-2
91	653	645	0.0011		0.0011	0.0107	60	401.49	72.36	230.3	756	831	East Exhaust Main	Figure H-2
92	645	638	0.0009		0.0009	0.0092	60	401.49	72.36	198.2	650	715	East Exhaust Main	Figure H-2
93	638	633	0.0007		0.0007	0.0072	60	401.49	72.36	154.7	508	558	East Exhaust Main	Figure H-2
94	633	630	0.0003		0.0003	0.0033	60	401.49	72.36	70.4	231	254	East Exhaust Main	Figure H-2
95	630	622	0.0011		0.0011	0.0108	60	401.49	72.36	231.8	760	837	East Exhaust Main	Figure H-2
96	622	615	0.0009		0.0009	0.0094	60	401.49	72.36	202.9	666	732	East Exhaust Main	Figure H-2
97	615	610	0.0007		0.0007	0.0067	60	401.49	72.36	144.9	475	523	East Exhaust Main	Figure H-2
98	610	603	0.0010		0.0010	0.0101	60	401.49	72.36	217.4	713	785	East Exhaust Main	Figure H-2
99	603	602	0.0002		0.0002	0.0020	60	401.49	72.36	43.5	143	157	East Exhaust Main	Figure H-2
100	602	601	0.0019		0.0019	0.0187	60	401.49	72.36	400.7	1315	1446	East Exhaust Main	Figure H-2
101	600	601	1000.0005	1000.0000	0.0005	0.0051	60	401.49	72.36	108.7	357	392	East Exhaust Main Reg (North Ramp Side)	Figure H-2
102	666	667	0.0002		0.0002	0.0016	60	401.49	72.36	33.5	110	121	East Exhaust Main	Figure H-2
103	667	675	0.0011		0.0011	0.0105	60	401.49	72.36	225.6	740	814	East Exhaust Main	Figure H-2
104	675	680	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	East Exhaust Main	Figure H-2
105	680	695	0.0021		0.0021	0.0210	60	401.49	72.36	450.0	1476	1624	East Exhaust Main	Figure H-2
106	695	6103	0.0010		0.0010	0.0105	60	401.49	72.36	225.1	739	812	East Exhaust Main	Figure H-2
107	6103	6105	0.0003		0.0003	0.0035	60	401.49	72.36	75.1	246	271	East Exhaust Main	Figure H-2
108	6105	6120	0.0021		0.0021	0.0210	60	401.49	72.36	450.2	1477	1625	East Exhaust Main	Figure H-2
109	6120	23	0.0040		0.0040	0.0400	60	401.49	72.36	860.1	2822	3104	East Exhaust Main	Figure H-2
110	7	23	1000.0010	1000.0000	0.0010	0.0099	60	401.49	72.36	213.4	700	770	East Exhaust Main Reg (South Ramp Side)	Figure H-2
111	766	760	0.0008		0.0008	0.0080	60	401.49	72.36	172.7	567	623	West Exhaust Main	Figure H-2
112	760	756	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	West Exhaust Main	Figure H-2
113	756	753	0.0003		0.0003	0.0034	60	401.49	72.36	72.0	236	260	West Exhaust Main	Figure H-2
114	753	745	0.0011		0.0011	0.0107	60	401.49	72.36	230.3	756	831	West Exhaust Main	Figure H-2
115	745	738	0.0009		0.0009	0.0092	60	401.49	72.36	198.1	650	715	West Exhaust Main	Figure H-2
116	738	733	0.0007		0.0007	0.0072	60	401.49	72.36	154.7	508	558	West Exhaust Main	Figure H-2
117	733	730	0.0003		0.0003	0.0033	60	401.49	72.36	70.4	231	254	West Exhaust Main	Figure H-2
118	730	722	0.0011		0.0011	0.0107	60	401.49	72.36	230.8	757	833	West Exhaust Main	Figure H-2
119	722	715	0.0009		0.0009	0.0094	60	401.49	72.36	202.9	666	732	West Exhaust Main	Figure H-2
120	715	710	0.0007		0.0007	0.0067	60	401.49	72.36	144.9	475	523	West Exhaust Main	Figure H-2

Table B-1. Calculation of Airway Resistances During Monitoring Phase for System A-1.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad01: VNETPC INPUT, Design Feature Development, Case 1 m^3/s per emplacement drift. (Data by RSJurani & A Linden)

Line No.	BRANCH FROM	BRANCH TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
121	710	703	0.0010		0.0010	0.0101	60	401.49	72.36	217.4	713	785	West Exhaust Main	Figure H-2
122	703	702	0.0002		0.0002	0.0020	60	401.49	72.36	43.5	143	157	West Exhaust Main	Figure H-2
123	702	701	0.0017		0.0017	0.0173	60	401.49	72.36	371.6	1219	1341	West Exhaust Main	Figure H-2
124	700	701	1000.0006	1000.0000	0.0006	0.0064	60	401.49	72.36	138.3	454	499	West Exhaust Main Reg (North Ramp Side)	Figure H-2
125	766	767	0.0002		0.0002	0.0016	60	401.49	72.36	33.5	110	121	West Exhaust Main	Figure H-2
126	767	775	0.0011		0.0011	0.0105	60	401.49	72.36	225.6	740	814	West Exhaust Main	Figure H-2
127	775	780	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	West Exhaust Main	Figure H-2
128	780	795	0.0021		0.0021	0.0210	60	401.49	72.36	450.2	1477	1625	West Exhaust Main	Figure H-2
129	795	7103	0.0010		0.0010	0.0105	60	401.49	72.36	225.1	739	812	West Exhaust Main	Figure H-2
130	7103	7105	0.0003		0.0003	0.0035	60	401.49	72.36	75.1	246	271	West Exhaust Main	Figure H-2
131	7105	7120	0.0021		0.0021	0.0210	60	401.49	72.36	450.2	1477	1625	West Exhaust Main	Figure H-2
132	7120	22	0.0040		0.0040	0.0403	60	401.49	72.36	865.8	2841	3125	West Exhaust Main	Figure H-2
133	8	22	1000.0010	1000.0000	0.0010	0.0100	60	401.49	72.36	214.9	705	776	West Exhaust Main Reg (South Ramp Side)	Figure H-2
134	202	402	0.0348		0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift West Side	Figure H-2
135	203	403	0.0152		0.0152	0.1516	70	211.30	52.57	559.9	1837	2021	PC 1 West Side	Fig. H-2, Appendix H
136	210	410	0.0348		0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift West Side	Figure H-2
137	215	415	0.0165		0.0165	0.1654	70	201.93	52.57	533.3	1750	1925	Emplacement Drift West Side (Empty)	Figure H-2
138	222	422	0.0348		0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift West Side	Figure H-2
139	230	430	0.2146	0.2000	0.0146	0.1457	70	211.30	52.57	538.3	1766	1943	Cross Block 30 West Side	Figure H-2
140	233	433	0.2156	0.2000	0.0156	0.1560	70	211.30	52.57	576.4	1891	2080	PC 2 West Side	Fig. H-2, Appendix H
141	238	438	0.0376		0.0376	0.3760	85	168.13	52.57	576.3	1891	2080	Emplacement Drift West Side	Figure H-2
142	245	445	0.1687	0.1500	0.0187	0.1867	70	201.93	52.57	601.9	1975	2172	Emplacement Drift West Side (Empty)	Figure H-2
143	253	453	0.1197	0.0800	0.0397	0.3970	85	168.13	52.57	608.4	1996	2196	Emplacement Drift West Side	Figure H-2
144	256	456	0.1672	0.1500	0.0172	0.1725	70	211.30	52.57	637.1	2090	2299	PC 3 West Side	Fig. H-2, Appendix H
145	260	460	0.0166		0.0166	0.1662	70	211.30	52.57	614.1	2015	2216	Cross Block 60	Figure H-2
146	266	466	0.2404	0.2000	0.0404	0.4039	85	168.13	52.57	619.0	2031	2234	Emplacement Drift West Side	Figure H-2
147	275	475	0.2409	0.2000	0.0409	0.4087	85	168.13	52.57	626.4	2055	2261	Emplacement Drift West Side	Figure H-2
148	280	281	0.0099		0.0099	0.0992	70	211.30	52.57	366.5	1202	1323	PC 4 West Side 1st leg	Fig. H-2, Appendix H
149	292	281	0.0200		0.0200	0.2001	70	177.60	48.44	476.3	1563	1719	ECRB West Side	Fig. H-2, Appendix H
150	281	467	0.0169		0.0169	0.1693	70	177.60	48.44	403.0	1322	1454	ECRB West Side	Figure H-2
151	281	480	0.0079		0.0079	0.0785	70	211.30	52.57	290.1	952	1047	PC 4 West Side 2nd leg	Figure H-2
152	295	495	0.2410	0.2000	0.0410	0.4104	85	168.13	52.57	629.0	2064	2270	Emplacement Drift West Side	Figure H-2
153	2103	4103	0.0171		0.0171	0.1708	70	211.30	52.57	630.8	2070	2277	PC 5 West Side	Fig. H-2, Appendix H
154	2105	4105	0.2161	0.2000	0.0161	0.1613	70	211.30	52.57	595.9	1955	2151	Cross Block 105	Figure H-2
155	2120	4120	0.2356	0.2000	0.0356	0.3565	85	168.13	52.57	546.3	1792	1972	Emplacement Drift West Side	Figure H-2
156	102	402	0.2348	0.2000	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift East Side	Figure H-2
157	103	403	0.2152	0.2000	0.0152	0.1516	70	211.30	52.57	559.9	1837	2021	PC 1 East Side	Fig. H-2, Appendix H
158	110	410	0.2348	0.2000	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift East Side	Figure H-2
159	115	415	0.2165	0.2000	0.0165	0.1654	70	201.93	52.57	533.3	1750	1925	Emplacement Drift East Side (Empty)	Figure H-2
160	122	422	0.2348	0.2000	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift East Side	Figure H-2

Table B-1. Calculation of Airway Resistances During Monitoring Phase for System A-1.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad01: VNETPC INPUT, Design Feature Development, Case 1 m^3/s per emplacement drift. (Data by RSJurani & A Linden)

Line No.	BRANCH FROM	BRANCH TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
161	130	430	0.5146	0.5000	0.0146	0.1457	70	211.30	52.57	538.3	1766	1943	Cross Block 30	Figure H-2
162	133	433	0.5156	0.5000	0.0156	0.1560	70	211.30	52.57	576.4	1891	2080	PC 2 East	Fig. H-2, Appendix H
163	138	438	0.2376	0.2000	0.0376	0.3760	85	168.13	52.57	576.3	1891	2080	Emplacement Drift East Side	Figure H-2
164	145	445	0.4187	0.4000	0.0187	0.1867	70	201.93	52.57	601.9	1975	2172	Emplacement Drift East Side (Empty)	Figure H-2
165	153	453	0.3897	0.3500	0.0397	0.3970	85	168.13	52.57	608.4	1996	2196	Emplacement Drift East Side	Figure H-2
166	156	157	0.4598	0.4500	0.0098	0.0982	70	211.30	52.57	362.9	1191	1310	PC 3 East Side 1st leg	Fig. H-2, Appendix H
167	157	456	0.2074	0.2000	0.0074	0.0742	70	211.30	52.57	274.2	900	990	PC 3 East Side 2nd leg	Figure H-2
168	157	467	0.0160		0.0160	0.1600	70	177.60	48.44	380.9	1250	1375	ECRB	Figure H-2
169	160	460	0.3166	0.3000	0.0166	0.1662	70	211.30	52.57	614.1	2015	2216	Cross Block 60	Figure H-2
170	166	466	0.5404	0.5000	0.0404	0.4039	85	168.13	52.57	619.0	2031	2234	Emplacement Drift East Side	Figure H-2
171	175	475	0.5409	0.5000	0.0409	0.4087	85	168.13	52.57	626.4	2055	2261	Emplacement Drift East Side	Figure H-2
172	180	480	0.2678	0.2500	0.0178	0.1778	70	211.30	52.57	656.6	2154	2370	PC 4 East Side	Fig. H-2, Appendix H
173	195	495	0.5410	0.5000	0.0410	0.4104	85	168.13	52.57	629.0	2064	2270	Emplacement Drift East Side	Figure H-2
174	1103	4103	0.2171	0.2000	0.0171	0.1708	70	211.30	52.57	630.8	2070	2277	PC 5 East Side	Fig. H-2, Appendix H
175	1105	4105	0.5161	0.5000	0.0161	0.1613	70	211.30	52.57	595.9	1955	2151	Cross Block 105	Figure H-2
176	1120	4120	0.5356	0.5000	0.0356	0.3565	85	168.13	52.57	546.3	1792	1972	Emplacement Drift East Side	Figure H-2
177	402	502	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Empl Level to Exhaust Ma	Appendix H
178	403	503	0.0702		0.0702	0.7022	20	24.43	17.52	42.1	138	152	Raise Connector, PC Level to Exhaust Main	Appendix H
179	410	510	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Empl Level to Exhaust Ma	Appendix H
180	415	515	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Emp Level to Exhaust Mai	Appendix H
181	422	522	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Emp Level to Exhaust Mai	Appendix H
182	430	530	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Emp Level to Exhaust Mai	Appendix H
183	433	533	0.0706		0.0706	0.7055	20	24.43	17.52	42.3	139	153	Raise Connector, PC Level to Exhaust Main	Appendix H
184	438	538	0.0280		0.0280	0.2802	20	24.43	17.52	16.8	55	61	Raise Connector, Emp Level to Exhaust Mai	Appendix H
185	445	545	0.0285		0.0285	0.2852	20	24.43	17.52	17.1	56	62	Raise Connector, Emp Level to Exhaust Mai	Appendix H
186	453	553	0.0289		0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Emp Level to Exhaust Mai	Appendix H
187	456	556	0.0714		0.0714	0.7139	20	24.43	17.52	42.8	140	154	Raise Connector, PC Level to Exhaust Main	Appendix H
188	460	560	0.0289		0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Emp Level to Exhaust Mai	Appendix H
189	466	566	0.0289		0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Emp Level to Exhaust Mai	Appendix H
190	467	567	0.0709		0.0709	0.7089	20	24.43	17.52	42.5	139	153	Raise Connector, ECRB Level to Exh Main	Appendix H
191	475	575	0.0289		0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Emp Level to Exhaust Mai	Appendix H
192	480	580	0.0714		0.0714	0.7139	20	24.43	17.52	42.8	140	154	Raise Connector, PC Level to Exhaust Main	Appendix H
193	495	595	0.0284		0.0284	0.2835	20	24.43	17.52	17.0	56	61	Raise Connector, Emp Level to Exhaust Mai	Appendix H
194	4103	5103	0.0714		0.0714	0.7139	20	24.43	17.52	42.8	140	154	Raise Connector, PC Level to Exhaust Main	Appendix H
195	4105	5105	0.0284		0.0284	0.2835	20	24.43	17.52	17.0	56	61	Raise Connector, Emp Level to Exhaust Mai	Appendix H
196	4120	5120	0.0284		0.0284	0.2835	20	24.43	17.52	17.0	56	61	Raise Connector, Emp Level to Exhaust Mai	Appendix H
197	502	602	0.0497	0.0100	0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exhaust Main	Figure H-2
198	503	603	0.0497	0.0100	0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exhaust Main	Figure H-2
199	510	610	0.0497	0.0100	0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exhaust Main	Figure H-2
200	515	615	0.0497	0.0100	0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exhaust Main	Figure H-2

Table B-1. Calculation of Airway Resistances During Monitoring Phase for System A-1.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad01: VNETPC INPUT, Design Feature Development, Case 1 m^3/s per emplacement drift. (Data by RSJurani & A Linden)														
Line No.	BRANCH FROM	TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
201	522	622	0.0497	0.0100	0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exhaust Main	Figure H-2
202	530	630	99000.0387	99000.0000	0.0387	0.3870	20	24.43	17.52	23.2	76	84	Horizontal Raise Connector of Exhaust Main	Figure H-2
203	533	633	99000.0385	99000.0000	0.0385	0.3853	20	24.43	17.52	23.1	76	83	Horizontal Raise Connector of Exhaust Main	Figure H-2
204	538	638	0.0485	0.0100	0.0385	0.3853	20	24.43	17.52	23.1	76	83	Horizontal Raise Connector of Exhaust Main	Figure H-2
205	545	645	0.1394	0.1000	0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exhaust Main	Figure H-2
206	553	653	0.0494	0.0100	0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exhaust Main	Figure H-2
207	556	656	0.1394	0.1000	0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exhaust Main	Figure H-2
208	560	660	1.0397	1.0000	0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exhaust Main	Figure H-2
209	566	666	0.0494	0.0100	0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exhaust Main	Figure H-2
210	567	667	10.0394	10.0000	0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exhaust Main	Figure H-2
211	575	675	0.0494	0.0100	0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exhaust Main	Figure H-2
212	580	680	10.0397	10.0000	0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exhaust Main	Figure H-2
213	595	695	0.0512	0.0100	0.0412	0.4120	20	24.43	17.52	24.7	81	89	Horizontal Raise Connector of Exhaust Main	Figure H-2
214	5103	6103	0.1412	0.1000	0.0412	0.4120	20	24.43	17.52	24.7	81	89	Horizontal Raise Connector of Exhaust Main	Figure H-2
215	5105	6105	0.1412	0.1000	0.0412	0.4120	20	24.43	17.52	24.7	81	89	Horizontal Raise Connector of Exhaust Main	Figure H-2
216	5120	6120	0.0512	0.0100	0.0412	0.4120	20	24.43	17.52	24.7	81	89	Horizontal Raise Connector of Exhaust Main	Figure H-2
217	502	702	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
218	503	703	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
219	510	710	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
220	515	715	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
221	522	722	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
222	530	730	0.1000	0.1000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
223	533	733	0.1000	0.1000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
224	538	738	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
225	545	745	0.5000	0.5000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
226	553	753	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
227	556	756	0.5000	0.5000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
228	560	760	1.0000	1.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
229	566	766	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
230	567	767	0.5000	0.5000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
231	575	775	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
232	580	780	10.0000	10.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
233	595	795	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
234	5103	7103	10.0000	10.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
235	5105	7105	0.1000	0.1000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
236	5120	7120	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
237	3	104	0.0178		0.0178	0.1775	70	211.30	52.57	655.7	2151	2366	PC 1 North Ramp Side 1st leg	Figure H-2
238	104	103	0.0067		0.0067	0.0670	70	211.30	52.57	247.5	812	893	PC 1 North Ramp Side 2nd leg	Figure H-2
239	1	24	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
240	4	24	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	

Table B-1. Calculation of Airway Resistances During Monitoring Phase for System A-1.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad01: VNETPC INPUT, Design Feature Development, Case 1 m^3/s per emplacement drift. (Data by RSJurani & A Linden)

Line No.	BRANCH FROM	BRANCH TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
241	24	25	0.0001		0.0001	0.0007	25	828.57	102.04	240.3	788	867	Intake Shaft 9.9 m dia	Fig. H-4, Appendix H
242	25	133	2.0009	2.0000	0.0009	0.0093	25	389.33	72.36	437.9	1437	1580	Shaft Connecting Drift 7.62 dia	Fig. H-4
243	25	145	0.1005	0.1000	0.0005	0.0049	25	446.53	80.13	314.5	1032	1135	Connecting Drift	Figure H-4
244	25	245	0.0040		0.0040	0.0397	25	389.33	72.36	1864.8	6118	6730	Shaft Connecting Drift 7.62 dia	Fig. H-4, Appendix H
245	760	26	0.5001	0.5000	0.0001	0.0006	25	389.33	72.36	26.1	86	94	West Exhaust Main to Connector Drift	Appendix H
246	660	26	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector Drift	Appendix H
247	680	27	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector Drift	Appendix H
248	780	27	2.0001	2.0000	0.0001	0.0006	25	389.33	72.36	26.1	86	94	West Exhaust Main to Connector Drift	Appendix H
249	26	28	0.0005		0.0005	0.0048	25	446.53	80.13	305.6	1003	1103	Connecting Access Drift	Fig. H-4, Appendix H
250	27	28	0.0008		0.0008	0.0079	25	446.53	80.13	506.7	1662	1829	Connecting Access Drift	Fig. H-4, Appendix H
251	28	29	0.0001		0.0001	0.0013	25	828.57	102.04	408.3	1340	1474	Exhaust Shaft 9.9 m dia	Fig. H-4, Appendix H
252	29	30	0.0010	0.0010	0.0000	0.0000	0	0	0	0.0	0	0	Primary Fan	
253	30	31	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage	
254	31	29	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage	
255	30	32	0.0015	0.0015	0.0000	0.0000	0	0	0	0.0	0	0	Evase	
256	32	33	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
257	33	20	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
258	32	34	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
259	34	35	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
260	35	12	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	

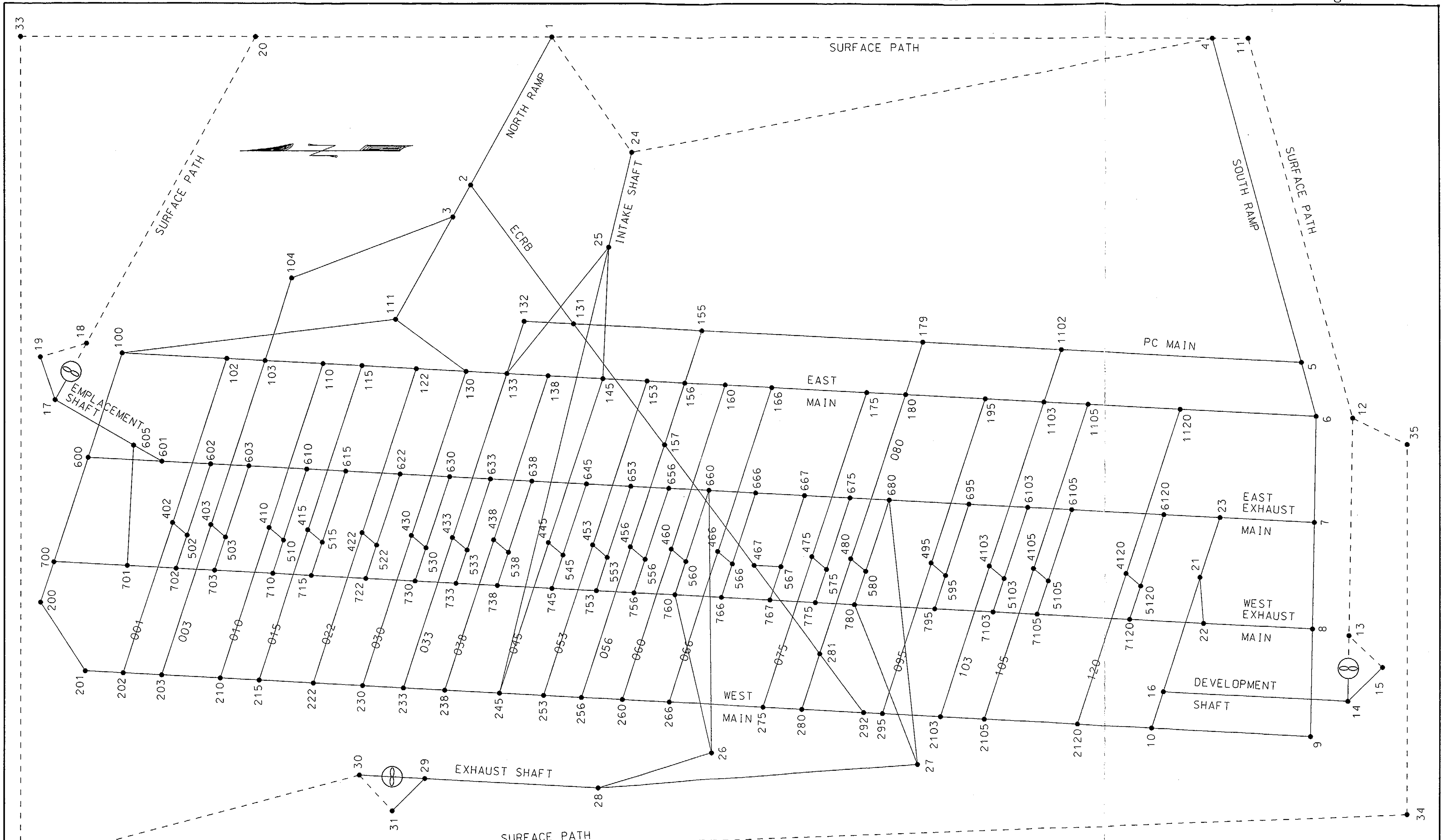


FIGURE B-1
SCHEMATIC OF VENTILATION NODES
SYSTEM A - 1.0 m³/sec

APPENDIX C

VNETPC OUTPUT FOR SYSTEM A–1.0 cms

APPENDIX C

VNETPC OUTPUT FOR SYSTEM A–1.0 cms

This appendix contains fan airflow and air power data obtained from VNETPC file, VNETWIN\REPLAD01.VNW.

See Appendix C, page 17 for fan results showing airflow and airpower values.

Total Fan Airflow (kcfm) = 583.18 + 574.97 + 627.41 = 1,785.56 kcfm
Note: 1 cfm = 0.000472 m^3/s
Total Fan Airflow (m^3/s) = 1,785,560 cfm x 0.000472 = 842.78 or approximately 843 m^3/s

Total Air Power (hp) = 656.13 + 679.60 + 434.02 = 1,769.75 hp.
Note: Fan Efficiency = 75 % (Section 4.1.7)
Brake horsepower = 1,769.75 / 75% =2,359.67 or approximately 2,360 hp.

Note: 1 hp. = 0.746 kW.
Power Consumption = 2,359.67 hp. x 0.746 = 1,760.31 or approximately 1,760 kW.

Appendix C is arranged in the following order:

Inputs on K Factors, Airway Cross Sectional Areas and Perimeters are contained in Section 4.2.1.
Branch Resistance is calculated in Appendix B.
Fan Efficiency = 75% (Section 4.1.7.)
Cost of Power = $ 0.10 per kWh (Section 4.2.19)
Fan locations, nodes and branches are shown in Figure B-1

EPOSITORY LA DESIGN FEATURE
YUCCA MOUNTAIN PROJECT
M&O/MK/RSJURANI
DUAL EXHAUST @1.0 M3S/EMPL DRIFT

Avg. Fan Efficiency: 75.0 %
Cost of Power: 10.00 c/kWh
Reference Junction: 1
Units: British

Number of Branches: 260
Number of Junctions: 171
Number of Fans: 3
Fixed Quantities: 1

Last Airflow Analysis
Date: 05/08/99
Time: 12:52 AM
Elapsed Time: 00:00:02

Number of Iterations: 3
Number of Errors: 0
Modified Since: NO

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
1	1	2		R	0.00510								
2	2	3		R	0.00010								
3	3	111		R	0.00040								
4	111	100		R	0.00390								
5	100	102		R	0.00390								
6	102	103		R	0.00030								
7	103	110		R	0.00130								
8	110	115		R	0.00090								
9	115	122		R	0.00120								
10	122	130		R	0.00140								
11	111	130		R	0.00180								
12	601	605		R	0.10010								
13	701	605		R	0.00010								
14	605	17		R	0.00080								
15	17	18	F	R	0.00200								
16	18	19		R	1000.00000								
17	19	17		R	1000.00000								
18	18	20		R	0.00300								
19	4	5		R	0.00720								
20	5	6		R	0.00030								
21	6	7		R	0.00430								
22	7	8		R	0.00010								
23	8	9		R	0.00120								
24	9	10		R	0.00100								
25	10	16		R	15.00010								
26	23	21		R	0.00010								
27	22	21		R	0.00000								
28	21	16		R	0.00040								
29	16	14		R	0.00260								
30	14	13	F	R	0.00200								
31	13	15		R	1000.00000								
32	15	14		R	1000.00000								
33	13	12		R	0.00500								
34	12	11		R	0.00000								
35	11	4		R	0.00000								
36	4	1		R	0.00000								
37	20	1		R	0.00000								
38	100	600		R	0.00200								
39	600	700		R	0.00010								
40	700	200		R	0.00140								
41	200	201		R	0.00140								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
42	201	202		R	0.00150								
43	202	203		R	0.00030								
44	203	210		R	0.00130								
45	210	215		R	0.00090								
46	215	222		R	0.00120								
47	222	230		R	0.00140								
48	230	233		R	0.00040								
49	233	238		R	0.00090								
50	238	245		R	0.00120								
51	245	253		R	0.00140								
52	253	256		R	0.00040								
53	256	260		R	0.00080								
54	260	266		R	0.00100								
55	10	2120		R	0.00600								
56	2120	2105		R	0.00280								
57	2105	2103		R	0.00050								
58	2103	295		R	0.00140								
59	295	292		R	0.00050								
60	292	280		R	0.00220								
61	280	275		R	0.00080								
62	275	266		R	0.00150								
63	130	133		R	0.00040								
64	133	138		R	0.00090								
65	138	145		R	0.00120								
66	145	153		R	0.00140								
67	153	156		R	0.00040								
68	156	160		R	0.00080								
69	160	166		R	0.00100								
70	6	1120		R	0.00650								
71	1120	1105		R	0.00260								
72	1105	1103		R	0.00040								
73	1103	195		R	0.00130								
74	195	180		R	0.00270								
75	180	175		R	0.00080								
76	175	166		R	0.00160								
77	2	131		R	0.03130								
78	131	155		R	0.01190								
79	5	1102		R	0.03950								
80	1102	179		R	0.01800								
81	179	155		R	0.01880								
82	131	132		R	0.00610								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
83	132	133		R	0.00090								
84	131	157		R	0.52010								
85	155	156		R	0.00090								
86	179	180		R	0.00090								
87	1102	1103		R	0.00090								
88	666	660		R	0.00080								
89	660	656		R	0.00060								
90	656	653		R	0.00030								
91	653	645		R	0.00110								
92	645	638		R	0.00090								
93	638	633		R	0.00070								
94	633	630		R	0.00030								
95	630	622		R	0.00110								
96	622	615		R	0.00090								
97	615	610		R	0.00070								
98	610	603		R	0.00100								
99	603	602		R	0.00020								
100	602	601		R	0.00190								
101	600	601		R	1000.00050								
102	666	667		R	0.00020								
103	667	675		R	0.00110								
104	675	680		R	0.00060								
105	680	695		R	0.00210								
106	695	6103		R	0.00100								
107	6103	6105		R	0.00030								
108	6105	6120		R	0.00210								
109	6120	23		R	0.00400								
110	7	23		R	1000.00100								
111	766	760		R	0.00080								
112	760	756		R	0.00060								
113	756	753		R	0.00030								
114	753	745		R	0.00110								
115	745	738		R	0.00090								
116	738	733		R	0.00070								
117	733	730		R	0.00030								
118	730	722		R	0.00110								
119	722	715		R	0.00090								
120	715	710		R	0.00070								
121	710	703		R	0.00100								
122	703	702		R	0.00020								
123	702	701		R	0.00170								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
124	700	701		R	1000.00060								
125	766	767		R	0.00020								
126	767	775		R	0.00110								
127	775	780		R	0.00060								
128	780	795		R	0.00210								
129	795	7103		R	0.00100								
130	7103	7105		R	0.00030								
131	7105	7120		R	0.00210								
132	7120	22		R	0.00400								
133	8	22		R	1000.00100								
134	202	402		R	0.03480								
135	203	403		R	0.01520								
136	210	410		R	0.03480								
137	215	415		R	0.01650								
138	222	422		R	0.03480								
139	230	430		R	0.21460								
140	233	433		R	0.21560								
141	238	438		R	0.03760								
142	245	445		R	0.16870								
143	253	453		R	0.11970								
144	256	456		R	0.16720								
145	260	460		R	0.01660								
146	266	466		R	0.24040								
147	275	475		R	0.24090								
148	280	281		R	0.00990								
149	292	281		R	0.02000								
150	281	467		R	0.01690								
151	281	480		R	0.00790								
152	295	495		R	0.24100								
153	2103	4103		R	0.01710								
154	2105	4105		R	0.21610								
155	2120	4120		R	0.23560								
156	102	402		R	0.23480								
157	103	403		R	0.21520								
158	110	410		R	0.23480								
159	115	415		R	0.21650								
160	122	422		R	0.23480								
161	130	430		R	0.51460								
162	133	433		R	0.51560								
163	138	438		R	0.23760								
164	145	445		R	0.41870								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
165	153	453		R	0.38970								
166	156	157		R	0.45980								
167	157	456		R	0.20740								
168	157	467		R	0.01600								
169	160	460		R	0.31660								
170	166	466		R	0.54040								
171	175	475		R	0.54090								
172	180	480		R	0.26780								
173	195	495		R	0.54100								
174	1103	4103		R	0.21710								
175	1105	4105		R	0.51610								
176	1120	4120		R	0.53560								
177	402	502		R	0.02770								
178	403	503		R	0.07020								
179	410	510		R	0.02770								
180	415	515		R	0.02770								
181	422	522		R	0.02770								
182	430	530		R	0.02770								
183	433	533		R	0.07060								
184	438	538		R	0.02800								
185	445	545		R	0.02850								
186	453	553		R	0.02890								
187	456	556		R	0.07140								
188	460	560		R	0.02890								
189	466	566		R	0.02890								
190	467	567		R	0.07090								
191	475	575		R	0.02890								
192	480	580		R	0.07140								
193	495	595		R	0.02840								
194	4103	5103		R	0.07140								
195	4105	5105		R	0.02840								
196	4120	5120		R	0.02840								
197	502	602		R	0.04970								
198	503	603		R	0.04970								
199	510	610		R	0.04970								
200	515	615		R	0.04970								
201	522	622		R	0.04970								
202	530	630		R	99000.03870								
203	533	633		R	99000.03850								
204	538	638		R	0.04850								
205	545	645		R	0.13940								

Branch No.	From	To	FQi	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
206	553	653		R	0.04940								
207	556	656		R	0.13940								
208	560	660		R	1.03970								
209	566	666		R	0.04940								
210	567	667		R	10.03940								
211	575	675		R	0.04940								
212	580	680		R	10.03970								
213	595	695		R	0.05120								
214	5103	6103		R	0.14120								
215	5105	6105		R	0.14120								
216	5120	6120		R	0.05120								
217	502	702		R	99000.00000								
218	503	703		R	99000.00000								
219	510	710		R	99000.00000								
220	515	715		R	99000.00000								
221	522	722		R	99000.00000								
222	530	730		R	0.10000								
223	533	733		R	0.10000								
224	538	738		R	99000.00000								
225	545	745		R	0.50000								
226	553	753		R	99000.00000								
227	556	756		R	0.50000								
228	560	760		R	1.00000								
229	566	766		R	99000.00000								
230	567	767		R	0.50000								
231	575	775		R	99000.00000								
232	580	780		R	10.00000								
233	595	795		R	99000.00000								
234	5103	7103		R	10.00000								
235	5105	7105		R	0.10000								
236	5120	7120		R	99000.00000								
237	3	104		R	0.01780								
238	104	103		R	0.00670								
239	1	24		R	0.00000								
240	4	24		R	0.00000								
241	24	25		R	0.00010								
242	25	133		R	2.00090								
243	25	145		R	0.10050								
244	25	245		R	0.00400								
245	760	26		R	0.50010								
246	660	26		R	0.00010								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
247	680	27		R	0.00010								
248	780	27		R	2.00010								
249	26	28		R	0.00050								
250	27	28		R	0.00080								
251	28	29		R	0.00010								
252	29	30	F	R	0.00100								
253	30	31		R	1000.00000								
254	31	29	Q	R	1000.00000								
255	30	32		R	0.00150								
256	32	33		R	0.00000								
257	33	20		R	0.00000								
258	32	34		R	0.00000								
259	34	35		R	0.00000								
260	35	12		R	0.00000								

Branch No.	From	To	F R B	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
1	1	2		0.00510	537.94	1475.8	125.10	109000
2	2	3		0.00010	464.64	21.6	1.58	1378
3	3	111		0.00040	382.94	58.7	3.54	3086
4	111	100		0.00390	164.69	105.8	2.75	2392
5	100	102		0.00390	-8.79	-0.3	0.00	0
6	102	103		0.00030	-43.48	-0.6	0.00	0
7	103	110		0.00130	6.29	0.1	0.00	0
8	110	115		0.00090	-28.91	-0.8	0.00	0
9	115	122		0.00120	-63.08	-4.8	0.05	42
10	122	130		0.00140	-98.92	-13.7	0.21	186
11	111	130		0.00180	218.24	85.7	2.95	2568
12	601	605		0.10010	161.18	2600.5	66.05	57549
13	701	605		0.00010	420.21	17.7	1.17	1021
14	605	17		0.00080	581.39	270.4	24.77	21584
15	17	18	F	0.00200	583.18	680.2	62.51	54464
16	18	19		1000.00000	1.80	3230.0	0.92	798
17	19	17		1000.00000	1.80	3230.0	0.92	798
18	18	20		0.00300	581.39	1014.0	92.90	80942
19	4	5		0.00720	444.01	1419.4	99.31	86529
20	5	6		0.00030	365.93	40.2	2.32	2020
21	6	7		0.00430	205.60	181.8	5.89	5132
22	7	8		0.00010	204.00	4.2	0.14	118
23	8	9		0.00120	202.39	49.2	1.57	1367
24	9	10		0.00100	202.39	41.0	1.31	1139
25	10	16		15.00010	13.19	2608.1	5.42	4723
26	23	21		0.00010	393.95	15.5	0.96	838
27	22	21		0.00000	165.99	0.0	0.00	0
28	21	16		0.00040	559.94	125.4	11.06	9641
29	16	14		0.00260	573.12	854.0	77.12	67200
30	14	13	F	0.00200	574.97	661.2	59.91	52197
31	13	15		1000.00000	1.85	3420.1	1.00	869
32	15	14		1000.00000	1.85	3420.1	1.00	869
33	13	12		0.00500	573.12	1642.3	148.32	129230
34	12	11		0.00000	534.82	0.0	0.00	0
35	11	4		0.00000	534.82	0.0	0.00	0
36	4	1		0.00000	534.82	0.0	0.00	0
37	20	1		0.00000	1245.61	0.0	0.00	0
38	100	600		0.00200	173.49	60.2	1.65	1434
39	600	700		0.00010	172.56	3.0	0.08	71
40	700	200		0.00140	170.71	40.8	1.10	956
41	200	201		0.00140	170.71	40.8	1.10	956
42	201	202		0.00150	170.71	43.7	1.18	1024
43	202	203		0.00030	118.83	4.2	0.08	69
44	203	210		0.00130	77.60	7.8	0.10	83
45	210	215		0.00090	26.86	0.7	0.00	0
46	215	222		0.00120	-28.20	-1.0	0.00	0
47	222	230		0.00140	-80.41	-9.1	0.12	100
48	230	233		0.00040	-143.01	-8.2	0.18	161
49	233	238		0.00090	-199.22	-35.7	1.12	976
50	238	245		0.00120	-261.83	-82.3	3.40	2959
51	245	253		0.00140	324.84	147.7	7.56	6587
52	253	256		0.00040	267.51	28.6	1.21	1050
53	256	260		0.00080	217.39	37.8	1.29	1128
54	260	266		0.00100	172.20	29.7	0.81	702
55	10	2120		0.00600	189.21	214.8	6.40	5580
56	2120	2105		0.00280	131.47	48.4	1.00	874
57	2105	2103		0.00050	66.01	2.2	0.02	20

Branch No.	From	To	F R B	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
58	2103	295		0.00140	19.91	0.6	0.00	0
59	295	292		0.00050	-31.86	-0.5	0.00	0
60	292	280		0.00220	-43.79	-4.2	0.03	25
61	280	275		0.00080	-70.50	-4.0	0.04	39
62	275	266		0.00150	-121.48	-22.1	0.42	369
63	130	133		0.00040	74.11	2.2	0.03	22
64	133	138		0.00090	62.27	3.5	0.03	30
65	138	145		0.00120	26.20	0.8	0.00	0
66	145	153		0.00140	112.54	17.7	0.31	273
67	153	156		0.00040	73.38	2.2	0.03	22
68	156	160		0.00080	74.25	4.4	0.05	45
69	160	166		0.00100	43.35	1.9	0.01	0
70	6	1120		0.00650	160.33	167.1	4.22	3678
71	1120	1105		0.00260	114.82	34.3	0.62	541
72	1105	1103		0.00040	65.34	1.7	0.02	0
73	1103	195		0.00130	76.38	7.6	0.09	80
74	195	180		0.00270	33.90	3.1	0.02	14
75	180	175		0.00080	39.47	1.2	0.01	0
76	175	166		0.00160	-2.27	0.0	0.00	0
77	2	131		0.03130	73.30	168.2	1.94	1693
78	131	155		0.01190	44.39	23.4	0.16	143
79	5	1102		0.03950	78.08	240.8	2.96	2581
80	1102	179		0.01800	25.48	11.7	0.05	41
81	179	155		0.01880	-15.18	-4.3	0.01	9
82	131	132		0.00610	1.41	0.0	0.00	0
83	132	133		0.00090	1.41	0.0	0.00	0
84	131	157		0.52010	27.51	393.5	1.71	1486
85	155	156		0.00090	29.21	0.8	0.00	0
86	179	180		0.00090	40.66	1.5	0.01	0
87	1102	1103		0.00090	52.59	2.5	0.02	18
88	666	660		0.00080	-82.98	-5.5	0.07	63
89	660	656		0.00060	-537.54	-173.4	14.69	12798
90	656	653		0.00030	-499.08	-74.7	5.87	5119
91	653	645		0.00110	-402.71	-178.4	11.32	9864
92	645	638		0.00090	-360.32	-116.8	6.63	5778
93	638	633		0.00070	-261.77	-48.0	1.98	1725
94	633	630		0.00030	-261.84	-20.6	0.85	741
95	630	622		0.00110	-261.91	-75.5	3.12	2715
96	622	615		0.00090	-174.01	-27.3	0.75	652
97	615	610		0.00070	-84.93	-5.1	0.07	59
98	610	603		0.00100	0.85	0.0	0.00	0
99	603	602		0.00020	73.85	1.1	0.01	0
100	602	601		0.00190	160.26	48.8	1.23	1074
101	600	601		1000.00050	0.92	852.9	0.12	108
102	666	667		0.00020	174.68	6.1	0.17	146
103	667	675		0.00110	184.10	37.3	1.08	943
104	675	680		0.00060	276.70	45.9	2.00	1744
105	680	695		0.00210	91.38	17.5	0.25	220
106	695	6103		0.00100	185.53	34.4	1.01	876
107	6103	6105		0.00030	261.06	20.4	0.84	731
108	6105	6120		0.00210	289.20	175.6	8.00	6973
109	6120	23		0.00400	392.35	615.7	38.07	33167
110	7	23		1000.00100	1.60	2561.8	0.65	563
111	766	760		0.00080	25.53	0.5	0.00	0
112	760	756		0.00060	108.27	7.0	0.12	104
113	756	753		0.00030	156.82	7.4	0.18	159
114	753	745		0.00110	156.94	27.1	0.67	584

Branch No.	From	To	F R B	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
115	745	738		0.00090	211.92	40.4	1.35	1175
116	738	733		0.00070	212.06	31.5	1.05	917
117	733	730		0.00030	309.69	28.8	1.41	1225
118	730	722		0.00110	417.56	191.8	12.62	10996
119	722	715		0.00090	417.71	157.0	10.33	9004
120	715	710		0.00070	417.87	122.2	8.05	7011
121	710	703		0.00100	418.03	174.7	11.51	10027
122	703	702		0.00020	418.19	35.0	2.31	2010
123	702	701		0.00170	418.35	297.5	19.61	17088
124	700	701		1000.00060	1.85	3433.1	1.00	872
125	766	767		0.00020	-25.42	-0.1	0.00	0
126	767	775		0.00110	32.41	1.2	0.01	0
127	775	780		0.00060	32.52	0.6	0.00	0
128	780	795		0.00210	65.26	8.9	0.09	80
129	795	7103		0.00100	65.37	4.3	0.04	39
130	7103	7105		0.00030	77.48	1.8	0.02	0
131	7105	7120		0.00210	164.28	56.7	1.47	1279
132	7120	22		0.00400	164.38	108.1	2.80	2440
133	8	22		1000.00100	1.60	2573.2	0.65	565
134	202	402		0.03480	51.89	93.7	0.77	668
135	203	403		0.01520	41.23	25.8	0.17	146
136	210	410		0.03480	50.74	89.6	0.72	624
137	215	415		0.01650	55.06	50.0	0.43	378
138	222	422		0.03480	52.21	94.9	0.78	680
139	230	430		0.21460	62.60	841.0	8.30	7228
140	233	433		0.21560	56.20	681.0	6.03	5255
141	238	438		0.03760	62.62	147.4	1.45	1267
142	245	445		0.16870	58.14	570.3	5.22	4552
143	253	453		0.11970	57.34	393.5	3.56	3098
144	256	456		0.16720	50.12	420.0	3.32	2890
145	260	460		0.01660	45.18	33.9	0.24	210
146	266	466		0.24040	50.73	618.6	4.94	4309
147	275	475		0.24090	50.97	626.0	5.03	4381
148	280	281		0.00990	26.71	7.1	0.03	26
149	292	281		0.02000	11.94	2.9	0.01	5
150	281	467		0.01690	48.30	39.4	0.30	261
151	281	480		0.00790	-9.66	-0.7	0.00	0
152	295	495		0.24100	51.77	645.9	5.27	4591
153	2103	4103		0.01710	46.09	36.3	0.26	230
154	2105	4105		0.21610	65.46	926.0	9.55	8322
155	2120	4120		0.23560	57.74	785.5	7.15	6227
156	102	402		0.23480	34.69	282.5	1.54	1346
157	103	403		0.21520	31.93	219.4	1.10	962
158	110	410		0.23480	35.20	291.0	1.61	1406
159	115	415		0.21650	34.17	252.8	1.36	1186
160	122	422		0.23480	35.83	301.5	1.70	1483
161	130	430		0.51460	45.21	1052.0	7.49	6530
162	133	433		0.51560	41.35	881.7	5.74	5006
163	138	438		0.23760	36.07	309.1	1.76	1531
164	145	445		0.41870	39.23	644.3	3.98	3470
165	153	453		0.38970	39.16	597.6	3.69	3213
166	156	157		0.45980	28.34	369.3	1.65	1437
167	157	456		0.20740	36.89	282.2	1.64	1429
168	157	467		0.01600	18.96	5.8	0.02	15
169	160	460		0.31660	30.90	302.3	1.47	1283
170	166	466		0.54040	41.08	911.9	5.90	5143
171	175	475		0.54090	41.74	942.4	6.20	5401

Branch No.	From	To	F R B	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
172	180	480		0.26780	35.09	329.8	1.82	1589
173	195	495		0.54100	42.48	976.4	6.54	5695
174	1103	4103		0.21710	41.54	374.7	2.45	2137
175	1105	4105		0.51610	49.49	1263.9	9.86	8588
176	1120	4120		0.53560	45.51	1109.3	7.96	6931
177	402	502		0.02770	86.57	207.6	2.83	2468
178	403	503		0.07020	73.16	375.7	4.33	3774
179	410	510		0.02770	85.94	204.6	2.77	2414
180	415	515		0.02770	89.23	220.6	3.10	2703
181	422	522		0.02770	88.05	214.7	2.98	2596
182	430	530		0.02770	107.81	322.0	5.47	4766
183	433	533		0.07060	97.55	671.9	10.33	8999
184	438	538		0.02800	98.68	272.7	4.24	3695
185	445	545		0.02850	97.37	270.2	4.15	3612
186	453	553		0.02890	96.49	269.1	4.09	3565
187	456	556		0.07140	87.01	540.5	7.41	6457
188	460	560		0.02890	76.08	167.3	2.01	1748
189	466	566		0.02890	91.81	243.6	3.52	3071
190	467	567		0.07090	67.26	320.7	3.40	2962
191	475	575		0.02890	92.71	248.4	3.63	3162
192	480	580		0.07140	25.44	46.2	0.19	161
193	495	595		0.02840	94.25	252.3	3.75	3265
194	4103	5103		0.07140	87.64	548.4	7.57	6599
195	4105	5105		0.02840	114.95	375.2	6.80	5922
196	4120	5120		0.02840	103.25	302.8	4.93	4293
197	502	602		0.04970	86.41	371.1	5.05	4403
198	503	603		0.04970	73.00	264.8	3.05	2654
199	510	610		0.04970	85.78	365.7	4.94	4307
200	515	615		0.04970	89.08	394.4	5.54	4824
201	522	622		0.04970	87.90	384.0	5.32	4634
202	530	630		99000.03870	-0.06	-384.8	0.00	3
203	533	633		99000.03850	-0.07	-546.0	0.01	5
204	538	638		0.04850	98.55	471.0	7.31	6373
205	545	645		0.13940	42.40	250.6	1.67	1459
206	553	653		0.04940	96.37	458.8	6.97	6071
207	556	656		0.13940	38.45	206.1	1.25	1088
208	560	660		1.03970	32.55	1101.6	5.65	4923
209	566	666		0.04940	91.70	415.4	6.00	5230
210	567	667		10.03940	9.42	891.5	1.32	1153
211	575	675		0.04940	92.61	423.6	6.18	5386
212	580	680		10.03970	11.33	1289.5	2.30	2006
213	595	695		0.05120	94.15	453.8	6.73	5866
214	5103	6103		0.14120	75.53	805.5	9.59	8353
215	5105	6105		0.14120	28.14	111.8	0.50	432
216	5120	6120		0.05120	103.15	544.7	8.85	7714
217	502	702		99000.00000	0.17	2708.7	0.07	63
218	503	703		99000.00000	0.16	2565.1	0.06	56
219	510	710		99000.00000	0.16	2494.0	0.06	55
220	515	715		99000.00000	0.16	2394.7	0.06	53
221	522	722		99000.00000	0.15	2199.6	0.05	45
222	530	730		0.10000	107.88	1163.7	19.78	17236
223	533	733		0.10000	97.63	953.1	14.66	12776
224	538	738		99000.00000	0.14	1890.0	0.04	36
225	545	745		0.50000	54.98	1511.2	13.09	11408
226	553	753		99000.00000	0.12	1513.9	0.03	25
227	556	756		0.50000	48.56	1178.8	9.02	7859
228	560	760		1.00000	43.53	1895.0	13.00	11326

Branch No.	From	To	F R B	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
229	566	766		99000.00000	0.11	1201.6	0.02	18
230	567	767		0.50000	57.84	1672.6	15.24	13283
231	575	775		99000.00000	0.11	1167.6	0.02	18
232	580	780		10.00000	14.10	1989.1	4.42	3851
233	595	795		99000.00000	0.11	1143.9	0.02	17
234	5103	7103		10.00000	12.11	1466.0	2.80	2438
235	5105	7105		0.10000	86.80	753.5	10.31	8980
236	5120	7120		99000.00000	0.10	1067.1	0.02	15
237	3	104		0.01780	81.71	118.8	1.53	1333
238	104	103		0.00670	81.71	44.7	0.58	501
239	1	24		0.00000	1242.49	0.0	0.00	0
240	4	24		0.00000	-444.01	0.0	0.00	0
241	24	25		0.00010	798.48	63.8	8.03	6994
242	25	133		2.00090	28.10	1580.3	7.00	6097
243	25	145		0.10050	125.57	1584.6	31.35	27319
244	25	245		0.00400	644.81	1663.1	168.98	147237
245	760	26		0.50010	-39.20	-768.5	4.75	4136
246	660	26		0.00010	487.11	23.7	1.82	1585
247	680	27		0.00010	196.65	3.9	0.12	105
248	780	27		2.00010	-18.63	-694.5	2.04	1776
249	26	28		0.00050	447.91	100.3	7.08	6168
250	27	28		0.00080	178.02	25.4	0.71	621
251	28	29		0.00010	625.92	39.2	3.87	3369
252	29	30	F	0.00100	627.41	393.6	38.91	33906
253	30	31		1000.00000	1.49	2220.1	0.52	454
254	31	29	B	1000.00000	1.49	2220.1	0.52	454
255	30	32		0.00150	625.92	587.7	57.96	50506
256	32	33		0.00000	664.23	0.0	0.00	0
257	33	20		0.00000	664.23	0.0	0.00	0
258	32	34		0.00000	-38.30	0.0	0.00	0
259	34	35		0.00000	-38.30	0.0	0.00	0
260	35	12		0.00000	-38.30	0.0	0.00	0

Branch No.	From	To	I R	Fixed Airflow (kcfm)	Booster Pressure (m.in.wg)	Regulator Resistance (P.U.)	Branch Resistance (P.U.)	Total Resistance (P.U.)
254	31	29		1.49	444		1000.00000	

Fan No.: 1
From: 17
To: 18
Pressure: 6.000 in.w.g.
Description: First Empl Shaft Fan

Fan Name: VNETPC 3.1 #19
Fan Setting:
Comments: JOY-M132-79-710 BLADE SET 25 DEG
Points: 10

Quantity	Pressure	Description
50.00	18.000	
130.00	15.000	
200.00	12.600	
270.00	11.400	
325.00	12.600	
380.00	13.400	
440.00	12.400	
500.00	10.800	
600.00	6.400	
660.00	2.000	

Fan No.: 2
From: 14
To: 13
Pressure: 6.000 in.w.g.
Description: Former Dev Shaft Fan

Fan Name: VNETPC 3.1 #19
Fan Setting:
Comments: JOY-M132-79-710 BLADE SET 25 DEG
Points: 10

Quantity	Pressure	Description
50.00	18.000	
130.00	15.000	
200.00	12.600	
270.00	11.400	
325.00	12.600	
380.00	13.400	
440.00	12.400	
500.00	10.800	
600.00	6.400	
660.00	2.000	

Fan No.: 3
From: 29
To: 30
Pressure: 6.000 in.w.g.
Description: Mid Empl Shaft Fan

Fan Name: VNETPC 3.1 #19
Fan Setting:
Comments: JOY-M132-79-710 BLADE SET 25 DEG
Points: 10

Quantity	Pressure	Description
50.00	18.000	
130.00	15.000	
200.00	12.600	
270.00	11.400	
325.00	12.600	
380.00	13.400	
440.00	12.400	
500.00	10.800	
600.00	6.400	
660.00	2.000	

Fan No.	From	To	Fan Pressure (in.wg)	Fan Airflow (kcfm)	Fan Curve	Air Power (hp)	Operating Cost ($/yr)	Fan Description
1	17	18	7.140	583.18	On	656.13	571702	First Empl Shaft Fan
2	14	13	7.501	574.97	On	679.60	592150	Former Dev Shaft Fan
3	29	30	4.390	627.41	On	434.02	378168	Mid Empl Shaft Fan

APPENDIX D

CALCULATION OF AIRWAY RESISTANCES FOR SYSTEM B–5.0 cms

APPENDIX D

CALCULATION OF AIRWAY RESISTANCES FOR SYSTEM B–5.0 cms

This table develops the input file for VNETPC for this system. The descriptions for the inputs for this table are located in Appendix A and Section 4.2.

The input values for K, A and P can be found in Section 4.2.1. The actual lengths are from Appendix H (as indicated by reference column). The regulator resistance (RPU_b) can be found in Section 4.2.20.

Fan locations, nodes and branches are shown in Figure D-1

Table D-1. Calculation of Airway Resistances During Monitoring Phase for System B-5.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad05: VNETPC INPUT, Design Feature Development, Case 5 m^3/s per emplacement drift. (Data by RSJurani & A Linden)														
Line No.	BRANCH		RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
	FROM	TO												
1	1	2	0.0051		0.0051	0.0509	30	389.33	72.36	1992.0	6535	7189	North Ramp	Figure H-2
2	2	3	0.0001		0.0001	0.0011	30	389.33	72.36	43.6	143	157	North Ramp	Figure H-2
3	3	111	0.0004		0.0004	0.0039	30	389.33	72.36	151.4	497	546	North Ramp	Figure H-2
4	111	100	0.0039		0.0039	0.0394	30	389.33	72.36	1543.0	5062	5569	North Ramp Ext	Figure H-2
5	100	102	0.0039		0.0039	0.0390	70	389.33	72.36	654.6	2148	2362	East Main Drift Ext.	Figure H-2
6	102	103	0.0003		0.0003	0.0026	70	389.33	72.36	43.5	143	157	East Main Drift	Figure H-2
7	103	110	0.0013		0.0013	0.0130	70	389.33	72.36	217.4	713	785	East Main Drift	Figure H-2
8	110	115	0.0009		0.0009	0.0086	70	389.33	72.36	144.9	475	523	East Main Drift	Figure H-2
9	115	122	0.0012		0.0012	0.0121	70	389.33	72.36	202.9	666	732	East Main Drift	Figure H-2
10	122	130	0.0014		0.0014	0.0138	70	389.33	72.36	231.9	761	837	East Main Drift	Figure H-2
11	111	130	0.0018		0.0018	0.0178	30	389.33	72.36	698.5	2292	2521	North Ramp Curve	Figure H-2
12	601	605	0.1001	0.1000	0.0001	0.0010	25	446.53	80.13	67.0	220	242	East Exhaust Main to Empl Shaft	Figure H-2
13	701	605	0.0001		0.0001	0.0009	25	446.53	80.13	57.5	189	208	West Exhaust Main Connector to Empl Shaft	Figure H-2
14	605	17	0.0008		0.0008	0.0082	25	402.49	71.12	431.2	1415	1556	Emplacement Shaft (6.9 m dia.)	Fig. H-5, Appendix H
15	17	18	0.0020	0.0020	0.0000	0.0000	0	0	0	0.0	0	0	Primary Fan- Emplacement Shaft	
16	18	19	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage Loop-1st leg	
17	19	17	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage Loop-2nd leg	
18	18	20	0.0030	0.0030	0.0000	0.0000	0	0	0	0.0	0	0	Surface Discharge - Evase (Outlet Cone)	
19	4	5	0.0072		0.0072	0.0716	60	389.33	72.36	1402.6	4602	5062	South Ramp to PC	Figure H-2
20	5	6	0.0003		0.0003	0.0025	60	389.33	72.36	49.2	161	178	South Ramp	Figure H-2
21	6	7	0.0043		0.0043	0.0427	60	389.33	72.36	835.8	2742	3016	South Ramp	Figure H-2
22	7	8	0.0001		0.0001	0.0012	60	389.33	72.36	23.1	76	83	South Ramp	Figure H-2
23	8	9	0.0012		0.0012	0.0116	60	389.33	72.36	227.2	745	820	South Ramp	Figure H-2
24	9	10	0.0010		0.0010	0.0102	60	389.33	72.36	200.0	656	722	South Ramp Ext Curve	Figure H-2
25	10	16	15.0001	15.0000	0.0001	0.0011	25	446.53	80.13	69.7	229	252	West Main to Development Shaft Drift	Figure H-2
26	23	21	0.0001		0.0001	0.0010	25	446.53	80.13	66.6	219	240	East Exhaust Main to Connector	Appendix H
27	22	21	0.0000		0.0000	0.0004	25	446.53	80.13	26.1	86	94	West Exhaust Main to Connector	Appendix H
28	21	16	0.0004		0.0004	0.0039	25	446.53	80.13	249.3	818	900	Exhaust Main Connecting Drift to Dev Shaft	Figure H-2
29	16	14	0.0026		0.0026	0.0258	95	402.49	71.12	358.8	1177	1295	Dev Shaft (Man/material - 6.9 m dia)	Fig. H-5, Appendix H
30	14	13	0.0020	0.0020	0.0000	0.0000	0	0	0	0.0	0	0	Primary Fan- Development Shaft	
31	13	15	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage 1st leg	
32	15	14	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage 2nd leg	
33	13	12	0.0050	0.0050	0.0000	0.0000	0	0	0	0.0	0	0	Surface Outlet - Evase	
34	12	11	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Dummy Connector	
35	11	14	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Dummy Connector	
36	4	1	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Dummy Connector	
37	20	1	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Dummy Connector	
38	100	600	0.0020		0.0020	0.0200	70	389.33	72.36	336.5	1104	1214	North Main	Figure H-2
39	600	700	0.0001		0.0001	0.0015	70	389.33	72.36	25.1	82	91	North Main	Figure H-2
40	700	200	0.0014		0.0014	0.0144	70	389.33	72.36	241.7	793	872	North Main	Figure H-2

Table D-1. Calculation of Airway Resistances During Monitoring Phase for System B-5.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad05: VNETPC INPUT, Design Feature Development, Case 5 m^3/s per emplacement drift. (Data by RSJurani & A Linden)														
Line No.	BRANCH		RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
	FROM	TO												
41	200	201	0.0014		0.0014	0.0141	70	389.33	72.36	236.1	775	852	West Main	Figure H-2
42	201	202	0.0015		0.0015	0.0147	70	389.33	72.36	246.5	809	890	West main	Figure H-2
43	202	203	0.0003		0.0003	0.0026	70	389.33	72.36	43.5	143	157	West main	Figure H-2
44	203	210	0.0013		0.0013	0.0130	70	389.33	72.36	217.4	713	785	West main	Figure H-2
45	210	215	0.0009		0.0009	0.0086	70	389.33	72.36	144.9	475	523	West main	Figure H-2
46	215	222	0.0012		0.0012	0.0121	70	389.33	72.36	202.9	666	732	West main	Figure H-2
47	222	230	0.0014		0.0014	0.0137	70	389.33	72.36	230.1	755	830	West main	Figure H-2
48	230	233	0.0004		0.0004	0.0042	70	389.33	72.36	70.1	230	253	West main	Figure H-2
49	233	238	0.0009		0.0009	0.0092	70	389.33	72.36	154.5	507	558	West main	Figure H-2
50	238	245	0.0012		0.0012	0.0117	70	389.33	72.36	197.1	647	711	West main	Figure H-2
51	245	253	0.0014		0.0014	0.0136	70	389.33	72.36	228.9	751	826	West main	Figure H-2
52	253	256	0.0004		0.0004	0.0043	70	389.33	72.36	71.5	235	258	West main	Figure H-2
53	256	260	0.0008		0.0008	0.0077	70	389.33	72.36	128.7	422	464	West main	Figure H-2
54	260	266	0.0010		0.0010	0.0102	70	389.33	72.36	171.7	563	620	West main	Figure H-2
55	10	2120	0.0060		0.0060	0.0595	70	389.33	72.36	999.2	3278	3606	West main	Figure H-2
56	2120	2105	0.0028		0.0028	0.0280	70	389.33	72.36	470.3	1543	1697	West main	Figure H-2
57	2105	2103	0.0005		0.0005	0.0047	70	389.33	72.36	78.4	257	283	West main	Figure H-2
58	2103	295	0.0014		0.0014	0.0140	70	389.33	72.36	235.2	772	849	West main	Figure H-2
59	295	292	0.0005		0.0005	0.0045	70	389.33	72.36	75.9	249	274	West main	Figure H-2
60	292	280	0.0022		0.0022	0.0224	70	389.33	72.36	376.2	1234	1358	West main	Figure H-2
61	280	275	0.0008		0.0008	0.0077	70	389.33	72.36	128.7	422	464	West main	Figure H-2
62	275	266	0.0015		0.0015	0.0153	70	389.33	72.36	257.5	845	929	West main	Figure H-2
63	130	133	0.0004		0.0004	0.0043	70	389.33	72.36	72.5	238	262	East Main	Figure H-2
64	133	138	0.0009		0.0009	0.0095	70	389.33	72.36	159.4	523	575	East Main	Figure H-2
65	138	145	0.0012		0.0012	0.0121	70	389.33	72.36	202.9	666	732	East Main	Figure H-2
66	145	153	0.0014		0.0014	0.0138	70	389.33	72.36	231.9	761	837	East Main	Figure H-2
67	153	156	0.0004		0.0004	0.0043	70	389.33	72.36	72.5	238	262	East Main	Figure H-2
68	156	160	0.0008		0.0008	0.0078	70	389.33	72.36	130.4	428	471	East Main	Figure H-2
69	160	166	0.0010		0.0010	0.0104	70	389.33	72.36	173.9	571	628	East Main	Figure H-2
70	6	1120	0.0065		0.0065	0.0651	70	389.33	72.36	1093.1	3586	3945	East Main	Figure H-2
71	1120	1105	0.0026		0.0026	0.0259	70	389.33	72.36	434.8	1427	1569	East Main	Figure H-2
72	1105	1103	0.0004		0.0004	0.0043	70	389.33	72.36	72.5	238	262	East Main	Figure H-2
73	1103	195	0.0013		0.0013	0.0130	70	389.33	72.36	217.4	713	785	East Main	Figure H-2
74	195	180	0.0027		0.0027	0.0268	70	389.33	72.36	449.3	1474	1621	East Main	Figure H-2
75	180	175	0.0008		0.0008	0.0078	70	389.33	72.36	130.4	428	471	East Main	Figure H-2
76	175	166	0.0016		0.0016	0.0155	70	389.33	72.36	260.9	856	942	East Main	Figure H-2
77	2	131	0.0313		0.0313	0.3130	70	177.60	48.44	745.0	2444	2689	ECRB	Figure H-2
78	131	155	0.0119		0.0119	0.1193	70	211.30	52.57	440.8	1446	1591	PC Main	Figure H-2
79	5	1102	0.0395		0.0395	0.3946	70	211.30	52.57	1457.6	4782	5260	PC Main	Figure H-2
80	1102	179	0.0180		0.0180	0.1805	70	211.30	52.57	666.7	2187	2406	PC Main	Figure H-2

Table D-1. Calculation of Airway Resistances During Monitoring Phase for System B-5.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad05: VNETPC INPUT, Design Feature Development, Case 5 m^3/s per emplacement drift. (Data by RSJurani & A Linden)														
Line No.	BRANCH		RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
	FROM	TO												
81	179	155	0.0188		0.0188	0.1883	70	211.30	52.57	695.7	2282	2511	PC Main	Figure H-2
82	131	132	0.0061		0.0061	0.0612	70	211.30	52.57	225.9	741	815	PC Main	Figure H-2
83	132	133	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 2	Figure H-2
84	131	157	0.5201	0.5000	0.0201	0.2014	70	177.60	48.44	479.4	1573	1730	ECRB	Figure H-2
85	155	156	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 3	Figure H-2
86	179	180	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 4	Figure H-2
87	1102	1103	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 5	Figure H-2
88	666	660	0.0008		0.0008	0.0080	60	401.49	72.36	172.7	567	623	East Exhaust Main	Figure H-2
89	660	656	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	East Exhaust Main	Figure H-2
90	656	653	0.0003		0.0003	0.0034	60	401.49	72.36	72.0	236	260	East Exhaust Main	Figure H-2
91	653	645	0.0011		0.0011	0.0107	60	401.49	72.36	230.3	756	831	East Exhaust Main	Figure H-2
92	645	638	0.0009		0.0009	0.0092	60	401.49	72.36	198.2	650	715	East Exhaust Main	Figure H-2
93	638	633	0.0007		0.0007	0.0072	60	401.49	72.36	154.7	508	558	East Exhaust Main	Figure H-2
94	633	630	0.0003		0.0003	0.0033	60	401.49	72.36	70.4	231	254	East Exhaust Main	Figure H-2
95	630	622	0.0011		0.0011	0.0108	60	401.49	72.36	231.8	760	837	East Exhaust Main	Figure H-2
96	622	615	0.0009		0.0009	0.0094	60	401.49	72.36	202.9	666	732	East Exhaust Main	Figure H-2
97	615	610	0.0007		0.0007	0.0067	60	401.49	72.36	144.9	475	523	East Exhaust Main	Figure H-2
98	610	603	0.0010		0.0010	0.0101	60	401.49	72.36	217.4	713	785	East Exhaust Main	Figure H-2
99	603	602	0.0002		0.0002	0.0020	60	401.49	72.36	43.5	143	157	East Exhaust Main	Figure H-2
100	602	601	0.0019		0.0019	0.0187	60	401.49	72.36	400.7	1315	1446	East Exhaust Main	Figure H-2
101	600	601	1000.0005	1000.0000	0.0005	0.0051	60	401.49	72.36	108.7	357	392	East Exhaust Main Reg (North Ramp Side)	Figure H-2
102	666	667	0.0002		0.0002	0.0016	60	401.49	72.36	33.5	110	121	East Exhaust Main	Figure H-2
103	667	675	0.0011		0.0011	0.0105	60	401.49	72.36	225.6	740	814	East Exhaust Main	Figure H-2
104	675	680	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	East Exhaust Main	Figure H-2
105	680	695	0.0021		0.0021	0.0210	60	401.49	72.36	450.0	1476	1624	East Exhaust Main	Figure H-2
106	695	6103	0.0010		0.0010	0.0105	60	401.49	72.36	225.1	739	812	East Exhaust Main	Figure H-2
107	6103	6105	0.0003		0.0003	0.0035	60	401.49	72.36	75.1	246	271	East Exhaust Main	Figure H-2
108	6105	6120	0.0021		0.0021	0.0210	60	401.49	72.36	450.2	1477	1625	East Exhaust Main	Figure H-2
109	6120	23	0.0040		0.0040	0.0400	60	401.49	72.36	860.1	2822	3104	East Exhaust Main	Figure H-2
110	7	23	1000.0010	1000.0000	0.0010	0.0099	60	401.49	72.36	213.4	700	770	East Exhaust Main Reg (South Ramp Side)	Figure H-2
111	766	760	0.0008		0.0008	0.0080	60	401.49	72.36	172.7	567	623	West Exhaust Main	Figure H-2
112	760	756	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	West Exhaust Main	Figure H-2
113	756	753	0.0003		0.0003	0.0034	60	401.49	72.36	72.0	236	260	West Exhaust Main	Figure H-2
114	753	745	0.0011		0.0011	0.0107	60	401.49	72.36	230.3	756	831	West Exhaust Main	Figure H-2
115	745	738	0.0009		0.0009	0.0092	60	401.49	72.36	198.1	650	715	West Exhaust Main	Figure H-2
116	738	733	0.0007		0.0007	0.0072	60	401.49	72.36	154.7	508	558	West Exhaust Main	Figure H-2
117	733	730	0.0003		0.0003	0.0033	60	401.49	72.36	70.4	231	254	West Exhaust Main	Figure H-2
118	730	722	0.0011		0.0011	0.0107	60	401.49	72.36	230.8	757	833	West Exhaust Main	Figure H-2
119	722	715	0.0009		0.0009	0.0094	60	401.49	72.36	202.9	666	732	West Exhaust Main	Figure H-2
120	715	710	0.0007		0.0007	0.0067	60	401.49	72.36	144.9	475	523	West Exhaust Main	Figure H-2

Table D-1. Calculation of Airway Resistances During Monitoring Phase for System B-5.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad05: VNETPC INPUT, Design Feature Development, Case 5 m^3/s per emplacement drift. (Data by RSJurani & A Linden)															
Line No.	BRANCH		RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
	FROM	TO												
121	710	703	0.0010		0.0010	0.0101	60	401.49	72.36	217.4	713	785	West Exhaust Main	Figure H-2
122	703	702	0.0002		0.0002	0.0020	60	401.49	72.36	43.5	143	157	West Exhaust Main	Figure H-2
123	702	701	0.0017		0.0017	0.0173	60	401.49	72.36	371.6	1219	1341	West Exhaust Main	Figure H-2
124	700	701	1000.0006	1000.0000	0.0006	0.0064	60	401.49	72.36	138.3	454	499	West Exhaust Main Reg (North Ramp Side)	Figure H-2
125	766	767	0.0002		0.0002	0.0016	60	401.49	72.36	33.5	110	121	West Exhaust Main	Figure H-2
126	767	775	0.0011		0.0011	0.0105	60	401.49	72.36	225.6	740	814	West Exhaust Main	Figure H-2
127	775	780	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	West Exhaust Main	Figure H-2
128	780	795	0.0021		0.0021	0.0210	60	401.49	72.36	450.2	1477	1625	West Exhaust Main	Figure H-2
129	795	7103	0.0010		0.0010	0.0105	60	401.49	72.36	225.1	739	812	West Exhaust Main	Figure H-2
130	7103	7105	0.0003		0.0003	0.0035	60	401.49	72.36	75.1	246	271	West Exhaust Main	Figure H-2
131	7105	7120	0.0021		0.0021	0.0210	60	401.49	72.36	450.2	1477	1625	West Exhaust Main	Figure H-2
132	7120	22	0.0040		0.0040	0.0403	60	401.49	72.36	865.8	2841	3125	West Exhaust Main	Figure H-2
133	8	22	1000.0010	1000.0000	0.0010	0.0100	60	401.49	72.36	214.9	705	776	West Exhaust Main Reg (South Ramp Side)	Figure H-2
134	202	402	0.0348	As low as R/4	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift West Side	Figure H-2
135	203	403	0.1152	0.1000	0.0152	0.1516	70	211.30	52.57	559.9	1837	2021	PC 1 West Side	Fig. H-2, Appendix H
136	210	410	0.0348	As low as R/4	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift West Side	Figure H-2
137	215	415	0.1165	0.1000	0.0165	0.1654	70	201.93	52.57	533.3	1750	1925	Emplacement Drift West Side (Empty)	Figure H-2
138	222	422	0.0348	As low as R/4	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift West Side	Figure H-2
139	230	430	0.1146	0.1000	0.0146	0.1457	70	211.30	52.57	538.3	1766	1943	Cross Block 30 West Side	Figure H-2
140	233	433	0.1156	0.1000	0.0156	0.1560	70	211.30	52.57	576.4	1891	2080	PC 2 West Side	Fig. H-2, Appendix H
141	238	438	0.0376	As low as R/4	0.0376	0.3760	85	168.13	52.57	576.3	1891	2080	Emplacement Drift West Side	Figure H-2
142	245	445	0.1187	0.1000	0.0187	0.1867	70	201.93	52.57	601.9	1975	2172	Emplacement Drift West Side (Empty)	Figure H-2
143	253	453	0.0397	As low as R/4	0.0397	0.3970	85	168.13	52.57	608.4	1996	2196	Emplacement Drift West Side	Figure H-2
144	256	456	0.1172	0.1000	0.0172	0.1725	70	211.30	52.57	637.1	2090	2299	PC 3 West Side	Fig. H-2, Appendix H
145	260	460	0.1166	0.1000	0.0166	0.1662	70	211.30	52.57	614.1	2015	2216	Cross Block 60	Figure H-2
146	266	466	0.0404	As low as R/4	0.0404	0.4039	85	168.13	52.57	619.0	2031	2234	Emplacement Drift West Side	Figure H-2
147	275	475	0.0409	As low as R/4	0.0409	0.4087	85	168.13	52.57	626.4	2055	2261	Emplacement Drift West Side	Figure H-2
148	280	281	0.1099	0.1000	0.0099	0.0992	70	211.30	52.57	366.5	1202	1323	PC 4 West Side 1st leg	Fig. H-2, Appendix H
149	292	281	0.1200	0.1000	0.0200	0.2001	70	177.60	48.44	476.3	1563	1719	ECRB West Side	Fig. H-2, Appendix H
150	281	467	0.0169		0.0169	0.1693	70	177.60	48.44	403.0	1322	1454	ECRB West Side	Figure H-2
151	281	480	0.0079		0.0079	0.0785	70	211.30	52.57	290.1	952	1047	PC 4 West Side 2nd leg	Figure H-2
152	295	495	0.0410	As low as R/4	0.0410	0.4104	85	168.13	52.57	629.0	2064	2270	Emplacement Drift West Side	Figure H-2
153	2103	4103	0.1171	0.1000	0.0171	0.1708	70	211.30	52.57	630.8	2070	2277	PC 5 West Side	Fig. H-2, Appendix H
154	2105	4105	0.1161	0.1000	0.0161	0.1613	70	211.30	52.57	595.9	1955	2151	Cross Block 105	Figure H-2
155	2120	4120	0.0356	As low as R/4	0.0356	0.3565	85	168.13	52.57	546.3	1792	1972	Emplacement Drift West Side	Figure H-2
156	102	402	0.0348	As low as R/4	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift East Side	Figure H-2
157	103	403	0.1152	0.1000	0.0152	0.1516	70	211.30	52.57	559.9	1837	2021	PC 1 East Side	Fig. H-2, Appendix H
158	110	410	0.0348	As low as R/4	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift East Side	Figure H-2
159	115	415	0.1165	0.1000	0.0165	0.1654	70	201.93	52.57	533.3	1750	1925	Emplacement Drift East Side (Empty)	Figure H-2
160	122	422	0.0348	As low as R/4	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift East Side	Figure H-2

Table D-1. Calculation of Airway Resistances During Monitoring Phase for System B-5.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad05: VNETPC INPUT, Design Feature Development, Case 5 m^3/s per emplacement drift. (Data by RSJurani & A Linden)															
Line No.	BRANCH		RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
	FROM	TO												
161	130	430	0.1146	0.1000	0.0146	0.1457	70	211.30	52.57	538.3	1766	1943	Cross Block 30	Figure H-2
162	133	433	0.1156	0.1000	0.0156	0.1560	70	211.30	52.57	576.4	1891	2080	PC 2 East	Fig. H-2, Appendix H
163	138	438	0.0376	As low as R/4	0.0376	0.3760	85	168.13	52.57	576.3	1891	2080	Emplacement Drift East Side	Figure H-2
164	145	445	0.1187	0.1000	0.0187	0.1867	70	201.93	52.57	601.9	1975	2172	Emplacement Drift East Side (Empty)	Figure H-2
165	153	453	0.0397	As low as R/4	0.0397	0.3970	85	168.13	52.57	608.4	1996	2196	Emplacement Drift East Side	Figure H-2
166	156	157	0.1098	0.1000	0.0098	0.0982	70	211.30	52.57	362.9	1191	1310	PC 3 East Side 1st leg	Fig. H-2, Appendix H
167	157	456	0.0074		0.0074	0.0742	70	211.30	52.57	274.2	900	990	PC 3 East Side 2nd leg	Figure H-2
168	157	467	0.0160		0.0160	0.1600	70	177.60	48.44	380.9	1250	1375	ECRB	Figure H-2
169	160	460	0.1166	0.1000	0.0166	0.1662	70	211.30	52.57	614.1	2015	2216	Cross Block 60	Figure H-2
170	166	466	0.0404	As low as R/4	0.0404	0.4039	85	168.13	52.57	619.0	2031	2234	Emplacement Drift East Side	Figure H-2
171	175	475	0.0409	As low as R/4	0.0409	0.4087	85	168.13	52.57	626.4	2055	2261	Emplacement Drift East Side	Figure H-2
172	180	480	0.1178	0.1000	0.0178	0.1778	70	211.30	52.57	656.6	2154	2370	PC 4 East Side	Fig. H-2, Appendix H
173	195	495	0.0410	As low as R/4	0.0410	0.4104	85	168.13	52.57	629.0	2064	2270	Emplacement Drift East Side	Figure H-2
174	1103	4103	0.1171	0.1000	0.0171	0.1708	70	211.30	52.57	630.8	2070	2277	PC 5 East Side	Fig. H-2, Appendix H
175	1105	4105	0.1161	0.1000	0.0161	0.1613	70	211.30	52.57	595.9	1955	2151	Cross Block 105	Figure H-2
176	1120	4120	0.0356	As low as R/4	0.0356	0.3565	85	168.13	52.57	546.3	1792	1972	Emplacement Drift East Side	Figure H-2
177	402	502	0.0277	As low as R/4	0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Empl Level to Exh Main	Appendix H
178	403	503	0.0702		0.0702	0.7022	20	24.43	17.52	42.1	138	152	Raise Connector, PC Level to Exhaust Main	Appendix H
179	410	510	0.0277	As low as R/4	0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Empl Level to Exh Main	Appendix H
180	415	515	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Emp Level to Exhaust Main	Appendix H
181	422	522	0.0277	As low as R/4	0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Emp Level to Exhaust Main	Appendix H
182	430	530	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Emp Level to Exhaust Main	Appendix H
183	433	533	0.0706		0.0706	0.7055	20	24.43	17.52	42.3	139	153	Raise Connector, PC Level to Exhaust Main	Appendix H
184	438	538	0.0280	As low as R/4	0.0280	0.2802	20	24.43	17.52	16.8	55	61	Raise Connector, Emp Level to Exhaust Main	Appendix H
185	445	545	0.0285		0.0285	0.2852	20	24.43	17.52	17.1	56	62	Raise Connector, Emp Level to Exhaust Main	Appendix H
186	453	553	0.0289	As low as R/4	0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Emp Level to Exhaust Main	Appendix H
187	456	556	0.0714		0.0714	0.7139	20	24.43	17.52	42.8	140	154	Raise Connector, PC Level to Exhaust Main	Appendix H
188	460	560	0.0289		0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Emp Level to Exhaust Main	Appendix H
189	466	566	0.0289	As low as R/4	0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Emp Level to Exhaust Main	Appendix H
190	467	567	0.0709		0.0709	0.7089	20	24.43	17.52	42.5	139	153	Raise Connector, ECRB Level to Exh Main	Appendix H
191	475	575	0.0289	As low as R/4	0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Emp Level to Exhaust Main	Appendix H
192	480	580	0.0714		0.0714	0.7139	20	24.43	17.52	42.8	140	154	Raise Connector, PC Level to Exhaust Main	Appendix H
193	495	595	0.0284	As low as R/4	0.0284	0.2835	20	24.43	17.52	17.0	56	61	Raise Connector, Emp Level to Exhaust Main	Appendix H
194	4103	5103	0.0714		0.0714	0.7139	20	24.43	17.52	42.8	140	154	Raise Connector, PC Level to Exhaust Main	Appendix H
195	4105	5105	0.0284		0.0284	0.2835	20	24.43	17.52	17.0	56	61	Raise Connector, Emp Level to Exhaust Main	Appendix H
196	4120	5120	0.0284	As low as R/4	0.0284	0.2835	20	24.43	17.52	17.0	56	61	Raise Connector, Emp Level to Exhaust Main	Appendix H
197	502	602	0.0397	As low as R/4	0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exhaust Mains	Figure H-2
198	503	603	0.0397		0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exhaust Mains	Figure H-2
199	510	610	0.0397	As low as R/4	0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exhaust Mains	Figure H-2
200	515	615	0.0397		0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exhaust Mains	Figure H-2

Table D-1. Calculation of Airway Resistances During Monitoring Phase for System B-5.0 cms

Line No.	BRANCH FROM	TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
FILE # Replad01-05-10-va.xls; Folder - Replad05: VNETPC INPUT, Design Feature Development, Case 5 m^3/s per emplacement drift. (Data by RSJurani & A Linden)														
201	522	622	0.0397	As low as R/4	0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exhaust Mains	Figure H-2
202	530	630	99000.0387	99000.0000	0.0387	0.3870	20	24.43	17.52	23.2	76	84	Horizontal Raise Connector of Exhaust Mains	Figure H-2
203	533	633	0.1385	0.1000	0.0385	0.3853	20	24.43	17.52	23.1	76	83	Horizontal Raise Connector of Exhaust Mains	Figure H-2
204	538	638	0.0385	As low as R/4	0.0385	0.3853	20	24.43	17.52	23.1	76	83	Horizontal Raise Connector of Exhaust Mains	Figure H-2
205	545	645	0.1394	0.1000	0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exhaust Mains	Figure H-2
206	553	653	0.0394	As low as R/4	0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exhaust Mains	Figure H-2
207	556	656	0.0394		0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exhaust Mains	Figure H-2
208	560	660	0.0397		0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exhaust Mains	Figure H-2
209	566	666	0.0394	As low as R/4	0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exhaust Mains	Figure H-2
210	567	667	0.0394		0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exhaust Mains	Figure H-2
211	575	675	0.0394	As low as R/4	0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exhaust Mains	Figure H-2
212	580	680	0.0397		0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exhaust Mains	Figure H-2
213	595	695	0.0412	As low as R/4	0.0412	0.4120	20	24.43	17.52	24.7	81	89	Horizontal Raise Connector of Exhaust Mains	Figure H-2
214	5103	6103	0.0412		0.0412	0.4120	20	24.43	17.52	24.7	81	89	Horizontal Raise Connector of Exhaust Mains	Figure H-2
215	5105	6105	0.0412		0.0412	0.4120	20	24.43	17.52	24.7	81	89	Horizontal Raise Connector of Exhaust Mains	Figure H-2
216	5120	6120	0.0412	As low as R/4	0.0412	0.4120	20	24.43	17.52	24.7	81	89	Horizontal Raise Connector of Exhaust Mains	Figure H-2
217	502	702	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
218	503	703	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
219	510	710	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
220	515	715	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
221	522	722	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
222	530	730	0.0000		0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
223	533	733	0.1000	0.1000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
224	538	738	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
225	545	745	0.0000		0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
226	553	753	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
227	556	756	0.0000		0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
228	560	760	0.0000		0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
229	566	766	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
230	567	767	0.0000		0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
231	575	775	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
232	580	780	0.0000		0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
233	595	795	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
234	5103	7103	0.0000		0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
235	5105	7105	0.0000		0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
236	5120	7120	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exhaust Main	
237	3	104	0.0178		0.0178	0.1775	70	211.30	52.57	655.7	2151	2366	PC 1 North Ramp Side 1st leg	Figure H-2
238	104	103	0.0067		0.0067	0.0670	70	211.30	52.57	247.5	812	893	PC 1 North Ramp Side 2nd leg	Figure H-2
239	1	24	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
240	24	25	0.0001		0.0001	0.0007	25	828.57	102.04	240.3	788	867	Intake Shaft 9.9 m dia	Fig H-5 , Appendix H

Table D-1. Calculation of Airway Resistances During Monitoring Phase for System B-5.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad05: VNETPC INPUT, Design Feature Development, Case 5 m^3/s per emplacement drift. (Data by RSJurani & A Linden)														
Line No.	BRANCH		RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
	FROM	TO												
241	25	133	0.0008		0.0008	0.0082	25	389.33	72.36	383.1	1257	1383	Connecting Drift 7.62 m dia	Figure H-5
242	25	245	0.0031		0.0031	0.0315	25	389.33	72.36	1479.9	4855	5341	Connecting Drift 7.62 m dia	Fig H-5 , Appendix H
243	25	275	0.0036		0.0036	0.0359	25	389.33	72.36	1686.9	5534	6088	Connecting Drift 7.62 m dia	Fig H-5 , Appendix H
244	24	26	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
245	4	26	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
246	26	27	0.0001		0.0001	0.0008	25	828.57	102.04	254.5	835	918	Intake Shaft 9.9 m dia	Fig H-5 , Appendix H
247	27	156	0.0010		0.0010	0.0099	25	446.53	80.13	632.9	2076	2284	Connecting Drift	Figure H-5
248	27	175	0.0006		0.0006	0.0065	25	446.53	80.13	416.2	1365	1502	Connecting Drift	Figure H-5
249	633	28	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector	Appendix H
250	733	28	0.0001		0.0001	0.0006	25	389.33	72.36	26.1	86	94	West Exhaust Main to Connector	Appendix H
251	638	29	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector	Appendix H
252	738	29	0.0001		0.0001	0.0006	25	389.33	72.36	26.1	86	94	West Exhaust Main to Connector	Appendix H
253	28	30	0.0005		0.0005	0.0054	25	446.53	80.13	343.3	1126	1239	Connecting Drift	Fig H-5 , Appendix H
254	29	30	0.0005		0.0005	0.0054	25	446.53	80.13	346.4	1136	1250	Connecting Drift	Fig H-5 , Appendix H
255	30	31	0.0001		0.0001	0.0013	25	828.57	102.04	424.3	1392	1531	Exhaust Shaft 9.9 m dia	Fig H-5 , Appendix H
256	31	32	0.0010	0.0010	0.0000	0.0000	0	0	0	0.0	0	0	Primary Fan	
257	32	33	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage	
258	33	31	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage	
259	32	34	0.0010	0.0010	0.0000	0.0000	0	0	0	0.0	0	0	Evase/Outlet Cone	
260	34	35	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
261	35	20	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
262	666	36	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector	Appendix H
263	766	36	0.0001		0.0001	0.0006	25	389.33	72.36	26.1	86	94	West Exhaust Main to Connector	Appendix H
264	675	37	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector	Appendix H
265	775	37	0.0001		0.0001	0.0006	25	389.33	72.36	26.1	86	94	West Exhaust Main to Connector	Appendix H
266	36	38	0.0004		0.0004	0.0038	25	446.53	80.13	244.3	802	882	Connecting Drift	Fig H-5 , Appendix H
267	37	38	0.0004		0.0004	0.0038	25	446.53	80.13	243.7	800	879	Connecting Drift	Fig H-5 , Appendix H
268	38	39	0.0001		0.0001	0.0013	25	828.57	102.04	414.1	1359	1494	Exhaust Shaft 9.9 m dia	Fig H-5 , Appendix H
269	39	40	0.0010	0.0010	0.0000	0.0000	0	0	0	0.0	0	0	Primary Fan	
270	40	41	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage	
271	41	39	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage	
272	40	42	0.0010	0.0010	0.0000	0.0000	0	0	0	0.0	0	0	Evase/Outlet Cone	
273	42	34	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
274	695	43	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector	Appendix H
275	795	43	0.0001		0.0001	0.0006	25	389.33	72.36	26.1	86	94	West Exhaust Main to Connector	Appendix H
276	51	44	0.0008		0.0008	0.0076	25	402.49	71.12	402.3	1320	1452	Exhaust Shaft 6.9 m dia	Fig H-5 , Appendix H
277	44	45	0.0010	0.0010	0.0000	0.0000	0	0	0	0.0	0	0	Primary Fan	
278	45	46	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage	
279	46	44	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage	
280	45	47	0.0010	0.0010	0.0000	0.0000	0	0	0	0.0	0	0	Evase/Outlet Cone	

Table D-1. Calculation of Airway Resistances During Monitoring Phase for System B-5.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad05: VNETPC INPUT, Design Feature Development, Case 5 m^3/s per emplacement drift. (Data by RSJurani & A Linden)															
Line No.	BRANCH		RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
	FROM	TO												
281	47	42	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
282	47	48	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
283	48	49	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
284	49	50	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
285	50	12	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
286	43	51	0.0003		0.0003	0.0034	25	446.53	80.13	219.6	720	793	Connecting Drift	Fig H-5 , Appendix H

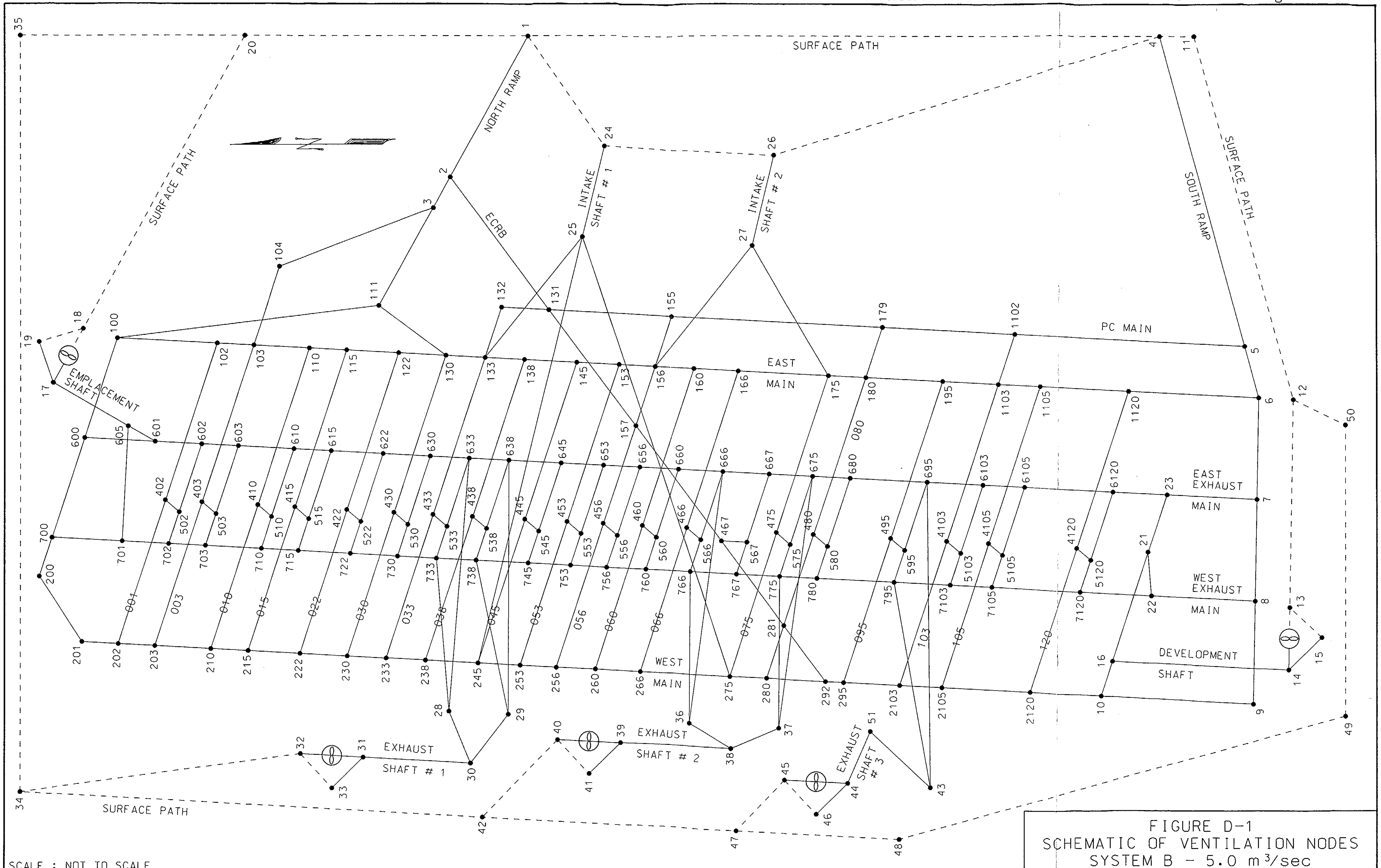


FIGURE D-1
SCHEMATIC OF VENTILATION NODES
SYSTEM B - 5.0 m³/sec

APPENDIX E

VNETPC OUTPUT FOR SYSTEM B–5.0 cms

APPENDIX E

VNETPC OUTPUT FOR SYSTEM B–5.0 cms

This appendix contains fan airflow and air power data obtained from VNETPC file, VNETWIN\REPLAD05.VNW.

See Appendix E, page 19 for fan results showing airflow and airpower values.

Total Fan Airflow (kcfm) = 540.43 + 189.87 + 1,303.19 + 1,300.26 +1,264.84 = 4,598.89 kcfm
Note: 1cfm = 0.000472 m^3/s
Total Fan Airflow (m^3/s) = 4,598,890 cfm x 0.000472 = 2,170.68 or approximately 2,171 m^3/s

Total Air Power (hp) = 731.59 + 199.98 + 2,016.14 + 2,045.83 + 2,273.31 = 7,266.85 hp.
Note: Fan Efficiency = 75 % (Section 4.1.7)
Brake horsepower = 7,266.85 / 75% = 9,689.13 or approximately 9,689 hp.

Note: 1 hp. = 0.746 kW.
Power Consumption = 9,689.13 hp. x 0.746 = 7,228.09 or approximately 7,228 kW.

Appendix E is arranged in the following order:

Inputs on K Factors, Airway Cross Sectional Areas and Perimeters are contained in Section 4.2.1.
Branch Resistance is calculated in Appendix D.
Fan Efficiency = 75% (Section 4.1.7.)
Cost of Power = $ 0.10 per kWh (Section 4.2.19)
Fan locations, nodes and branches are shown in Figure D-1

REPOSITORY LA DESIGN FEATURE
YUCCA MOUNTAIN PROJECT
M&O/MK/RSJURANI
DUAL EXHAUST @5.0 M3S/EMPL DRIFT

Avg. Fan Efficiency: 75.0 %
Cost of Power: 10.00 c/kWh
Reference Junction: 1
Units: British

Number of Branches: 286
Number of Junctions: 187
Number of Fans: 5
Fixed Quantities: 1

Last Airflow Analysis
Date: 05/08/99
Time: 02:08 AM
Elapsed Time: 00:00:01

Number of Iterations: 2
Number of Errors: 0
Modified Since: NO

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
1	1	2		R	0.00510								
2	2	3		R	0.00010								
3	3	111		R	0.00040								
4	111	100		R	0.00390								
5	100	102		R	0.00390								
6	102	103		R	0.00030								
7	103	110		R	0.00130								
8	110	115		R	0.00090								
9	115	122		R	0.00120								
10	122	130		R	0.00140								
11	111	130		R	0.00180								
12	601	605		R	0.10010								
13	701	605		R	0.00010								
14	605	17		R	0.00080								
15	17	18	F	R	0.00200								
16	18	19		R	1000.00000								
17	19	17		R	1000.00000								
18	18	20		R	0.00300								
19	4	5		R	0.00720								
20	5	6		R	0.00030								
21	6	7		R	0.00430								
22	7	8		R	0.00010								
23	8	9		R	0.00120								
24	9	10		R	0.00100								
25	10	16		R	15.00010								
26	23	21		R	0.00010								
27	22	21		R	0.00000								
28	21	16		R	0.00040								
29	16	14		R	0.00260								
30	14	13	F	R	0.00200								
31	13	15		R	1000.00000								
32	15	14		R	1000.00000								
33	13	12		R	0.00500								
34	12	11		R	0.00000								
35	11	4		R	0.00000								
36	4	1		R	0.00000								
37	20	1	Q	R	0.00000								
38	100	600		R	0.00200								
39	600	700		R	0.00010								
40	700	200		R	0.00140								
41	200	201		R	0.00140								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
42	201	202		R	0.00150								
43	202	203		R	0.00030								
44	203	210		R	0.00130								
45	210	215		R	0.00090								
46	215	222		R	0.00120								
47	222	230		R	0.00140								
48	230	233		R	0.00040								
49	233	238		R	0.00090								
50	238	245		R	0.00120								
51	245	253		R	0.00140								
52	253	256		R	0.00040								
53	256	260		R	0.00080								
54	260	266		R	0.00100								
55	10	2120		R	0.00600								
56	2120	2105		R	0.00280								
57	2105	2103		R	0.00050								
58	2103	295		R	0.00140								
59	295	292		R	0.00050								
60	292	280		R	0.00220								
61	280	275		R	0.00080								
62	275	266		R	0.00150								
63	130	133		R	0.00040								
64	133	138		R	0.00090								
65	138	145		R	0.00120								
66	145	153		R	0.00140								
67	153	156		R	0.00040								
68	156	160		R	0.00080								
69	160	166		R	0.00100								
70	6	1120		R	0.00650								
71	1120	1105		R	0.00260								
72	1105	1103		R	0.00040								
73	1103	195		R	0.00130								
74	195	180		R	0.00270								
75	180	175		R	0.00080								
76	175	166		R	0.00160								
77	2	131		R	0.03130								
78	131	155		R	0.01190								
79	5	1102		R	0.03950								
80	1102	179		R	0.01800								
81	179	155		R	0.01880								
82	131	132		R	0.00610								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
83	132	133		R	0.00090								
84	131	157		R	0.52010								
85	155	156		R	0.00090								
86	179	180		R	0.00090								
87	1102	1103		R	0.00090								
88	666	660		R	0.00080								
89	660	656		R	0.00060								
90	656	653		R	0.00030								
91	653	645		R	0.00110								
92	645	638		R	0.00090								
93	638	633		R	0.00070								
94	633	630		R	0.00030								
95	630	622		R	0.00110								
96	622	615		R	0.00090								
97	615	610		R	0.00070								
98	610	603		R	0.00100								
99	603	602		R	0.00020								
100	602	601		R	0.00190								
101	600	601		R	1000.00050								
102	666	667		R	0.00020								
103	667	675		R	0.00110								
104	675	680		R	0.00060								
105	680	695		R	0.00210								
106	695	6103		R	0.00100								
107	6103	6105		R	0.00030								
108	6105	6120		R	0.00210								
109	6120	23		R	0.00400								
110	7	23		R	1000.00100								
111	766	760		R	0.00080								
112	760	756		R	0.00060								
113	756	753		R	0.00030								
114	753	745		R	0.00110								
115	745	738		R	0.00090								
116	738	733		R	0.00070								
117	733	730		R	0.00030								
118	730	722		R	0.00110								
119	722	715		R	0.00090								
120	715	710		R	0.00070								
121	710	703		R	0.00100								
122	703	702		R	0.00020								
123	702	701		R	0.00170								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
124	700	701		R	1000.00060								
125	766	767		R	0.00020								
126	767	775		R	0.00110								
127	775	780		R	0.00060								
128	780	795		R	0.00210								
129	795	7103		R	0.00100								
130	7103	7105		R	0.00030								
131	7105	7120		R	0.00210								
132	7120	22		R	0.00400								
133	8	22		R	1000.00100								
134	202	402		R	0.03480								
135	203	403		R	0.11520								
136	210	410		R	0.03480								
137	215	415		R	0.11650								
138	222	422		R	0.03480								
139	230	430		R	0.11460								
140	233	433		R	0.11560								
141	238	438		R	0.03760								
142	245	445		R	0.11870								
143	253	453		R	0.03970								
144	256	456		R	0.11720								
145	260	460		R	0.11660								
146	266	466		R	0.04040								
147	275	475		R	0.04090								
148	280	281		R	0.10990								
149	292	281		R	0.12000								
150	281	467		R	0.01690								
151	281	480		R	0.00790								
152	295	495		R	0.04100								
153	2103	4103		R	0.11710								
154	2105	4105		R	0.11610								
155	2120	4120		R	0.03560								
156	102	402		R	0.03480								
157	103	403		R	0.11520								
158	110	410		R	0.03480								
159	115	415		R	0.11650								
160	122	422		R	0.03480								
161	130	430		R	0.11460								
162	133	433		R	0.11560								
163	138	438		R	0.03760								
164	145	445		R	0.11870								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
165	153	453		R	0.03970								
166	156	157		R	0.10980								
167	157	456		R	0.00740								
168	157	467		R	0.01600								
169	160	460		R	0.11660								
170	166	466		R	0.04040								
171	175	475		R	0.04090								
172	180	480		R	0.11780								
173	195	495		R	0.04100								
174	1103	4103		R	0.11710								
175	1105	4105		R	0.11610								
176	1120	4120		R	0.03560								
177	402	502		R	0.02770								
178	403	503		R	0.07020								
179	410	510		R	0.02770								
180	415	515		R	0.02770								
181	422	522		R	0.02770								
182	430	530		R	0.02770								
183	433	533		R	0.07060								
184	438	538		R	0.02800								
185	445	545		R	0.02850								
186	453	553		R	0.02890								
187	456	556		R	0.07140								
188	460	560		R	0.02890								
189	466	566		R	0.02890								
190	467	567		R	0.07090								
191	475	575		R	0.02890								
192	480	580		R	0.07140								
193	495	595		R	0.02840								
194	4103	5103		R	0.07140								
195	4105	5105		R	0.02840								
196	4120	5120		R	0.02840								
197	502	602		R	0.03970								
198	503	603		R	0.03970								
199	510	610		R	0.03970								
200	515	615		R	0.03970								
201	522	622		R	0.03970								
202	530	630		R	99000.03870								
203	533	633		R	0.13850								
204	538	638		R	0.03850								
205	545	645		R	0.13940								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
206	553	653		R	0.03940								
207	556	656		R	0.03940								
208	560	660		R	0.03970								
209	566	666		R	0.03940								
210	567	667		R	0.03940								
211	575	675		R	0.03940								
212	580	680		R	0.03970								
213	595	695		R	0.04120								
214	5103	6103		R	0.04120								
215	5105	6105		R	0.04120								
216	5120	6120		R	0.04120								
217	502	702		R	99000.00000								
218	503	703		R	99000.00000								
219	510	710		R	99000.00000								
220	515	715		R	99000.00000								
221	522	722		R	99000.00000								
222	530	730		R	0.00000								
223	533	733		R	0.10000								
224	538	738		R	99000.00000								
225	545	745		R	0.00000								
226	553	753		R	99000.00000								
227	556	756		R	0.00000								
228	560	760		R	0.00000								
229	566	766		R	99000.00000								
230	567	767		R	0.00000								
231	575	775		R	99000.00000								
232	580	780		R	0.00000								
233	595	795		R	99000.00000								
234	5103	7103		R	0.00000								
235	5105	7105		R	0.00000								
236	5120	7120		R	99000.00000								
237	3	104		R	0.01780								
238	104	103		R	0.00670								
239	1	24		R	0.00000								
240	24	25		R	0.00010								
241	25	133		R	0.00080								
242	25	245		R	0.00310								
243	25	275		R	0.00360								
244	24	26		R	0.00000								
245	4	26		R	0.00000								
246	26	27		R	0.00010								

Branch No.	From	To	FQi	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
247	27	156		R	0.00100								
248	27	175		R	0.00060								
249	633	28		R	0.00010								
250	733	28		R	0.00010								
251	638	29		R	0.00010								
252	738	29		R	0.00010								
253	28	30		R	0.00050								
254	29	30		R	0.00050								
255	30	31		R	0.00010								
256	31	32	F	R	0.00100								
257	32	33		R	1000.00000								
258	33	31		R	1000.00000								
259	32	34		R	0.00100								
260	34	35		R	0.00000								
261	35	20		R	0.00000								
262	666	36		R	0.00010								
263	766	36		R	0.00010								
264	675	37		R	0.00010								
265	775	37		R	0.00010								
266	36	38		R	0.00040								
267	37	38		R	0.00040								
268	38	39		R	0.00010								
269	39	40	F	R	0.00100								
270	40	41		R	1000.00000								
271	41	39		R	1000.00000								
272	40	42		R	0.00100								
273	42	34		R	0.00000								
274	695	43		R	0.00010								
275	795	43		R	0.00010								
276	51	44		R	0.00080								
277	44	45	F	R	0.00100								
278	45	46		R	1000.00000								
279	46	44		R	1000.00000								
280	45	47		R	0.00100								
281	47	42		R	0.00000								
282	47	48		R	0.00000								
283	48	49		R	0.00000								
284	49	50		R	0.00000								
285	50	12		R	0.00000								
286	43	51		R	0.00030								

Branch No.	From	To	F R B	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
1	1	2		0.00510	443.43	1002.8	70.07	61053
2	2	3		0.00010	481.64	23.2	1.76	1534
3	3	111		0.00040	348.07	48.5	2.66	2318
4	111	100		0.00390	313.93	384.4	19.02	16568
5	100	102		0.00390	41.68	6.8	0.04	39
6	102	103		0.00030	-90.28	-2.4	0.03	30
7	103	110		0.00130	-43.87	-2.5	0.02	15
8	110	115		0.00090	-179.20	-28.9	0.82	711
9	115	122		0.00120	-281.91	-95.4	4.24	3693
10	122	130		0.00140	-430.78	-259.8	17.64	15366
11	111	130		0.00180	34.14	2.1	0.01	10
12	601	605		0.10010	147.48	2177.2	50.60	44086
13	701	605		0.00010	390.94	15.3	0.94	821
14	605	17		0.00080	538.42	231.9	19.67	17143
15	17	18	F	0.00200	540.43	584.1	49.74	43340
16	18	19		1000.00000	2.00	4003.8	1.26	1099
17	19	17		1000.00000	2.00	4003.8	1.26	1099
18	18	20		0.00300	538.42	869.7	73.79	64292
19	4	5		0.00720	405.06	1181.3	75.40	65697
20	5	6		0.00030	362.76	39.5	2.26	1967
21	6	7		0.00430	252.67	274.5	10.93	9523
22	7	8		0.00010	250.48	6.3	0.25	217
23	8	9		0.00120	248.28	74.0	2.90	2523
24	9	10		0.00100	248.28	61.6	2.41	2100
25	10	16		15.00010	17.71	4706.4	13.13	11444
26	23	21		0.00010	90.51	0.8	0.01	0
27	22	21		0.00000	79.82	0.0	0.00	0
28	21	16		0.00040	170.34	11.6	0.31	271
29	16	14		0.00260	188.05	91.9	2.72	2373
30	14	13	F	0.00200	189.87	72.1	2.16	1880
31	13	15		1000.00000	1.82	3305.9	0.95	826
32	15	14		1000.00000	1.82	3305.9	0.95	826
33	13	12		0.00500	188.05	176.8	5.24	4565
34	12	11		0.00000	2388.50	0.0	0.00	0
35	11	4		0.00000	2388.50	0.0	0.00	0
36	4	1		0.00000	409.10	0.0	0.00	0
37	20	1		0.00000	2200.00	0.0	0.00	0
38	100	600		0.00200	272.25	148.2	6.36	5540
39	600	700		0.00010	270.49	7.3	0.31	271
40	700	200		0.00140	268.19	100.7	4.26	3708
41	200	201		0.00140	268.19	100.7	4.26	3708
42	201	202		0.00150	268.19	107.9	4.56	3973
43	202	203		0.00030	203.00	12.4	0.40	346
44	203	210		0.00130	143.88	26.9	0.61	531
45	210	215		0.00090	81.58	6.0	0.08	67
46	215	222		0.00120	4.51	0.0	0.00	0
47	222	230		0.00140	-58.61	-4.8	0.04	39
48	230	233		0.00040	-186.29	-13.9	0.41	356
49	233	238		0.00090	-256.87	-59.4	2.40	2095
50	238	245		0.00120	-328.38	-129.4	6.70	5834
51	245	253		0.00140	197.92	54.8	1.71	1489
52	253	256		0.00040	124.07	6.2	0.12	106
53	256	260		0.00080	21.28	0.4	0.00	0
54	260	266		0.00100	-106.04	-11.2	0.19	163
55	10	2120		0.00600	230.56	319.0	11.59	10098
56	2120	2105		0.00280	147.21	60.7	1.41	1227
57	2105	2103		0.00050	16.27	0.1	0.00	0

Branch No.	From	To	F R B	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
58	2103	295		0.00140	-76.23	-8.1	0.10	85
59	295	292		0.00050	-159.62	-12.7	0.32	278
60	292	280		0.00220	-249.19	-136.6	5.36	4674
61	280	275		0.00060	-349.21	-97.6	5.37	4680
62	275	266		0.00150	181.89	49.6	1.42	1239
63	130	133		0.00040	-551.70	-121.8	10.59	9226
64	133	138		0.00090	123.61	13.8	0.27	234
65	138	145		0.00120	-48.56	-2.8	0.02	19
66	145	153		0.00140	-201.40	-56.8	1.80	1571
67	153	156		0.00040	-369.65	-54.7	3.19	2776
68	156	160		0.00080	95.30	7.3	0.11	96
69	160	166		0.00100	-61.07	-3.7	0.04	31
70	6	1120		0.00650	110.09	78.8	1.37	1191
71	1120	1105		0.00260	-49.25	-6.3	0.05	43
72	1105	1103		0.00040	-202.15	-16.3	0.52	452
73	1103	195		0.00130	-157.68	-32.3	0.80	699
74	195	180		0.00270	-317.65	-272.4	13.63	11880
75	180	175		0.00080	-500.99	-200.8	15.85	13812
76	175	166		0.00160	232.41	86.4	3.16	2757
77	2	131		0.03130	-38.21	-45.7	0.28	240
78	131	155		0.01190	-82.60	-81.2	1.06	921
79	5	1102		0.03950	42.30	70.7	0.47	411
80	1102	179		0.01800	-124.15	-277.4	5.43	4728
81	179	155		0.01880	-72.45	-98.7	1.13	982
82	131	132		0.00610	-18.07	-2.0	0.01	0
83	132	133		0.00090	-18.07	-0.3	0.00	0
84	131	157		0.52010	62.46	2028.8	19.97	17398
85	155	156		0.00090	-155.05	-21.6	0.53	460
86	179	180		0.00090	-51.70	-2.4	0.02	17
87	1102	1103		0.00090	166.45	24.9	0.65	569
88	666	660		0.00080	-354.46	-100.5	5.61	4891
89	660	656		0.00060	-310.94	-58.0	2.84	2476
90	656	653		0.00030	-275.99	-22.9	1.00	868
91	653	645		0.00110	-34.04	-1.3	0.01	0
92	645	638		0.00090	-20.39	-0.4	0.00	0
93	638	633		0.00070	-207.65	-30.2	0.99	861
94	633	630		0.00030	-786.19	-185.4	22.97	20013
95	630	622		0.00110	-786.24	-680.0	84.25	73406
96	622	615		0.00090	-574.42	-297.0	26.88	23424
97	615	610		0.00070	-394.81	-109.1	6.79	5914
98	610	603		0.00100	-197.36	-39.0	1.21	1057
99	603	602		0.00020	-51.24	-0.5	0.00	0
100	602	601		0.00190	145.71	40.3	0.93	806
101	600	601		1000.00050	1.77	3122.4	0.87	759
102	666	667		0.00020	243.60	11.9	0.46	398
103	667	675		0.00110	260.39	74.6	3.06	2667
104	675	680		0.00060	187.38	21.1	0.62	543
105	680	695		0.00210	207.14	90.1	2.94	2562
106	695	6103		0.00100	-227.80	-51.9	1.86	1623
107	6103	6105		0.00030	-190.64	-10.9	0.33	285
108	6105	6120		0.00210	-154.23	-50.0	1.22	1059
109	6120	23		0.00400	88.31	31.2	0.43	378
110	7	23		1000.00100	2.20	4835.0	1.68	1460
111	766	760		0.00080	-467.2[illegible]	-174.7	12.86	11201
112	760	756		0.00060	-227.10	-30.9	1.11	963
113	756	753		0.00030	-58.89	-1.0	0.01	0
114	753	745		0.00110	-58.74	-3.8	0.04	31

Branch No.	From	To	FRB	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
115	745	738		0.00090	209.51	39.5	1.30	1136
116	738	733		0.00070	-6.50	0.0	0.00	0
117	733	730		0.00030	104.99	3.3	0.05	48
118	730	722		0.00110	387.77	165.4	10.11	8806
119	722	715		0.00090	387.94	135.5	8.28	7217
120	715	710		0.00070	388.11	105.4	6.45	5616
121	710	703		0.00100	388.29	150.8	9.23	8039
122	703	702		0.00020	388.46	30.2	1.85	1611
123	702	701		0.00170	388.65	256.8	15.73	13703
124	700	701		1000.00060	2.30	5276.1	1.91	1666
125	766	767		0.00020	95.21	1.8	0.03	0
126	767	775		0.00110	286.33	90.2	4.07	3546
127	775	780		0.00060	42.07	1.1	0.01	0
128	780	795		0.00210	237.06	118.0	4.41	3841
129	795	7103		0.00100	-347.27	-120.6	6.60	5750
130	7103	7105		0.00030	-169.94	-8.7	0.23	203
131	7105	7120		0.00210	77.47	12.6	0.15	134
132	7120	22		0.00400	77.63	24.1	0.29	257
133	8	22		1000.00100	2.20	4830.2	1.67	1459
134	202	402		0.03480	65.19	147.9	1.52	1324
135	203	403		0.11520	59.12	402.7	3.75	3269
136	210	410		0.03480	62.30	135.1	1.33	1156
137	215	415		0.11650	77.07	692.0	8.40	7322
138	222	422		0.03480	63.12	138.7	1.38	1202
139	230	430		0.11460	127.67	1868.0	37.58	32744
140	233	433		0.11560	70.58	575.8	6.40	5580
141	238	438		0.03760	71.51	192.3	2.17	1888
142	245	445		0.11870	129.07	1977.4	40.22	35042
143	253	453		0.03970	73.85	216.5	2.52	2195
144	256	456		0.11720	102.79	1238.3	20.06	17476
145	260	460		0.11660	127.31	1890.0	37.92	33036
146	266	466		0.04040	75.85	232.4	2.78	2420
147	275	475		0.04090	77.17	243.6	2.96	2581
148	280	281		0.10990	100.02	1099.5	17.33	15099
149	292	281		0.12000	89.57	962.8	13.59	11840
150	281	467		0.01690	106.48	191.6	3.21	2801
151	281	480		0.00790	83.11	54.6	0.72	623
152	295	495		0.04100	83.38	285.1	3.75	3264
153	2103	4103		0.11710	92.51	1002.1	14.61	12728
154	2105	4105		0.11610	130.94	1990.5	41.07	35785
155	2120	4120		0.03560	83.35	247.3	3.25	2830
156	102	402		0.03480	131.95	605.9	12.60	10977
157	103	403		0.11520	87.17	875.4	12.02	10477
158	110	410		0.03480	135.33	637.3	13.59	11841
159	115	415		0.11650	102.71	1229.0	19.89	17331
160	122	422		0.03480	148.87	771.2	18.09	15763
161	130	430		0.11460	155.06	2755.5	67.33	58663
162	133	433		0.11560	116.58	1571.1	28.86	25147
163	138	438		0.03760	172.17	1114.6	30.24	26348
164	145	445		0.11870	152.84	2772.9	66.78	58189
165	153	453		0.03970	168.25	1123.8	29.79	25960
166	156	157		0.10980	139.33	2131.6	46.80	40777
167	157	456		0.00740	100.37	74.6	1.18	1028
168	157	467		0.01600	101.42	164.6	2.[illegible]	[illegible]
169	160	460		0.11660	156.37	2851.1	70.25	61211
170	166	466		0.04040	171.34	1186.0	32.02	27900
171	175	475		0.04090	173.70	1234.0	33.78	29429

Branch No.	From	To	F R B	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
172	180	480		0.11780	131.64	2041.3	42.34	36894
173	195	495		0.04100	159.97	1049.3	26.45	23046
174	1103	4103		0.11710	121.98	1742.3	33.49	29180
175	1105	4105		0.11610	152.89	2714.0	65.39	56971
176	1120	4120		0.03560	159.34	903.9	22.70	19775
177	402	502		0.02770	197.14	1076.5	33.44	29138
178	403	503		0.07020	146.29	1502.4	34.63	30176
179	410	510		0.02770	197.63	1081.9	33.69	29357
180	415	515		0.02770	179.78	895.3	25.36	22099
181	422	522		0.02770	211.99	1244.8	41.58	36231
182	430	530		0.02770	282.74	2214.3	98.65	85959
183	433	533		0.07060	187.16	2473.0	72.93	63548
184	438	538		0.02800	243.68	1662.7	63.84	55629
185	445	545		0.02850	281.91	2265.0	100.62	87669
186	453	553		0.02890	242.09	1693.8	64.61	56300
187	456	556		0.07140	203.16	2947.0	94.34	82202
188	460	560		0.02890	283.69	2325.8	103.97	90591
189	466	566		0.02890	247.19	1765.9	68.78	59933
190	467	567		0.07090	207.90	3064.4	100.39	87471
191	475	575		0.02890	250.87	1818.8	71.90	62647
192	480	580		0.07140	214.75	3292.7	111.42	97085
193	495	595		0.02840	243.36	1681.9	64.50	56197
194	4103	5103		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
195	4105	5105		0.02840	283.83	2287.9	102.33	89158
196	4120	5120		0.02840	242.70	1672.8	63.97	55742
197	502	602		0.03970	196.95	1540.0	47.79	41643
198	503	603		0.03970	146.13	847.7	19.52	17008
199	510	610		0.03970	197.45	1547.7	48.15	41958
200	515	615		0.03970	179.61	1280.7	36.25	31582
201	522	622		0.03970	211.82	1781.2	59.45	51802
202	530	630		99000.03870	-0.05	-232.8	0.00	2
203	533	633		0.13850	84.98	1000.1	13.39	11669
204	538	638		0.03850	243.53	2283.4	87.62	76349
205	545	645		0.13940	13.66	26.0	0.06	49
206	553	653		0.03940	241.94	2306.3	87.93	76611
207	556	656		0.03940	34.95	48.1	0.26	231
208	560	660		0.03970	43.52	75.2	0.52	449
209	566	666		0.03940	247.03	2404.4	93.59	81550
210	567	667		0.03940	16.78	11.1	0.03	26
211	575	675		0.03940	250.71	2476.5	97.84	85246
212	580	680		0.03970	19.76	15.5	0.05	42
213	595	695		0.04120	243.20	2436.8	93.38	81367
214	5103	6103		0.04120	37.16	56.9	0.33	290
215	5105	6105		0.04120	36.42	54.6	0.31	273
216	5120	6120		0.04120	242.54	2423.6	92.63	80707
217	502	702		99000.00000	0.19	3485.6	0.10	91
218	503	703		99000.00000	0.17	2762.6	0.07	64
219	510	710		99000.00000	0.18	3272.8	0.09	81
220	515	715		99000.00000	0.17	2791.3	0.07	65
221	522	722		99000.00000	0.17	2859.4	0.08	67
222	530	730		0.00000	282.78	0.0	0.00	0
223	533	733		0.10000	102.18	1044.1	16.81	14648
224	538	738		99000.00000	0.15	2297.2	0.05	47
225	545	745		0.00000	269.25	0.0	0.00	0
226	553	753		99000.00000	0.15	2280.0	0.05	47
227	556	756		0.00000	168.21	0.0	0.00	0
228	560	760		0.00000	240.16	0.0	0.00	0

Branch No.	From	To	F R B	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
229	566	766		99000.00000	0.16	2403.4	0.06	53
230	567	767		0.00000	191.11	0.0	0.00	0
231	575	775		99000.00000	0.16	2481.0	0.06	55
232	580	780		0.00000	194.99	0.0	0.00	0
233	595	795		99000.00000	0.16	2448.6	0.06	54
234	5103	7103		0.00000	177.33	0.0	0.00	0
235	5105	7105		0.00000	247.41	0.0	0.00	0
236	5120	7120		99000.00000	0.16	2431.5	0.06	53
237	3	104		0.01780	133.57	317.6	6.66	5824
238	104	103		0.00670	133.57	119.5	2.52	2192
239	1	24		0.00000	2165.67	0.0	0.00	0
240	24	25		0.00010	2073.59	430.0	140.50	122422
241	25	133		0.00080	809.97	524.8	66.98	58362
242	25	245		0.00310	655.36	1331.4	137.49	119800
243	25	275		0.00360	608.26	1331.9	127.66	111231
244	24	26		0.00000	92.08	0.0	0.00	0
245	4	26		0.00000	1574.34	0.0	0.00	0
246	26	27		0.00010	1666.42	277.7	72.92	63537
247	27	156		0.00100	759.33	576.6	68.99	60113
248	27	175		0.00060	907.10	493.7	70.57	61487
249	633	28		0.00010	663.52	44.0	4.60	4008
250	733	28		0.00010	-9.31	0.0	0.00	0
251	638	29		0.00010	43[illegible].80	19.[illegible]	1.26	[illegible]
252	738	29		0.00010	216.17	4.7	0.16	139
253	28	30		0.00050	654.21	214.0	22.06	19222
254	29	30		0.00050	646.97	209.3	21.34	18592
255	30	31		0.00010	1301.18	169.3	34.71	30246
256	31	32	F	0.00100	1303.19	1698.3	348.75	303871
257	32	33		1000.00000	2.01	4059.7	1.29	1120
258	33	31		1000.00000	2.01	4059.7	1.29	1120
259	32	34		0.00100	1301.18	1693.1	347.14	302473
260	34	35		0.00000	1661.58	0.0	0.00	0
261	35	20		0.00000	1661.58	0.0	0.00	0
262	666	36		0.00010	357.89	12.8	0.72	629
263	766	36		0.00010	372.21	13.9	0.82	710
264	675	37		0.00010	323.71	10.5	0.54	467
265	775	37		0.00010	244.41	6.0	0.23	201
266	36	38		0.00040	730.10	213.2	24.53	21372
267	37	38		0.00040	568.13	129.1	11.56	10070
268	38	39		0.00010	1298.23	168.5	34.47	30034
269	39	40	F	0.00100	1300.26	1690.7	346.41	301831
270	40	41		1000.00000	2.04	4147.1	1.33	1162
271	41	39		1000.00000	2.04	4147.1	1.33	1162
272	40	42		0.00100	1298.23	1685.4	344.78	300415
273	42	34		0.00000	360.40	0.0	0.00	0
274	695	43		0.00010	678.14	46.0	4.92	4283
275	795	43		0.00010	584.49	34.2	3.15	2745
276	51	44		0.00080	1262.63	1275.4	253.75	221100
277	44	45	F	0.00100	1264.84	1599.8	318.85	277823
278	45	46		1000.00000	2.21	4903.2	1.71	1488
279	46	44		1000.00000	2.21	4903.2	1.71	1488
280	45	47		0.00100	1262.63	1594.2	317.18	276367
281	47	42		0.00000	-937.83	0.0	0.00	0
282	47	48		0.00000	2200.46	0.0	0.00	0
283	48	49		0.00000	2200.46	0.0	0.00	0
284	49	50		0.00000	2200.46	0.0	0.00	0
285	50	12		0.00000	2200.46	0.0	0.00	0

Branch No.	From	To	F R B	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
286	43	51		0.00030	1262.63	478.3	95.16	82917

Branch No.	From	To	I R	Fixed Airflow (kcfm)	Booster Pressure (m.in.wg)	Regulator Resistance (P.U.)	Branch Resistance (P.U.)	Total Resistance (P.U.)
37	20	1		2200.00			0.00000	

Fan No.: 1
From: 17
To: 18
Pressure: 6.000 in.w.g.
Description: First Empl Shaft Fan

Fan Name: Joy 144-79-590
Fan Setting: 4
Comments: Rep LADS, 1 cms, Empl Shaft Collar
Points: 10

Quantity	Pressure	Description
200.00	7.000	
250.00	8.000	
350.00	9.000	
470.00	9.500	
520.00	9.000	
620.00	7.000	
700.00	5.000	
740.00	4.000	
760.00	3.000	
800.00	1.000	

Fan No.: 2
From: 14
To: 13
Pressure: 6.000 in.w.g.
Description: Former Dev Shaft Fan

Fan Name: Joy84-~~56~~-880/144-79x
Fan Setting: 4 58 MJ 6/21/99
Comments: Repository LADS, 1cms, Former Dev Shaft Collar
Points: 10

Quantity	Pressure	Description
60.00	9.000	
80.00	10.000	
100.00	11.000	
125.00	11.500	
155.00	10.000	
180.00	8.000	
195.00	6.000	
210.00	4.000	
215.00	3.000	
220.00	2.000	

Fan No.: 3
From: 31
To: 32
Pressure: 6.000 in.w.g.
Description: 1st MidEmplShaft Fan

Fan Name: Joy 144-79-880
Fan Setting: 31.5 deg
Comments: Rep Lads, 5 cms, Mid Emplc Shaft Collars (3)
Points: 10

Quantity	Pressure	Description
500.00	18.000	
600.00	19.000	
750.00	21.000	
900.00	22.000	
1000.00	20.000	
1150.00	16.000	
1200.00	14.000	
1300.00	10.000	
1370.00	6.000	
1450.00	2.000	

Fan No.: 4
From: 39
To: 40
Pressure: 6.000 in.w.g.
Description: 2nd MidEmplShaft Fan

Fan Name: Joy 144-79-880
Fan Setting: 31.5 deg
Comments: Rep Lads, 5 cms, Mid Emplc Shaft Collars (3)
Points: 10

Quantity	Pressure	Description
500.00	18.000	
600.00	19.000	
750.00	21.000	
900.00	22.000	
1000.00	20.000	
1150.00	16.000	
1200.00	14.000	
1300.00	10.000	
1370.00	6.000	
1450.00	2.000	

Fan No.: 5
From: 44
To: 45
Pressure: 6.000 in.w.g.
Description: 3rd MidEmplShaft Fan

Fan Name: Joy 144-79-880
Fan Setting: 31.5 deg
Comments: Rep Lads, 5 cms, Mid Emplc Shaft Collars (3)
Points: 10

Quantity	Pressure	Description
500.00	18.000	
600.00	19.000	
750.00	21.000	
900.00	22.000	
1000.00	20.000	
1150.00	16.000	
1200.00	14.000	
1300.00	10.000	
1370.00	6.000	
1450.00	2.000	

Fan No.	From	To	Fan Pressure (in.wg)	Fan Airflow (kcfm)	Fan Curve	Air Power (hp)	Operating Cost ($/yr)	Fan Description
1	17	18	8.591	540.43	On	731.59	637450	First Empl Shaft Fan
2	14	13	6.684	189.87	On	199.98	174242	Former Dev Shaft Fan
3	31	32	9.818	1303.19	On	2016.14	1756699	1st MidEmplShaft Fan
4	39	40	9.985	1300.26	On	2045.83	1782568	2nd MidEmplShaft Fan
5	44	45	11.406	1264.84	On	2273.31	1980780	3rd MidEmplShaft Fan

APPENDIX F

CALCULATION OF AIRWAY RESISTANCES FOR SYSTEM C–10.0 cms

APPENDIX F

CALCULATION OF AIRWAY RESISTANCES FOR SYSTEM C–10.0 cms

This table develops the input file for VNETPC for this system. The descriptions for the inputs for this table are located in Appendix A and Section 4.2.

The input values for K, A and P can be found in Section 4.2.1. The actual lengths are from Appendix H (as indicated by reference column). The regulator resistance (RPU_b) can be found in Section 4.2.20.

Fan locations, nodes and branches are shown in Figure F-1

Table F-1. Calculation of Airway Resistances During Monitoring Phase for System C-10.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad10: VNETPC INPUT, Design Feature Development, Case 10 m^3/s per emplacement drift. (Data by RSJurani & A Linden)

Line No.	BRANCH FROM	BRANCH TO	RESISTANCE E in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE E in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
1	1	2	0.0051		0.0051	0.0509	30	389.33	72.36	1992.0	6535	7189	North Ramp	Figure H-2
2	2	3	0.0001		0.0001	0.0011	30	389.33	72.36	43.6	143	157	North Ramp	Figure H-2
3	3	111	0.0004		0.0004	0.0039	30	389.33	72.36	151.4	497	546	North Ramp	Figure H-2
4	111	27	0.0015		0.0015	0.0149	30	389.33	72.36	582.4	1911	2102	North Ramp Ext	Figure H-2
5	100	102	0.0039		0.0039	0.0390	70	389.33	72.36	654.6	2148	2362	East Main Drift Ext.	Figure H-2
6	102	103	0.0003		0.0003	0.0026	70	389.33	72.36	43.5	143	157	East Main Drift	Figure H-2
7	103	110	0.0013		0.0013	0.0130	70	389.33	72.36	217.4	713	785	East Main Drift	Figure H-2
8	110	115	0.0009		0.0009	0.0086	70	389.33	72.36	144.9	475	523	East Main Drift	Figure H-2
9	115	122	0.0012		0.0012	0.0121	70	389.33	72.36	202.9	666	732	East Main Drift	Figure H-2
10	122	130	0.0014		0.0014	0.0138	70	389.33	72.36	231.9	761	837	East Main Drift	Figure H-2
11	111	130	0.0018		0.0018	0.0178	30	389.33	72.36	698.5	2292	2521	North Ramp Curve	Figure H-2
12	601	605	0.1001	0.1000	0.0001	0.0010	25	446.53	80.13	67.0	220	242	East Exhaust Main to Empl Shaft	Figure H-2
13	701	605	0.0001		0.0001	0.0009	25	446.53	80.13	57.5	189	208	West Exhaust Main Connector to Empl Sh	Figure H-2
14	605	17	0.0008		0.0008	0.0082	25	402.49	71.12	431.2	1415	1556	Emplacement Shaft (6.9 m dia.)	Fig. H-6, Appendix H
15	17	18	0.0020	0.0020	0.0000	0.0000	0	0	0	0.0	0	0	Primary Fan- Emplacement Shaft	
16	18	19	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage Loop-1st leg	
17	19	17	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage Loop-2nd leg	
18	18	20	0.0030	0.0030	0.0000	0.0000	0	0	0	0.0	0	0	Surface Discharge - Evase (Outlet Cone)	
19	4	5	0.0072		0.0072	0.0716	60	389.33	72.36	1402.6	4602	5062	South Ramp to PC	Figure H-2
20	5	6	0.0003		0.0003	0.0025	60	389.33	72.36	49.2	161	178	South Ramp	Figure H-2
21	6	7	0.0043		0.0043	0.0427	60	389.33	72.36	835.8	2742	3016	South Ramp	Figure H-2
22	7	8	0.0001		0.0001	0.0012	60	389.33	72.36	23.1	76	83	South Ramp	Figure H-2
23	8	9	0.0012		0.0012	0.0116	60	389.33	72.36	227.2	745	820	South Ramp	Figure H-2
24	9	10	0.0010		0.0010	0.0102	60	389.33	72.36	200.0	656	722	South Ramp Ext Curve	Figure H-2
25	10	16	15.0001	15.0000	0.0001	0.0011	25	446.53	80.13	69.7	229	252	West Main to Development Shaft Drift	Figure H-2
26	23	21	0.0001		0.0001	0.0010	25	446.53	80.13	66.6	219	240	East Exhaust Main to Connector	Appendix H
27	22	21	0.0000		0.0000	0.0004	25	446.53	80.13	26.1	86	94	West Exhaust Main to Connector	Appendix H
28	21	16	0.0004		0.0004	0.0039	25	446.53	80.13	249.3	818	900	Exhaust Main Connecting Drift to Dev Sha	Figure H-2
29	16	14	0.0026		0.0026	0.0258	95	402.49	71.12	358.8	1177	1295	Dev Shaft (Man/material, 6.9 m dia)	Fig. H-6, Appendix H
30	14	13	0.0020	0.0020	0.0000	0.0000	0	0	0	0.0	0	0	Primary Fan- Development Shaft	
31	13	15	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage 1st leg	
32	15	14	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage 2nd leg	
33	13	12	0.0050	0.0050	0.0000	0.0000	0	0	0	0.0	0	0	Surface Outlet - Evase	
34	12	11	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Dummy Connector	
35	11	14	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Dummy Connector	
36	4	1	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Dummy Connector	
37	20	1	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Dummy Connector	
38	100	600	0.0020		0.0020	0.0200	70	389.33	72.36	336.5	1104	1214	North Main	Figure H-2
39	600	700	0.0001		0.0001	0.0015	70	389.33	72.36	25.1	82	91	North Main	Figure H-2
40	700	200	0.0014		0.0014	0.0144	70	389.33	72.36	241.7	793	872	North Main	Figure H-2

Table F-1. Calculation of Airway Resistances During Monitoring Phase for System C-10.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad10: VNETPC INPUT, Design Feature Development, Case 10 m^3/s per emplacement drift. (Data by RSJurani & A Linden)														
Line No.	BRANCH		RESISTANCE E in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE E in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
	FROM	TO												
41	200	201	0.0014		0.0014	0.0141	70	389.33	72.36	236.1	775	852	West Main	Figure H-2
42	201	202	0.0015		0.0015	0.0147	70	389.33	72.36	246.5	809	890	West main	Figure H-2
43	202	203	0.0003		0.0003	0.0026	70	389.33	72.36	43.5	143	157	West main	Figure H-2
44	203	210	0.0013		0.0013	0.0130	70	389.33	72.36	217.4	713	785	West main	Figure H-2
45	210	215	0.0009		0.0009	0.0086	70	389.33	72.36	144.9	475	523	West main	Figure H-2
46	215	222	0.0012		0.0012	0.0121	70	389.33	72.36	202.9	666	732	West main	Figure H-2
47	222	230	0.0014		0.0014	0.0137	70	389.33	72.36	230.1	755	830	West main	Figure H-2
48	230	233	0.0004		0.0004	0.0042	70	389.33	72.36	70.1	230	253	West main	Figure H-2
49	233	238	0.0009		0.0009	0.0092	70	389.33	72.36	154.5	507	558	West main	Figure H-2
50	238	245	0.0012		0.0012	0.0117	70	389.33	72.36	197.1	647	711	West main	Figure H-2
51	245	253	0.0014		0.0014	0.0136	70	389.33	72.36	228.9	751	826	West main	Figure H-2
52	253	256	0.0004		0.0004	0.0043	70	389.33	72.36	71.5	235	258	West main	Figure H-2
53	256	260	0.0008		0.0008	0.0077	70	389.33	72.36	128.7	422	464	West main	Figure H-2
54	260	266	0.0010		0.0010	0.0102	70	389.33	72.36	171.7	563	620	West main	Figure H-2
55	10	2120	0.0060		0.0060	0.0595	70	389.33	72.36	999.2	3278	3606	West main	Figure H-2
56	2120	2105	0.0028		0.0028	0.0280	70	389.33	72.36	470.3	1543	1697	West main	Figure H-2
57	2105	2103	0.0005		0.0005	0.0047	70	389.33	72.36	78.4	257	283	West main	Figure H-2
58	2103	295	0.0014		0.0014	0.0140	70	389.33	72.36	235.2	772	849	West main	Figure H-2
59	295	292	0.0005		0.0005	0.0045	70	389.33	72.36	75.9	249	274	West main	Figure H-2
60	292	280	0.0022		0.0022	0.0224	70	389.33	72.36	376.2	1234	1358	West main	Figure H-2
61	280	275	0.0008		0.0008	0.0077	70	389.33	72.36	128.7	422	464	West main	Figure H-2
62	275	266	0.0015		0.0015	0.0153	70	389.33	72.36	257.5	845	929	West main	Figure H-2
63	130	133	0.0004		0.0004	0.0043	70	389.33	72.36	72.5	238	262	East Main	Figure H-2
64	133	138	0.0009		0.0009	0.0095	70	389.33	72.36	159.4	523	575	East Main	Figure H-2
65	138	145	0.0012		0.0012	0.0121	70	389.33	72.36	202.9	666	732	East Main	Figure H-2
66	145	153	0.0014		0.0014	0.0138	70	389.33	72.36	231.9	761	837	East Main	Figure H-2
67	153	156	0.0004		0.0004	0.0043	70	389.33	72.36	72.5	238	262	East Main	Figure H-2
68	156	160	0.0008		0.0008	0.0078	70	389.33	72.36	130.4	428	471	East Main	Figure H-2
69	160	166	0.0010		0.0010	0.0104	70	389.33	72.36	173.9	571	628	East Main	Figure H-2
70	6	1120	0.0065		0.0065	0.0651	70	389.33	72.36	1093.1	3586	3945	East Main	Figure H-2
71	1120	1105	0.0026		0.0026	0.0259	70	389.33	72.36	434.8	1427	1569	East Main	Figure H-2
72	1105	1103	0.0004		0.0004	0.0043	70	389.33	72.36	72.5	238	262	East Main	Figure H-2
73	1103	195	0.0013		0.0013	0.0130	70	389.33	72.36	217.4	713	785	East Main	Figure H-2
74	195	180	0.0027		0.0027	0.0268	70	389.33	72.36	449.3	1474	1621	East Main	Figure H-2
75	180	175	0.0008		0.0008	0.0078	70	389.33	72.36	130.4	428	471	East Main	Figure H-2
76	175	166	0.0016		0.0016	0.0155	70	389.33	72.36	260.9	856	942	East Main	Figure H-2
77	2	131	0.0313		0.0313	0.3130	70	177.60	48.44	745.0	2444	2689	ECRB	Figure H-2
78	131	155	0.0119		0.0119	0.1193	70	211.30	52.57	440.8	1446	1591	PC Main	Figure H-2
79	5	1102	0.0395		0.0395	0.3946	70	211.30	52.57	1457.6	4782	5260	PC Main	Figure H-2
80	1102	179	0.0180		0.0180	0.1805	70	211.30	52.57	666.7	2187	2406	PC Main	Figure H-2

Table F-1. Calculation of Airway Resistances During Monitoring Phase for System C-10.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad10: VNETPC INPUT, Design Feature Development, Case 10 m^3/s per emplacement drift. (Data by RSJurani & A Linden)

Line No.	BRANCH FROM	TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5,2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
81	179	155	0.0188		0.0188	0.1883	70	211.30	52.57	695.7	2282	2511	PC Main	Figure H-2
82	131	132	0.0061		0.0061	0.0612	70	211.30	52.57	225.9	741	815	PC Main	Figure H-2
83	132	133	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 2	Figure H-2
84	131	157	0.5201	0.5000	0.0201	0.2014	70	177.60	48.44	479.4	1573	1730	ECRB	Figure H-2
85	155	156	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 3	Figure H-2
86	179	180	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 4	Figure H-2
87	1102	1103	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 5	Figure H-2
88	666	660	0.0008		0.0008	0.0080	60	401.49	72.36	172.7	567	623	East Exhaust Main	Figure H-2
89	660	656	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	East Exhaust Main	Figure H-2
90	656	653	0.0003		0.0003	0.0034	60	401.49	72.36	72.0	236	260	East Exhaust Main	Figure H-2
91	653	645	0.0011		0.0011	0.0107	60	401.49	72.36	230.3	756	831	East Exhaust Main	Figure H-2
92	645	638	0.0009		0.0009	0.0092	60	401.49	72.36	198.2	650	715	East Exhaust Main	Figure H-2
93	638	633	0.0007		0.0007	0.0072	60	401.49	72.36	154.7	508	558	East Exhaust Main	Figure H-2
94	633	630	0.0003		0.0003	0.0033	60	401.49	72.36	70.4	231	254	East Exhaust Main	Figure H-2
95	630	622	0.0011		0.0011	0.0108	60	401.49	72.36	231.8	760	837	East Exhaust Main	Figure H-2
96	622	615	0.0009		0.0009	0.0094	60	401.49	72.36	202.9	666	732	East Exhaust Main	Figure H-2
97	615	610	0.0007		0.0007	0.0067	60	401.49	72.36	144.9	475	523	East Exhaust Main	Figure H-2
98	610	603	0.0010		0.0010	0.0101	60	401.49	72.36	217.4	713	785	East Exhaust Main	Figure H-2
99	603	602	0.0002		0.0002	0.0020	60	401.49	72.36	43.5	143	157	East Exhaust Main	Figure H-2
100	602	601	0.0019		0.0019	0.0187	60	401.49	72.36	400.7	1315	1446	East Exhaust Main	Figure H-2
101	600	601	1000.0005	1000.0000	0.0005	0.0051	60	401.49	72.36	108.7	357	392	East Exhaust Main Reg (North Ramp Side	Figure H-2
102	666	667	0.0002		0.0002	0.0016	60	401.49	72.36	33.5	110	121	East Exhaust Main	Figure H-2
103	667	675	0.0011		0.0011	0.0105	60	401.49	72.36	225.6	740	814	East Exhaust Main	Figure H-2
104	675	680	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	East Exhaust Main	Figure H-2
105	680	695	0.0021		0.0021	0.0210	60	401.49	72.36	450.0	1476	1624	East Exhaust Main	Figure H-2
106	695	6103	0.0010		0.0010	0.0105	60	401.49	72.36	225.1	739	812	East Exhaust Main	Figure H-2
107	6103	6105	0.0003		0.0003	0.0035	60	401.49	72.36	75.1	246	271	East Exhaust Main	Figure H-2
108	6105	6120	0.0021		0.0021	0.0210	60	401.49	72.36	450.2	1477	1625	East Exhaust Main	Figure H-2
109	6120	23	0.0040		0.0040	0.0400	60	401.49	72.36	860.1	2822	3104	East Exhaust Main	Figure H-2
110	7	23	1000.0010	1000.0000	0.0010	0.0099	60	401.49	72.36	213.4	700	770	East Exhaust Main Reg (South Ramp Side	Figure H-2
111	766	760	0.0008		0.0008	0.0080	60	401.49	72.36	172.7	567	623	West Exhaust Main	Figure H-2
112	760	756	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	West Exhaust Main	Figure H-2
113	756	753	0.0003		0.0003	0.0034	60	401.49	72.36	72.0	236	260	West Exhaust Main	Figure H-2
114	753	745	0.0011		0.0011	0.0107	60	401.49	72.36	230.3	756	831	West Exhaust Main	Figure H-2
115	745	738	0.0009		0.0009	0.0092	60	401.49	72.36	198.1	650	715	West Exhaust Main	Figure H-2
116	738	733	0.0007		0.0007	0.0072	60	401.49	72.36	154.7	508	558	West Exhaust Main	Figure H-2
117	733	730	0.0003		0.0003	0.0033	60	401.49	72.36	70.4	231	254	West Exhaust Main	Figure H-2
118	730	722	0.0011		0.0011	0.0107	60	401.49	72.36	230.8	757	833	West Exhaust Main	Figure H-2
119	722	715	0.0009		0.0009	0.0094	60	401.49	72.36	202.9	666	732	West Exhaust Main	Figure H-2
120	715	710	0.0007		0.0007	0.0067	60	401.49	72.36	144.9	475	523	West Exhaust Main	Figure H-2

Table F-1. Calculation of Airway Resistances During Monitoring Phase for System C-10.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad10: VNETPC INPUT, Design Feature Development, Case 10 m^3/s per emplacement drift. (Data by RSJurani & A Linden)

Line No.	BRANCH FROM	BRANCH TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
121	710	703	0.0010		0.0010	0.0101	60	401.49	72.36	217.4	713	785	West Exhaust Main	Figure H-2
122	703	702	0.0002		0.0002	0.0020	60	401.49	72.36	43.5	143	157	West Exhaust Main	Figure H-2
123	702	701	0.0017		0.0017	0.0173	60	401.49	72.36	371.6	1219	1341	West Exhaust Main	Figure H-2
124	700	701	1000.0006	1000.0000	0.0006	0.0064	60	401.49	72.36	138.3	454	499	West Exhaust Main Reg (North Ramp Side	Figure H-2
125	766	767	0.0002		0.0002	0.0016	60	401.49	72.36	33.5	110	121	West Exhaust Main	Figure H-2
126	767	775	0.0011		0.0011	0.0105	60	401.49	72.36	225.6	740	814	West Exhaust Main	Figure H-2
127	775	780	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	West Exhaust Main	Figure H-2
128	780	795	0.0021		0.0021	0.0210	60	401.49	72.36	450.2	1477	1625	West Exhaust Main	Figure H-2
129	795	7103	0.0010		0.0010	0.0105	60	401.49	72.36	225.1	739	812	West Exhaust Main	Figure H-2
130	7103	7105	0.0003		0.0003	0.0035	60	401.49	72.36	75.1	246	271	West Exhaust Main	Figure H-2
131	7105	7120	0.0021		0.0021	0.0210	60	401.49	72.36	450.2	1477	1625	West Exhaust Main	Figure H-2
132	7120	22	0.0040		0.0040	0.0403	60	401.49	72.36	865.8	2841	3125	West Exhaust Main	Figure H-2
133	8	22	1000.0010	1000.0000	0.0010	0.0100	60	401.49	72.36	214.9	705	776	West Exhaust Main Reg (South Ramp Sid	Figure H-2
134	202	402	0.0348	As low as R/9	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift West Side	Figure H-2
135	203	403	0.1152	0.1000	0.0152	0.1516	70	211.30	52.57	559.9	1837	2021	PC 1 West Side	Fig. H-2, Appendix H
136	210	410	0.0348	As low as R/9	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift West Side	Figure H-2
137	215	415	0.1165	0.1000	0.0165	0.1654	70	201.93	52.57	533.3	1750	1925	Emplacement Drift West Side (Empty)	Figure H-2
138	222	422	0.0348	As low as R/9	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift West Side	Figure H-2
139	230	430	0.1146	0.1000	0.0146	0.1457	70	211.30	52.57	538.3	1766	1943	Cross Block 30 West Side	Figure H-2
140	233	433	0.1156	0.1000	0.0156	0.1560	70	211.30	52.57	576.4	1891	2080	PC 2 West Side	Fig. H-2, Appendix H
141	238	438	0.0376	As low as R/9	0.0376	0.3760	85	168.13	52.57	576.3	1891	2080	Emplacement Drift West Side	Figure H-2
142	245	445	0.1187	0.1000	0.0187	0.1867	70	201.93	52.57	601.9	1975	2172	Emplacement Drift West Side (Empty)	Figure H-2
143	253	453	0.0397	As low as R/9	0.0397	0.3970	85	168.13	52.57	608.4	1996	2196	Emplacement Drift West Side	Figure H-2
144	256	456	0.1172	0.1000	0.0172	0.1725	70	211.30	52.57	637.1	2090	2299	PC 3 West Side	Fig. H-2, Appendix H
145	260	460	0.1166	0.1000	0.0166	0.1662	70	211.30	52.57	614.1	2015	2216	Cross Block 60	Figure H-2
146	266	466	0.0404	As low as R/9	0.0404	0.4039	85	168.13	52.57	619.0	2031	2234	Emplacement Drift West Side	Figure H-2
147	275	475	0.0409	As low as R/9	0.0409	0.4087	85	168.13	52.57	626.4	2055	2261	Emplacement Drift West Side	Figure H-2
148	280	281	0.1099	0.1000	0.0099	0.0992	70	211.30	52.57	366.5	1202	1323	PC 4 West Side 1st leg	Fig. H-2, Appendix H
149	292	281	0.1200	0.1000	0.0200	0.2001	70	177.60	48.44	476.3	1563	1719	ECRB West Side	Fig. H-2, Appendix H
150	281	467	0.0169		0.0169	0.1693	70	177.60	48.44	403.0	1322	1454	ECRB West Side	Figure H-2
151	281	480	0.0079		0.0079	0.0785	70	211.30	52.57	290.1	952	1047	PC 4 West Side 2nd leg	Figure H-2
152	295	495	0.0410	As low as R/9	0.0410	0.4104	85	168.13	52.57	629.0	2064	2270	Emplacement Drift West Side	Figure H-2
153	2103	4103	0.1171	0.1000	0.0171	0.1708	70	211.30	52.57	630.8	2070	2277	PC 5 West Side	Fig. H-2, Appendix H
154	2105	4105	0.1161	0.1000	0.0161	0.1613	70	211.30	52.57	595.9	1955	2151	Cross Block 105	Figure H-2
155	2120	4120	0.0356	As low as R/9	0.0356	0.3565	85	168.13	52.57	546.3	1792	1972	Emplacement Drift West Side	Figure H-2
156	102	402	0.0348	As low as R/9	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift East Side	Figure H-2
157	103	403	0.1152	0.1000	0.0152	0.1516	70	211.30	52.57	559.9	1837	2021	PC 1 East Side	Fig. H-2, Appendix H
158	110	410	0.0348	As low as R/9	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift East Side	Figure H-2
159	115	415	0.1165	0.1000	0.0165	0.1654	70	201.93	52.57	533.3	1750	1925	Emplacement Drift East Side (Empty)	Figure H-2
160	122	422	0.0348	As low as R/9	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift East Side	Figure H-2

Table F-1. Calculation of Airway Resistances During Monitoring Phase for System C-10.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad10: VNETPC INPUT, Design Feature Development, Case 10 m^3/s per emplacement drift. (Data by RSJurani & A Linden)														
Line No.	BRANCH		RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
	FROM	TO												
161	130	430	0.1146	0.1000	0.0146	0.1457	70	211.30	52.57	538.3	1766	1943	Cross Block 30	Figure H-2
162	133	433	0.1156	0.1000	0.0156	0.1560	70	211.30	52.57	576.4	1891	2080	PC 2 East	Fig. H-2, Appendix H
163	138	438	0.0376	As low as R/9	0.0376	0.3760	85	168.13	52.57	576.3	1891	2080	Emplacement Drift East Side	Figure H-2
164	145	445	0.1187	0.1000	0.0187	0.1867	70	201.93	52.57	601.9	1975	2172	Emplacement Drift East Side (Empty)	Figure H-2
165	153	453	0.0397	As low as R/9	0.0397	0.3970	85	168.13	52.57	608.4	1996	2196	Emplacement Drift East Side	Figure H-2
166	156	157	0.1098	0.1000	0.0098	0.0982	70	211.30	52.57	362.9	1191	1310	PC 3 East Side 1st leg	Fig. H-2, Appendix H
167	157	456	0.0074		0.0074	0.0742	70	211.30	52.57	274.2	900	990	PC 3 East Side 2nd leg	Figure H-2
168	157	467	0.0160		0.0160	0.1600	70	177.60	48.44	380.9	1250	1375	ECRB	Figure H-2
169	160	460	0.1166	0.1000	0.0166	0.1662	70	211.30	52.57	614.1	2015	2216	Cross Block 60	Figure H-2
170	166	466	0.0404	As low as R/9	0.0404	0.4039	85	168.13	52.57	619.0	2031	2234	Emplacement Drift East Side	Figure H-2
171	175	475	0.0409	As low as R/9	0.0409	0.4087	85	168.13	52.57	626.4	2055	2261	Emplacement Drift East Side	Figure H-2
172	180	480	0.1178	0.1000	0.0178	0.1778	70	211.30	52.57	656.6	2154	2370	PC 4 East Side	Fig. H-2, Appendix H
173	195	495	0.0410	As low as R/9	0.0410	0.4104	85	168.13	52.57	629.0	2064	2270	Emplacement Drift East Side	Figure H-2
174	1103	4103	0.1171	0.1000	0.0171	0.1708	70	211.30	52.57	630.8	2070	2277	PC 5 East Side	Fig. H-2, Appendix H
175	1105	4105	0.1161	0.1000	0.0161	0.1613	70	211.30	52.57	595.9	1955	2151	Cross Block 105	Figure H-2
176	1120	4120	0.0356	As low as R/9	0.0356	0.3565	85	168.13	52.57	546.3	1792	1972	Emplacement Drift East Side	Figure H-2
177	402	502	0.0277	As low as R/9	0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Empl Level to Exh Main	Appendix H
178	403	503	0.0702		0.0702	0.7022	20	24.43	17.52	42.1	138	152	Raise Connector, PC Level to Exh Main	Appendix H
179	410	510	0.0277	As low as R/9	0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Empl Level to Exh Main	Appendix H
180	415	515	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Empl Level to Exh Main	Appendix H
181	422	522	0.0277	As low as R/9	0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Empl Level to Exh Main	Appendix H
182	430	530	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Empl Level to Exh Main	Appendix H
183	433	533	0.0706		0.0706	0.7055	20	24.43	17.52	42.3	139	153	Raise Connector, PC Level to Exh Main	Appendix H
184	438	538	0.0280	As low as R/9	0.0280	0.2802	20	24.43	17.52	16.8	55	61	Raise Connector, Empl Level to Exh Main	Appendix H
185	445	545	0.0285		0.0285	0.2852	20	24.43	17.52	17.1	56	62	Raise Connector, Empl Level to Exh Main	Appendix H
186	453	553	0.0289	As low as R/9	0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Empl Level to Exh Main	Appendix H
187	456	556	0.0714		0.0714	0.7139	20	24.43	17.52	42.8	140	154	Raise Connector, PC Level to Exh Main	Appendix H
188	460	560	0.0289		0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Empl Level to Exh Main	Appendix H
189	466	566	0.0289	As low as R/9	0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Empl Level to Exh Main	Appendix H
190	467	567	0.0709		0.0709	0.7089	20	24.43	17.52	42.5	139	153	Raise Connector, ECRB Level to Exh Main	Appendix H
191	475	575	0.0289	As low as R/9	0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Empl Level to Exh Main	Appendix H
192	480	580	0.0714		0.0714	0.7139	20	24.43	17.52	42.8	140	154	Raise Connector, PC Level to Exh Main	Appendix H
193	495	595	0.0284	As low as R/9	0.0284	0.2835	20	24.43	17.52	17.0	56	61	Raise Connector, Empl Level to Exh Main	Appendix H
194	4103	5103	0.0714		0.0714	0.7139	20	24.43	17.52	42.8	140	154	Raise Connector, PC Level to Exh Main	Appendix H
195	4105	5105	0.0284		0.0284	0.2835	20	24.43	17.52	17.0	56	61	Raise Connector, Empl Level to Exh Main	Appendix H
196	4120	5120	0.0284	As low as R/9	0.0284	0.2835	20	24.43	17.52	17.0	56	61	Raise Connector, Empl Level to Exh Main	Appendix H
197	502	602	0.0397	As low as R/9	0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exh Mains	Figure H-2
198	503	603	0.0397		0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exh Mains	Figure H-2
199	510	610	0.0397	As low as R/9	0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exh Mains	Figure H-2
200	515	615	0.0397		0 0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exh Mains	Figure H-2

Table F-1. Calculation of Airway Resistances During Monitoring Phase for System C-10.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad10: VNETPC INPUT, Design Feature Development, Case 10 m^3/s per emplacement drift. (Data by RSJurani & A Linden)

Line No.	BRANCH		RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
	FROM	TO												
201	522	622	0.0397	As low as R/9	0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exh Mains	Figure H-2
202	530	630	99000.0387	99000.0000	0.0387	0.3870	20	24.43	17.52	23.2	76	84	Horizontal Raise Connector of Exh Mains	Figure H-2
203	533	633	0.1385	0.1000	0.0385	0.3853	20	24.43	17.52	23.1	76	83	Horizontal Raise Connector of Exh Mains	Figure H-2
204	538	638	0.0385	As low as R/9	0.0385	0.3853	20	24.43	17.52	23.1	76	83	Horizontal Raise Connector of Exh Mains	Figure H-2
205	545	645	0.1394	0.1000	0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exh Mains	Figure H-2
206	553	653	0.0394	As low as R/9	0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exh Mains	Figure H-2
207	556	656	0.0394		0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exh Mains	Figure H-2
208	560	660	0.0397		0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exh Mains	Figure H-2
209	566	666	0.0394	As low as R/9	0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exh Mains	Figure H-2
210	567	667	0.0394		0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exh Mains	Figure H-2
211	575	675	0.0394	As low as R/9	0.0394	0.3936	20	24.43	17.52	23.6	77	85	Horizontal Raise Connector of Exh Mains	Figure H-2
212	580	680	0.0397		0.0397	0.3970	20	24.43	17.52	23.8	78	86	Horizontal Raise Connector of Exh Mains	Figure H-2
213	595	695	0.0412	As low as R/9	0.0412	0.4120	20	24.43	17.52	24.7	81	89	Horizontal Raise Connector of Exh Mains	Figure H-2
214	5103	6103	0.0412		0.0412	0.4120	20	24.43	17.52	24.7	81	89	Horizontal Raise Connector of Exh Mains	Figure H-2
215	5105	6105	0.0412		0.0412	0.4120	20	24.43	17.52	24.7	81	89	Horizontal Raise Connector of Exh Mains	Figure H-2
216	5120	6120	0.0412	As low as R/9	0.0412	0.4120	20	24.43	17.52	24.7	81	89	Horizontal Raise Connector of Exh Mains	Figure H-2
217	502	702	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
218	503	703	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
219	510	710	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
220	515	715	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
221	522	722	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
222	530	730	0.0000		0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
223	533	733	0.1000	0.1000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
224	538	738	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
225	545	745	0.0000		0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
226	553	753	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
227	556	756	0.0000		0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
228	560	760	0.0000		0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
229	566	766	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
230	567	767	0.0000		0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
231	575	775	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
232	580	780	0.0000		0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
233	595	795	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
234	5103	7103	0.0000		0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
235	5105	7105	0.0000		0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
236	5120	7120	99000.0000	99000.0000	0.0000	0.0000	20	24.43	17.52	0.0	0	0	Door/Reg from Raise to West Exh Main	
237	3	104	0.0178		0.0178	0.1775	70	211.30	52.57	655.7	2151	2366	PC 1 North Ramp Side 1st leg	Figure H-2
238	104	103	0.0067		0.0067	0.0670	70	211.30	52.57	247.5	812	893	PC 1 North Ramp Side 2nd leg	Figure H-2
239	27	100	0.0025		0.0025	0.0245	30	389.33	72.36	960.6	3152	3467	North Ramp Ext. Leg 7.62 m dia	Figure H-2
240	27	26	0.0008		0.0008	0.0077	25	389.33	72.36	363.0	1191	1310	Shaft Connecting Drift	Figure H-6

Table F-1. Calculation of Airway Resistances During Monitoring Phase for System C-10.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad10: VNETPC INPUT, Design Feature Development, Case 10 m^3/s per emplacement drift. (Data by RSJurani & A Linden)

Line No.	BRANCH FROM	TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
241	26	25	0.0008		0.0008	0.0077	25	389.33	72.36	363.8	1194	1313	Shaft Connecting Drift 7.62 m dia	Figure H-6
242	1	24	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
243	24	25	0.0001		0.0001	0.0009	25	828.57	102.04	274.2	900	990	IntakeShaft 9.9 m dia	Fig H-6 , Appendix H
244	25	215	0.0031		0.0031	0.0307	25	389.33	72.36	1444.2	4738	5212	Shaft Connecting Drift 7.62 dia	Fig H-6 , Appendix H
245	25	245	0.0030		0.0030	0.0303	25	389.33	72.36	1424.2	4673	5140	Shaft Connecting Drift 7.62 dia	Fig H-6 , Appendix H
246	24	28	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
247	28	29	0.0001		0.0001	0.0007	25	828.57	102.04	228.6	750	825	IntakeShaft 9.9 m dia	Fig H-6 , Appendix H
248	29	145	0.0003		0.0003	0.0033	25	446.53	80.13	210.2	690	759	Connecting Drift	Fig H-6 , Appendix H
249	29	153	0.0004		0.0004	0.0040	25	446.53	80.13	253.6	832	915	Connecting Drift	Fig H-6 , Appendix H
250	28	30	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
251	30	31	0.0001		0.0001	0.0008	25	828.57	102.04	252.8	829	912	IntakeShaft 9.9 m dia	Fig H-6 , Appendix H
252	31	166	0.0011		0.0011	0.0112	25	389.33	72.36	525.9	1725	1898	Shaft Connecting Drift 7.62 dia	Figure H-6
253	31	275	0.0034		0.0034	0.0339	25	389.33	72.36	1593.3	5227	5750	Shaft Connecting Drift 7.62 dia	Fig H-6 , Appendix H
254	31	295	0.0035		0.0035	0.0351	25	389.33	72.36	1648.6	5409	5950	Shaft Connecting Drift 7.62 dia	Fig H-6 , Appendix H
255	4	32	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
256	32	30	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
257	32	33	0.0001		0.0001	0.0008	25	828.57	102.04	258.7	849	934	IntakeShaft 9.9 m dia	Fig H-6 , Appendix H
258	33	195	0.0004		0.0004	0.0036	25	446.53	80.13	231.3	759	835	Connecting Drift	Figure H-6
259	33	1103	0.0002		0.0002	0.0018	25	446.53	80.13	113.8	373	411	Connecting Drift	Figure H-6
260	622	34	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector	Appendix H
261	722	34	0.0001		0.0001	0.0006	25	389.33	72.36	26.1	86	94	West Exhaust Main to Connector	Appendix H
262	34	36	0.0004		0.0004	0.0044	25	446.53	80.13	280.1	919	1011	Connecting Drift	Fig H-6 , Appendix H
263	630	35	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector	Appendix H
264	730	35	0.0001		0.0001	0.0006	25	389.33	72.36	26.1	86	94	West Exhaust Main to Connector	Appendix H
265	35	36	0.0005		0.0005	0.0046	25	446.53	80.13	295.6	970	1067	Connecting Drift	Fig H-6 , Appendix H
266	36	37	0.0001		0.0001	0.0013	25	828.57	102.04	417.1	1368	1505	Exhaust Shaft 9.9 m dia	Fig H-6 , Appendix H
267	37	38	0.0010	0.0010	0.0000	0.0000	0	0	0	0.0	0	0	Primary Fan	
268	38	39	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage 1st leg	
269	39	37	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage 2nd leg	
270	38	40	0.0010	0.0010	0.0000	0.0000	0	0	0	0.0	0	0	Evase/Outlet Cone	
271	40	41	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
272	41	20	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
273	645	42	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector	Appendix H
274	745	42	0.0001		0.0001	0.0006	25	389.33	72.36	26.1	86	94	West Exhaust Main to Connector	Appendix H
275	42	44	0.0004		0.0004	0.0045	25	446.53	80.13	285.4	936	1030	Connecting Drift	Fig H-6 , Appendix H
276	653	43	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector	Appendix H
277	753	43	0.0001		0.0001	0.0006	25	389.33	72.36	26.1	86	94	West Exhaust Main to Connector	Appendix H
278	43	44	0.0005		0.0005	0.0050	25	446.53	80.13	317.8	1043	1147	Connecting Drift	Fig H-6 , Appendix H
279	44	45	0.0001		0.0001	0.0013	25	828.57	102.04	417.1	1368	1505	Exhaust Shaft 9.9 m dia	Fig H-6 , Appendix H
280	45	46	0.0010	0.0010	0.0000	0.0000	0	0	0	0.0	0	0	Primary Fan	

Table F-1. Calculation of Airway Resistances During Monitoring Phase for System C-10.0 cms

FILE # Replad01-05-10-va.xls; Folder - Replad10: VNETPC INPUT, Design Feature Development, Case 10 m^3/s per emplacement drift. (Data by RSJurani & A Linden)

Line No.	BRANCH FROM	TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb	RESISTANCE in PU from R RPUa = R/10	AIRWAY RESISTANCE R= KLP/(5.2A^3) In.min^2/ft^6	FRICTION FACTOR K (x10^-10) lb-min^2/ft^4	X-SECT AREA A (Ft^2)	PERIMETER P (Ft)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L = L'+10% (Ft)	NOTES FOR BRANCH DESCRIPTION	Reference
281	46	47	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage 1st leg	
282	47	45	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage 2nd leg	
283	46	48	0.0010	0.0010	0.0000	0.0000	0	0	0	0.0	0	0	Evase/Outlet Cone	
284	48	40	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
285	675	49	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector	Appendix H
286	775	49	0.0001		0.0001	0.0006	25	389.33	72.36	26.1	86	94	West Exhaust Main to Connector	Appendix H
287	49	51	0.0004		0.0004	0.0036	25	446.53	80.13	230.3	756	831	Connecting Drift	Fig H-6 , Appendix H
288	680	50	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector	Appendix H
289	780	50	0.0001		0.0001	0.0006	25	389.33	72.36	26.1	86	94	West Exhaust Main to Connector	Appendix H
290	50	51	0.0004		0.0004	0.0037	25	446.53	80.13	235.6	773	850	Connecting Drift	Fig H-6 , Appendix H
291	51	52	0.0001		0.0001	0.0013	25	828.57	102.04	416.9	1368	1505	Exhaust Shaft 9.9 m dia	Fig H-6 , Appendix H
292	52	53	0.0010	0.0010	0.0000	0.0000	0	0	0	0.0	0	0	Primary Fan	
293	53	54	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage 1st leg	
294	54	52	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage 2nd leg	
295	53	55	0.0010	0.0010	0.0000	0.0000	0	0	0	0.0	0	0	Evase/Outlet Cone	
296	55	48	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
297	695	56	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector	Appendix H
298	795	56	0.0001		0.0001	0.0006	25	389.33	72.36	26.1	86	94	West Exhaust Main to Connector	Appendix H
299	56	58	0.0004		0.0004	0.0038	25	446.53	80.13	241.9	794	873	Connecting Drift	Fig H-6 , Appendix H
300	6103	57	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector	Appendix H
301	7103	57	0.0001		0.0001	0.0006	25	389.33	72.36	26.1	86	94	West Exhaust Main to Connector	Appendix H
302	57	58	0.0004		0.0004	0.0041	25	446.53	80.13	260.5	855	940	Connecting Drift	Fig H-6 , Appendix H
303	58	59	0.0001		0.0001	0.0012	25	828.57	102.04	394.8	1295	1425	Exhaust Shaft 9.9 m dia	Fig H-6 , Appendix H
304	59	60	0.0010	0.0010	0.0000	0.0000	0	0	0	0.0	0	0	Primary Fan	
305	60	61	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage 1st leg	
306	61	59	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage 2nd leg	
307	60	62	0.0010	0.0010	0.0000	0.0000	0	0	0	0.0	0	0	Evase/Outlet Cone	
308	62	55	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
309	62	63	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
310	63	64	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
311	64	65	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	
312	65	12	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Loop/Dummy	

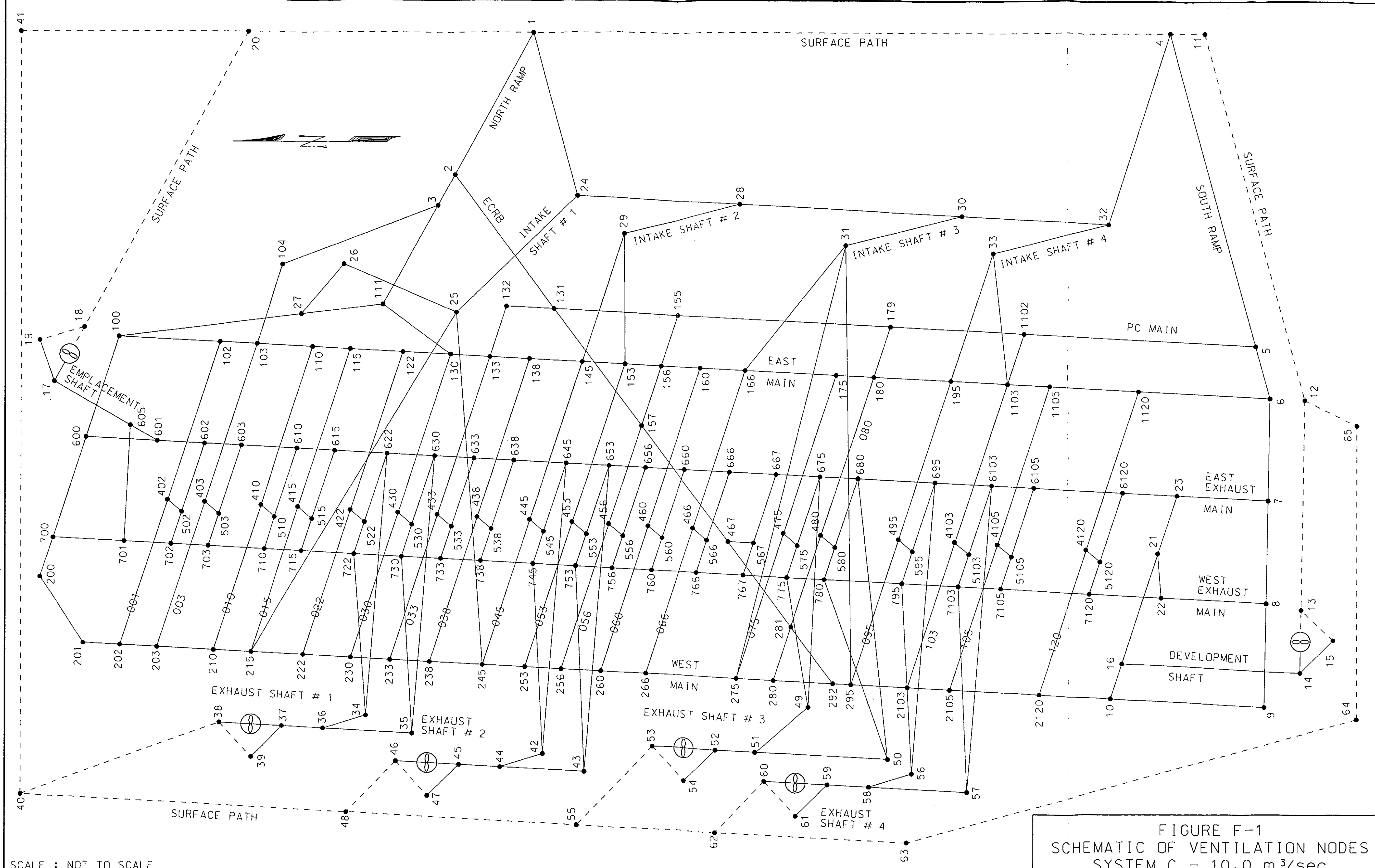


FIGURE F-1
SCHEMATIC OF VENTILATION NODES
SYSTEM C - 10.0 m^3/sec

APPENDIX G

VNETPC OUTPUT FOR SYSTEM C–10.0 cms

APPENDIX G

VNETPC OUTPUT FOR SYSTEM C–10.0 cms

This appendix contains fan airflow and air power data obtained from VNETPC file, VNETWIN\REPLAD10.VNW.

See Appendix G, page 20 for fan results showing airflow and airpower values.

Total Fan Airflow (kcfm) = 633.22 + 207.95 + 1,688.71 + 1,685.96 + 1,667.25 + 1,664.97 = 7,548.06 kcfm

Note: 1 cfm = 0.000472 m^3/s

Total Fan Airflow (m^3/s) = 7,548,060 cfm x 0.000472 = 3,562.68 or approximately 3,563 m^3/s

Total Air Power (hp) = 665.44 + 140.02 + 2,572.92 + 2,579.89 + 2,624.82 + 2,630.40 = 11,213.49 hp.

Note: Fan Efficiency = 75 % (Section 4.1.7)

Brake horsepower = 11,213.49 / 75% = 14,951.32 or approximately 14,951. hp.

Note: 1 hp. = 0.746 kW.

Power Consumption = 14,951.32 hp. x 0.746 = 11,153.68 or approximately 11,154 kW.

Appendix G is arranged in the following order:

Inputs on K Factors, Airway Cross Sectional Areas and Perimeters are contained in Section 4.2.1

Branch Resistance is calculated in Appendix F.

Fan Efficiency = 75% (Section 4.1.7.)

Cost of Power = $ 0.10 per kWh (Section 4.2.19)

Fan locations, nodes and branches are shown in Figure F-1

REPOSITORY LA DESIGN FEATURE
"CA MOUNTAIN PROJECT
M../MK/RSJURANI
DUAL EXHAUST @10.0 M3S/EMPL DRIFT

Avg. Fan Efficiency: 75.0 %
Cost of Power: 10.00 c/kWh
Reference Junction: 1
Units: British

Number of Branches: 312
Number of Junctions: 201
Number of Fans: 6
Fixed Quantities: 2

Last Airflow Analysis
Date: 05/08/99
Time: 12:55 AM
Elapsed Time: 00:00:02

Number of Iterations: 3
Number of Errors: 0
Modified Since: NO

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
1	1	2		R	0.00510								
2	2	3		R	0.00010								
3	3	111		R	0.00040								
4	111	27		R	0.00150								
5	100	102		R	0.00390								
6	102	103		R	0.00030								
7	103	110		R	0.00130								
8	110	115		R	0.00090								
9	115	122		R	0.00120								
10	122	130		R	0.00140								
11	111	130		R	0.00180								
12	601	605		R	0.10010								
13	701	605		R	0.00010								
14	605	17		R	0.00080								
15	17	18	F	R	0.00200								
16	18	19		R	1000.00000								
17	19	17		R	1000.00000								
18	18	20		R	0.00300								
19	4	5		R	0.00720								
20	5	6		R	0.00030								
21	6	7		R	0.00430								
22	7	8		R	0.00010								
23	8	9		R	0.00120								
24	9	10		R	0.00100								
25	10	16		R	15.00010								
26	23	21		R	0.00010								
27	22	21		R	0.00000								
28	21	16		R	0.00040								
29	16	14		R	0.00260								
30	14	13	F	R	0.00200								
31	13	15		R	1000.00000								
32	15	14		R	1000.00000								
33	13	12		R	0.00500								
34	12	11	Q	R	0.00000								
35	11	4		R	0.00000								
36	4	1		R	0.00000								
37	20	1	Q	R	0.00000								
38	100	600		R	0.00200								
39	600	700		R	0.00010								
40	700	200		R	0.00140								
41	200	201		R	0.00140								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
42	201	202		R	0.00150								
43	202	203		R	0.00030								
44	203	210		R	0.00130								
45	210	215		R	0.00090								
46	215	222		R	0.00120								
47	222	230		R	0.00140								
48	230	233		R	0.00040								
49	233	238		R	0.00090								
50	238	245		R	0.00120								
51	245	253		R	0.00140								
52	253	256		R	0.00040								
53	256	260		R	0.00080								
54	260	266		R	0.00100								
55	10	2120		R	0.00600								
56	2120	2105		R	0.00280								
57	2105	2103		R	0.00050								
58	2103	295		R	0.00140								
59	295	292		R	0.00050								
60	292	280		R	0.00220								
61	280	275		R	0.00080								
62	275	266		R	0.00150								
63	130	133		R	0.00040								
64	133	138		R	0.00090								
65	138	145		R	0.00120								
66	145	153		R	0.00140								
67	153	156		R	0.00040								
68	156	160		R	0.00080								
69	160	166		R	0.00100								
70	6	1120		R	0.00650								
71	1120	1105		R	0.00260								
72	1105	1103		R	0.00040								
73	1103	195		R	0.00130								
74	195	180		R	0.00270								
75	180	175		R	0.00080								
76	175	166		R	0.00160								
77	2	131		R	0.03130								
78	131	155		R	0.01190								
79	5	1102		R	0.03950								
80	1102	179		R	0.01800								
81	179	155		R	0.01880								
82	131	132		R	0.00610								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
83	132	133		R	0.00090								
84	131	157		R	0.52010								
85	155	156		R	0.00090								
86	179	180		R	0.00090								
87	1102	1103		R	0.00090								
88	666	660		R	0.00080								
89	660	656		R	0.00060								
90	656	653		R	0.00030								
91	653	645		R	0.00110								
92	645	638		R	0.00090								
93	638	633		R	0.00070								
94	633	630		R	0.00030								
95	630	622		R	0.00110								
96	622	615		R	0.00090								
97	615	610		R	0.00070								
98	610	603		R	0.00100								
99	603	602		R	0.00020								
100	602	601		R	0.00190								
101	600	601		R	1000.00050								
102	666	667		R	0.00020								
103	667	675		R	0.00110								
104	675	680		R	0.00060								
105	680	695		R	0.00210								
106	695	6103		R	0.00100								
107	6103	6105		R	0.00030								
108	6105	6120		R	0.00210								
109	6120	23		R	0.00400								
110	7	23		R	1000.00100								
111	766	760		R	0.00080								
112	760	756		R	0.00060								
113	756	753		R	0.00030								
114	753	745		R	0.00110								
115	745	738		R	0.00090								
116	738	733		R	0.00070								
117	733	730		R	0.00030								
118	730	722		R	0.00110								
119	722	715		R	0.00090								
120	715	710		R	0.00070								
121	710	703		R	0.00100								
122	703	702		R	0.00020								
123	702	701		R	0.00170								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
124	700	701		R	1000.00060								
125	766	767		R	0.00020								
126	767	775		R	0.00110								
127	775	780		R	0.00060								
128	780	795		R	0.00210								
129	795	7103		R	0.00100								
130	7103	7105		R	0.00030								
131	7105	7120		R	0.00210								
132	7120	22		R	0.00400								
133	8	22		R	1000.00100								
134	202	402		R	0.03480								
135	203	403		R	0.11520								
136	210	410		R	0.03480								
137	215	415		R	0.11650								
138	222	422		R	0.03480								
139	230	430		R	0.11460								
140	233	433		R	0.11560								
141	238	438		R	0.03760								
142	245	445		R	0.11870								
143	253	453		R	0.03970								
144	256	456		R	0.11720								
145	260	460		R	0.11660								
146	266	466		R	0.04040								
147	275	475		R	0.04090								
148	280	281		R	0.10990								
149	292	281		R	0.12000								
150	281	467		R	0.01690								
151	281	480		R	0.00790								
152	295	495		R	0.04100								
153	2103	4103		R	0.11710								
154	2105	4105		R	0.11610								
155	2120	4120		R	0.03560								
156	102	402		R	0.03480								
157	103	403		R	0.11520								
158	110	410		R	0.03480								
159	115	415		R	0.11650								
160	122	422		R	0.03480								
161	130	430		R	0.11460								
162	133	433		R	0.11560								
163	138	438		R	0.03760								
164	145	445		R	0.11870								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
165	153	453		R	0.03970								
166	156	157		R	0.10980								
167	157	456		R	0.00740								
168	157	467		R	0.01600								
169	160	460		R	0.11660								
170	166	466		R	0.04040								
171	175	475		R	0.04090								
172	180	480		R	0.11780								
173	195	495		R	0.04100								
174	1103	4103		R	0.11710								
175	1105	4105		R	0.11610								
176	1120	4120		R	0.03560								
177	402	502		R	0.02770								
178	403	503		R	0.07020								
179	410	510		R	0.02770								
180	415	515		R	0.02770								
181	422	522		R	0.02770								
182	430	530		R	0.02770								
183	433	533		R	0.07060								
184	438	538		R	0.02800								
185	445	545		R	0.02850								
186	453	553		R	0.02890								
187	456	556		R	0.07140								
188	460	560		R	0.02890								
189	466	566		R	0.02890								
190	467	567		R	0.07090								
191	475	575		R	0.02890								
192	480	580		R	0.07140								
193	495	595		R	0.02840								
194	4103	5103		R	0.07140								
195	4105	5105		R	0.02840								
196	4120	5120		R	0.02840								
197	502	602		R	0.03970								
198	503	603		R	0.03970								
199	510	610		R	0.03970								
200	515	615		R	0.03970								
201	522	622		R	0.03970								
202	530	630		R	99000.03870								
203	533	633		R	0.13850								
204	538	638		R	0.03850								
205	545	645		R	0.13940								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
206	553	653		R	0.03940								
207	556	656		R	0.03940								
208	560	660		R	0.03970								
209	566	666		R	0.03940								
210	567	667		R	0.03940								
211	575	675		R	0.03940								
212	580	680		R	0.03970								
213	595	695		R	0.04120								
214	5103	6103		R	0.04120								
215	5105	6105		R	0.04120								
216	5120	6120		R	0.04120								
217	502	702		R	99000.00000								
218	503	703		R	99000.00000								
219	510	710		R	99000.00000								
220	515	715		R	99000.00000								
221	522	722		R	99000.00000								
222	530	730		R	0.00000								
223	533	733		R	0.10000								
224	538	738		R	99000.00000								
225	545	745		R	0.00000								
226	553	753		R	99000.00000								
227	556	756		R	0.00000								
228	560	760		R	0.00000								
229	566	766		R	99000.00000								
230	567	767		R	0.00000								
231	575	775		R	99000.00000								
232	580	780		R	0.00000								
233	595	795		R	99000.00000								
234	5103	7103		R	0.00000								
235	5105	7105		R	0.00000								
236	5120	7120		R	99000.00000								
237	3	104		R	0.01780								
238	104	103		R	0.00670								
239	27	100		R	0.00250								
240	27	26		R	0.00080								
241	26	25		R	0.00080								
242	1	24		R	0.00000								
243	24	25		R	0.00010								
244	25	215		R	0.00310								
245	25	245		R	0.00300								
246	24	28		R	0.00000								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
247	28	29		R	0.00010								
248	29	145		R	0.00030								
249	29	153		R	0.00040								
250	28	30		R	0.00000								
251	30	31		R	0.00010								
252	31	166		R	0.00110								
253	31	275		R	0.00340								
254	31	295		R	0.00350								
255	4	32		R	0.00000								
256	32	30		R	0.00000								
257	32	33		R	0.00010								
258	33	195		R	0.00040								
259	33	1103		R	0.00020								
260	622	34		R	0.00010								
261	722	34		R	0.00010								
262	34	36		R	0.00040								
263	630	35		R	0.00010								
264	730	35		R	0.00010								
265	35	36		R	0.00050								
266	36	37		R	0.00010								
267	37	38	F	R	0.00100								
268	38	39		R	1000.00000								
269	39	37		R	1000.00000								
270	38	40		R	0.00100								
271	40	41		R	0.00000								
272	41	20		R	0.00000								
273	645	42		R	0.00010								
274	745	42		R	0.00010								
275	42	44		R	0.00040								
276	653	43		R	0.00010								
277	753	43		R	0.00010								
278	43	44		R	0.00050								
279	44	45		R	0.00010								
280	45	46	F	R	0.00100								
281	46	47		R	1000.00000								
282	47	45		R	1000.00000								
283	46	48		R	0.00100								
284	48	40		R	0.00000								
285	675	49		R	0.00010								
286	775	49		R	0.00010								
287	49	51		R	0.00040								

Branch No.	From	To	F Q i	Type	Branch Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Friction Factor (x10^-10)	Resistance per Length (R/1000ft)	Length (ft)	Equiv. Length (ft)	Area (ft^2)	Perim (ft)
288	680	50		R	0.00010								
289	780	50		R	0.00010								
290	50	51		R	0.00040								
291	51	52		R	0.00010								
292	52	53	F	R	0.00100								
293	53	54		R	1000.00000								
294	54	52		R	1000.00000								
295	53	55		R	0.00100								
296	55	48		R	0.00000								
297	695	56		R	0.00010								
298	795	56		R	0.00010								
299	56	58		R	0.00040								
300	6103	57		R	0.00010								
301	7103	57		R	0.00010								
302	57	58		R	0.00040								
303	58	59		R	0.00010								
304	59	60	F	R	0.00100								
305	60	61		R	1000.00000								
306	61	59		R	1000.00000								
307	60	62		R	0.00100								
308	62	55		R	0.00000								
309	62	63		R	0.00000								
310	63	64		R	0.00000								
311	64	65		R	0.00000								
312	65	12		R	0.00000								

Branch No.	From	To	F R B	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
1	1	2		0.00510	438.48	980.6	67.75	59035
2	2	3		0.00010	399.28	15.9	1.00	872
3	3	111		0.00040	226.66	20.5	0.73	638
4	111	27		0.00150	-120.12	-21.6	0.41	356
5	100	102		0.00390	203.17	161.0	5.15	4491
6	102	103		0.00030	15.23	0.1	0.00	0
7	103	110		0.00130	52.79	3.6	0.03	26
8	110	115		0.00090	-136.86	-16.9	0.36	318
9	115	122		0.00120	-301.95	-109.4	5.21	4535
10	122	130		0.00140	-514.44	-370.5	30.03	26169
11	111	130		0.00180	346.78	216.5	11.83	10308
12	601	605		0.10010	168.76	2850.8	75.81	66055
13	701	605		0.00010	462.75	21.4	1.56	1360
14	605	17		0.00080	631.51	319.0	31.74	27659
15	17	18	F	0.00200	633.22	801.9	80.01	69717
16	18	19		1000.00000	1.71	2933.7	0.79	689
17	19	17		1000.00000	1.71	2933.7	0.79	689
18	18	20		0.00300	631.51	1196.4	119.05	103734
19	4	5		0.00720	270.52	526.9	22.46	19570
20	5	6		0.00030	337.49	34.2	1.82	1585
21	6	7		0.00430	331.54	472.7	24.70	21517
22	7	8		0.00010	327.99	10.8	0.56	486
23	8	9		0.00120	324.44	126.3	6.46	5626
24	9	10		0.00100	324.44	105.3	5.38	4691
25	10	16		15.00010	28.73	12384.8	56.07	48853
26	23	21		0.00010	149.52	2.2	0.05	45
27	22	21		0.00000	28.25	0.0	0.00	0
28	21	16		0.00040	177.77	12.6	0.35	308
29	16	14		0.00260	206.50	110.9	3.61	3144
30	14	13	F	0.00200	207.95	86.5	2.83	2470
31	13	15		1000.00000	1.45	2093.4	0.48	417
32	15	14		1000.00000	1.45	2093.4	0.48	417
33	13	12		0.00500	206.50	213.2	6.94	6045
34	12	11	B	0.00000	2520.80	0.0	0.00	0
35	11	4		0.00000	2520.80	0.0	0.00	0
36	4	1		0.00000	53.62	0.0	0.00	0
37	20	1	B	0.00000	5016.60	0.0	0.00	0
38	100	600		0.00200	274.40	150.6	6.51	5674
39	600	700		0.00010	271.30	7.4	0.32	276
40	700	200		0.00140	267.78	100.4	4.24	3691
41	200	201		0.00140	267.78	100.4	4.24	3691
42	201	202		0.00150	267.78	107.6	4.54	3956
43	202	203		0.00030	104.83	3.3	0.05	47
44	203	210		0.00130	-20.06	-0.5	0.00	0
45	210	215		0.00090	-185.05	-30.8	0.90	783
46	215	222		0.00120	371.45	165.6	9.69	8446
47	222	230		0.00140	201.42	56.8	1.80	1571
48	230	233		0.00040	-14.03	-0.1	0.00	0
49	233	238		0.00090	-147.63	-19.6	0.46	397
50	238	245		0.00120	-300.86	-108.6	5.15	4486
51	245	253		0.00140	235.22	77.5	2.87	2503
52	253	256		0.00040	96.14	3.7	0.06	49
53	256	260		0.00080	-72.26	-4.2	0.05	42
54	260	266		0.00100	-281.98	-79.5	3.53	3078
55	10	2120		0.00600	295.70	524.6	24.44	21298
56	2120	2105		0.00280	141.59	56.1	1.25	1091
57	2105	2103		0.00050	-78.21	-3.1	0.04	33

Branch No.	From	To	F R B	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
58	2103	295		0.00140	-236.30	-78.2	2.91	2537
59	295	292		0.00050	255.57	32.7	1.32	1147
60	292	280		0.00220	91.82	18.6	0.27	234
61	280	275		0.00080	-78.80	-5.0	0.06	54
62	275	266		0.00150	427.01	273.5	18.40	16035
63	130	133		0.00040	-402.27	-64.7	4.10	3573
64	133	138		0.00090	-424.98	-162.5	10.88	9482
65	138	145		0.00120	-660.33	-523.3	54.45	47444
66	145	153		0.00140	-37.18	-1.9	0.01	0
67	153	156		0.00040	459.03	84.3	6.10	5313
68	156	160		0.00080	103.55	8.6	0.14	122
69	160	166		0.00100	-136.65	-18.7	0.40	351
70	6	1120		0.00650	5.95	0.2	0.00	0
71	1120	1105		0.00260	-236.08	-144.9	5.39	4697
72	1105	1103		0.00040	-482.55	-93.1	7.08	6168
73	1103	195		0.00130	-36.87	-1.8	0.01	0
74	195	180		0.00270	290.39	227.7	10.42	9078
75	180	175		0.00080	150.66	18.2	0.43	376
76	175	166		0.00160	-86.48	-12.0	0.16	142
77	2	131		0.03130	39.20	48.1	0.30	259
78	131	155		0.01190	-193.09	-443.7	13.50	11763
79	5	1102		0.03950	-66.97	-177.2	1.87	1629
80	1102	179		0.01800	104.44	196.4	3.23	2816
81	179	155		0.01880	45.54	39.0	0.28	244
82	131	132		0.00610	141.50	122.1	2.72	2372
83	132	133		0.00090	141.50	18.0	0.40	350
84	131	157		0.52010	90.79	4287.3	61.34	53443
85	155	156		0.00090	-147.55	-19.6	0.46	397
86	179	180		0.00090	58.90	3.1	0.03	25
87	1102	1103		0.00090	-171.42	-26.4	0.71	621
88	666	660		0.00080	-125.56	-12.6	0.25	217
89	660	656		0.00060	-83.85	-4.2	0.06	48
90	656	653		0.00030	-45.43	-0.6	0.00	0
91	653	645		0.00110	12.82	0.2	0.00	0
92	645	638		0.00090	-325.53	-95.4	4.89	4264
93	638	633		0.00070	62.82	2.8	0.03	24
94	633	630		0.00030	199.19	11.9	0.37	325
95	630	622		0.00110	-312.91	-107.7	5.31	4627
96	622	615		0.00090	-1121.38	-1131.7	199.97	174241
97	615	610		0.00070	-799.06	-446.9	56.27	49029
98	610	603		0.00100	-444.68	-197.7	13.85	12070
99	603	602		0.00020	-184.95	-6.8	0.20	173
100	602	601		0.00190	165.66	52.1	1.36	1185
101	600	601		1000.00050	3.10	9583.1	4.68	4079
102	666	667		0.00020	513.58	52.8	4.27	3723
103	667	675		0.00110	546.46	328.5	28.29	24647
104	675	680		0.00060	375.52	84.6	5.01	4362
105	680	695		0.00210	82.05	14.1	0.18	159
106	695	6103		0.00100	-13.47	-0.2	0.00	0
107	6103	6105		0.00030	-283.84	-24.2	1.08	943
108	6105	6120		0.00210	-249.92	-131.2	5.17	4502
109	6120	23		0.00400	145.97	85.2	1.96	1708
110	7	23		1000.00100	3.55	12612.2	7.06	6147
111	766	760		0.00080	-302.97	-73.4	3.50	3053
12	760	756		0.00060	105.25	6.6	0.11	95
113	756	753		0.00030	394.32	46.6	2.90	2523
114	753	745		0.00110	-72.07	-5.7	0.06	56

Branch No.	From	To	F R B	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
115	745	738		0.00090	-169.73	-25.9	0.69	604
116	738	733		0.00070	-169.49	-20.1	0.54	468
117	733	730		0.00030	-8.07	0.0	0.00	0
118	730	722		0.00110	152.47	25.6	0.62	536
119	722	715		0.00090	458.22	189.0	13.65	11891
120	715	710		0.00070	458.46	147.1	10.63	9259
121	710	703		0.00100	458.73	210.4	15.21	13252
122	703	702		0.00020	458.96	42.1	3.04	2653
123	702	701		0.00170	459.23	358.5	25.94	22604
124	700	701		1000.00060	3.52	12405.2	6.88	5995
125	766	767		0.00020	303.21	18.4	0.88	766
126	767	775		0.00110	598.13	393.5	37.09	32315
127	775	780		0.00060	286.63	49.3	2.23	1940
128	780	795		0.00210	138.88	40.5	0.89	772
129	795	7103		0.00100	-188.10	-35.4	1.05	914
130	7103	7105		0.00030	-407.90	-49.9	3.21	2795
131	7105	7120		0.00210	24.45	1.3	0.01	0
132	7120	22		0.00400	24.70	2.4	0.01	8
133	8	22		1000.00100	3.55	12603.6	7.05	6143
134	202	402		0.03480	162.95	924.0	23.73	20672
135	203	403		0.11520	124.89	1796.9	35.36	30812
136	210	410		0.03480	165.00	947.4	24.63	21463
137	215	415		0.11650	157.47	2888.7	71.68	62455
138	222	422		0.03480	170.03	1006.1	26.96	23487
139	230	430		0.11460	215.45	5319.4	180.59	157353
140	233	433		0.11560	133.60	2063.4	43.44	37849
141	238	438		0.03760	153.23	882.8	21.32	18573
142	245	445		0.11870	210.96	5282.8	175.61	153014
143	253	453		0.03970	139.08	768.0	16.83	14665
144	256	456		0.11720	168.40	3323.6	88.19	76845
145	260	460		0.11660	209.72	5128.4	169.48	147669
146	266	466		0.04040	145.03	849.8	19.42	16922
147	275	475		0.04090	159.72	1043.3	26.26	22879
148	280	281		0.10990	170.62	3199.5	86.02	74951
149	292	281		0.12000	163.75	3217.6	83.02	72340
150	281	467		0.01690	188.17	598.4	17.74	15460
151	281	480		0.00790	146.20	168.9	3.89	3390
152	295	495		0.04100	153.91	971.2	23.55	20523
153	2103	4103		0.11710	158.09	2926.6	72.90	63523
154	2105	4105		0.11610	219.80	5608.9	194.27	169267
155	2120	4120		0.03560	154.12	845.6	20.54	17893
156	102	402		0.03480	187.94	1229.2	36.40	31718
157	103	403		0.11520	135.07	2101.7	44.73	38976
158	110	410		0.03480	189.65	1251.6	37.40	32590
159	115	415		0.11650	165.09	3175.3	82.60	71973
160	122	422		0.03480	212.49	1571.3	52.61	45842
161	130	430		0.11460	234.61	6308.1	233.20	203194
162	133	433		0.11560	164.20	3116.7	80.64	70264
163	138	438		0.03760	235.36	2082.8	77.24	67305
164	145	445		0.11870	240.99	6893.8	261.79	228099
165	153	453		0.03970	248.91	2459.8	96.48	84064
166	156	157		0.10980	207.93	4747.3	155.54	135528
167	157	456		0.00740	159.10	187.3	4.70	4091
168	157	467		0.01600	139.63	311.9	6.86	5979
169	160	460		0.11660	240.20	6727.4	254.63	221864
170	166	466		0.04040	243.23	2390.1	91.61	79818
171	175	475		0.04090	237.13	2299.9	85.94	74879

Branch No.	From	To	F R B	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
.72	180	480		0.11780	198.64	4648.1	145.49	126768
173	195	495		0.04100	243.23	2425.6	92.97	81003
174	1103	4103		0.11710	195.16	4460.1	137.16	119509
175	1105	4105		0.11610	246.47	7052.9	273.92	238670
176	1120	4120		0.03560	242.03	2085.4	79.53	69299
177	402	502		0.02770	350.89	3410.5	188.57	164307
178	403	503		0.07020	259.96	4744.1	194.33	169327
179	410	510		0.02770	354.64	3483.8	194.68	169632
180	415	515		0.02770	322.56	2882.0	146.49	127635
181	422	522		0.02770	382.52	4053.2	244.31	212872
182	430	530		0.02770	450.06	5610.8	397.91	346706
183	433	533		0.07060	297.80	6261.1	293.81	256001
184	438	538		0.02800	388.59	4228.0	258.89	225576
185	445	545		0.02850	451.96	5821.5	414.60	361245
186	453	553		0.02890	388.00	4350.7	266.00	231770
187	456	556		0.07140	327.49	7657.9	395.18	344330
188	460	560		0.02890	449.92	5850.2	414.76	361387
189	466	566		0.02890	388.26	4356.6	266.54	232240
190	467	567		0.07090	327.80	7618.3	393.51	342873
191	475	575		0.02890	396.85	4551.4	284.62	247992
192	480	580		0.07140	344.84	8490.6	461.37	401997
193	495	595		0.02840	397.14	4479.2	280.31	244237
194	4103	5103		0.07140	353.25	8909.8	495.95	432132
195	4105	5105		0.02840	466.27	6174.3	453.64	395268
196	4120	5120		0.02840	396.14	4456.8	278.20	242403
197	502	602		0.03970	350.61	4880.3	269.63	234929
198	503	603		0.03970	259.73	2678.2	109.61	95506
99	510	610		0.03970	354.37	4985.6	278.40	242572
200	515	615		0.03970	322.32	4124.4	209.48	182522
201	522	622		0.03970	382.28	5801.6	349.48	304506
202	530	630		99000.03870	-0.01	-17.8	0.00	0
203	533	633		0.13850	136.38	2575.9	55.36	48233
204	538	638		0.03850	388.35	5806.3	355.31	309592
205	545	645		0.13940	10.98	16.8	0.03	25
206	553	653		0.03940	387.75	5923.9	361.95	315374
207	556	656		0.03940	38.43	58.2	0.35	307
208	560	660		0.03970	41.70	69.0	0.45	395
209	566	666		0.03940	388.02	5932.0	362.70	316025
210	567	667		0.03940	32.88	42.6	0.22	192
211	575	675		0.03940	396.60	6197.2	387.29	337454
212	580	680		0.03970	17.97	12.8	0.04	32
213	595	695		0.04120	396.88	6489.6	405.85	353626
214	5103	6103		0.04120	22.93	21.7	0.08	68
215	5105	6105		0.04120	33.92	47.4	0.25	221
216	5120	6120		0.04120	395.89	6457.1	402.81	350977
217	502	702		99000.00000	0.27	7403.8	0.31	274
218	503	703		99000.00000	0.23	5152.3	0.19	163
219	510	710		99000.00000	0.27	7051.8	0.30	261
220	515	715		99000.00000	0.24	5596.3	0.21	184
221	522	722		99000.00000	0.25	5952.9	0.23	204
222	530	730		0.00000	450.07	0.0	0.00	0
223	533	733		0.10000	161.42	2605.7	66.28	57750
224	538	738		99000.00000	0.24	5858.9	0.22	193
225	545	745		0.00000	440.98	0.0	0.00	0
26	553	753		99000.00000	0.24	5913.0	0.22	195
227	556	756		0.00000	289.07	0.0	0.00	0
228	560	760		0.00000	408.22	0.0	0.00	0

Branch No.	From	To	F R B	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
229	566	766		99000.00000	0.24	5923.8	0.22	195
230	567	767		0.00000	294.92	0.0	0.00	0
231	575	775		99000.00000	0.25	6219.7	0.25	213
232	580	780		0.00000	326.87	0.0	0.00	0
233	595	795		99000.00000	0.26	6503.3	0.27	232
234	5103	7103		0.00000	330.32	0.0	0.00	0
235	5105	7105		0.00000	432.35	0.0	0.00	0
236	5120	7120		99000.00000	0.26	6542.2	0.27	234
237	3	104		0.01780	172.63	530.4	14.43	12571
238	104	103		0.00670	172.63	199.7	5.43	4733
239	27	100		0.00250	477.57	570.2	42.91	37388
240	27	26		0.00080	-597.70	-285.8	26.92	23454
241	26	25		0.00080	-597.70	-285.8	26.92	23454
242	1	24		0.00000	4631.74	0.0	0.00	0
243	24	25		0.00010	2058.71	423.8	137.48	119791
244	25	215		0.00310	713.96	1580.2	177.78	154900
245	25	245		0.00300	747.05	1674.3	197.09	171731
246	24	28		0.00000	2573.03	0.0	0.00	0
247	28	29		0.00010	1609.27	259.0	65.68	57226
248	29	145		0.00030	864.15	224.0	30.50	26577
249	29	153		0.00040	745.12	222.1	26.08	22722
250	28	30		0.00000	963.76	0.0	0.00	0
251	30	31		0.00010	1777.67	316.0	88.52	77127
252	31	166		0.00110	466.36	239.2	17.58	15316
253	31	275		0.00340	665.53	1506.0	157.94	137613
254	31	295		0.00350	645.78	1459.6	148.53	129415
255	4	32		0.00000	2196.66	0.0	0.00	0
256	32	30		0.00000	813.91	0.0	0.00	0
257	32	33		0.00010	1382.76	191.2	41.66	36300
258	33	195		0.00040	570.50	130.2	11.70	10198
259	33	1103		0.00020	812.26	132.0	16.90	14721
260	622	34		0.00010	1190.74	141.8	26.61	23182
261	722	34		0.00010	-305.51	-9.3	0.45	390
262	34	36		0.00040	885.23	313.5	43.73	38103
263	630	35		0.00010	512.09	26.2	2.11	1842
264	730	35		0.00010	289.54	8.4	0.38	334
265	35	36		0.00050	801.64	321.3	40.59	35364
266	36	37		0.00010	1686.86	284.6	75.65	65914
267	37	38	F	0.00100	1688.71	2851.7	758.84	661189
268	38	39		1000.00000	1.85	3408.8	0.99	866
269	39	37		1000.00000	1.85	3408.8	0.99	866
270	38	40		0.00100	1686.86	2845.5	756.36	659028
271	40	41		0.00000	4385.09	0.0	0.00	0
272	41	20		0.00000	4385.09	0.0	0.00	0
273	645	42		0.00010	349.33	12.2	0.67	585
274	745	42		0.00010	538.64	29.0	2.46	2145
275	42	44		0.00040	887.97	315.4	44.13	38453
276	653	43		0.00010	329.51	10.9	0.57	493
277	753	43		0.00010	466.63	21.8	1.60	1397
278	43	44		0.00050	796.14	316.9	39.76	34640
279	44	45		0.00010	1684.11	283.6	75.26	65576
280	45	46	F	0.00100	1685.96	2842.5	755.16	657982
281	46	47		1000.00000	1.85	3434.1	1.00	872
282	47	45		1000.00000	1.85	3434.1	1.00	872
83	46	48		0.00100	1684.11	2836.2	752.66	655804
284	48	40		0.00000	2698.23	0.0	0.00	0
285	675	49		0.00010	567.54	32.2	2.88	2509

Branch No.	From	To	FRB	Total Resistance (P.U.)	Airflow (kcfm)	Pressure Drop (m.in.wg)	Air Power Loss (hp)	Operating Cost ($/yr)
?86	775	49		0.00010	311.75	9.7	0.48	415
287	49	51		0.00040	879.29	309.3	42.85	37340
288	680	50		0.00010	311.45	9.7	0.48	415
289	780	50		0.00010	474.62	22.5	1.68	1466
290	50	51		0.00040	786.06	247.2	30.62	26679
291	51	52		0.00010	1665.35	277.3	72.77	63405
292	52	53	F	0.00100	1667.25	2779.7	730.28	636305
293	53	54		1000.00000	1.90	3605.7	1.08	941
294	54	52		1000.00000	1.90	3605.7	1.08	941
295	53	55		0.00100	1665.35	2773.4	727.79	634139
296	55	48		0.00000	1014.12	0.0	0.00	0
297	695	56		0.00010	492.40	24.2	1.88	1636
298	795	56		0.00010	327.24	10.7	0.55	481
299	56	58		0.00040	819.64	268.7	34.70	30238
300	6103	57		0.00010	293.30	8.6	0.40	346
301	7103	57		0.00010	550.13	30.3	2.63	2289
302	57	58		0.00040	843.43	284.5	37.81	32946
303	58	59		0.00010	1663.06	276.6	72.49	63158
304	59	60	F	0.00100	1664.97	2772.1	727.29	633697
305	60	61		1000.00000	1.90	3626.7	1.09	946
306	61	59		1000.00000	1.90	3626.7	1.09	946
307	60	62		0.00100	1663.06	2765.8	724.80	631532
308	62	55		0.00000	-651.23	0.0	0.00	0
309	62	63		0.00000	2314.30	0.0	0.00	0
310	63	64		0.00000	2314.30	0.0	0.00	0
311	64	65		0.00000	2314.30	0.0	0.00	0
312	65	12		0.00000	2314.30	0.0	0.00	0

Branch No.	From	To	I R	Fixed Airflow (kcfm)	Booster Pressure (m.in.wg)	Regulator Resistance (P.U.)	Branch Resistance (P.U.)	Total Resistance (P.U.)
34	12	11		2520.80	9798		0.00000	
37	20	1		5016.60	9798		0.00000	

Fan No.: 1
From: 17
To: 18
Pressure: 6.000 in.w.g.
Description: First Empl Shaft Fan

Fan Name: Joy 144-79-590
Fan Setting: 4
Comments: Rep LADS, 1 cms, Empl Shaft Collar
Points: 10

Quantity	Pressure	Description
200.00	7.000	
250.00	8.000	
350.00	9.000	
470.00	9.500	
520.00	9.000	
620.00	7.000	
700.00	5.000	
740.00	4.000	
760.00	3.000	
800.00	1.000	

Fan No.: 2
From: 14
To: 13
Pressure: 6.000 in.w.g.
Description: Former Dev Shaft Fan

Fan Name: Joy84-~~58~~-880/144-79x
Fan Setting: 4 58 CMN 6/21/99
Comments: Repository LADS, 1cms, Former Dev Shaft Collar
Points: 10

Quantity	Pressure	Description
60.00	9.000	
80.00	10.000	
100.00	11.000	
125.00	11.500	
155.00	10.000	
180.00	8.000	
195.00	6.000	
210.00	4.000	
215.00	3.000	
220.00	2.000	

Fan No.: 3
From: 37
To: 38
Pressure: 6.000 in.w.g.
Description: 1st MidEmpShaft Fan

Fan Name: Joy 144-79-710
Fan Setting: 26.5 (2 fans)
Comments: Mid Empl Shaft 10 cms with two parallel fan
Points: 10

Quantity	Pressure	Description
700.00	11.000	
900.00	13.000	
1100.00	13.800	
1300.00	14.000	
1400.00	13.000	
1600.00	11.000	
1800.00	8.000	
1900.00	6.000	
2000.00	4.000	
2060.00	2.000	

Fan No.: 4
From: 45
To: 46
Pressure: 6.000 in.w.g.
Description: 2nd MidEmpShaft Fan

Fan Name: Joy 144-79-710
Fan Setting: 26.5 (2 fans)
Comments: Mid Empl Shaft 10 cms with two parallel fan
Points: 10

Quantity	Pressure	Description
700.00	11.000	
900.00	13.000	
1100.00	13.800	
1300.00	14.000	
1400.00	13.000	
1600.00	11.000	
1800.00	8.000	
1900.00	6.000	
2000.00	4.000	
2060.00	2.000	

Fan No.: 5
From: 52
To: 53
Pressure: 6.000 in.w.g.
Description: 3rd Mid EmpShaft Fan

Fan Name: Joy 144-79-710
Fan Setting: 26.5 (2 fans)
Comments: Mid Empl Shaft 10 cms with two parallel fan
Points: 10

Quantity	Pressure	Description
700.00	11.000	
900.00	13.000	
1100.00	13.800	
1300.00	14.000	
1400.00	13.000	
1600.00	11.000	
1800.00	8.000	
1900.00	6.000	
2000.00	4.000	
2060.00	2.000	

Fan No.: 6
From: 59
To: 60
Pressure: 6.000 in.w.g.
Description: 4th MidEmpShaft Fan

Fan Name: Joy 144-79-710
Fan Setting: 26.5 (2 fans)
Comments: Mid Empl Shaft 10 cms with two parallel fan
Points: 10

Quantity	Pressure	Description
700.00	11.000	
900.00	13.000	
1100.00	13.800	
1300.00	14.000	
1400.00	13.000	
1600.00	11.000	
1800.00	8.000	
1900.00	6.000	
2000.00	4.000	
2060.00	2.000	

Fan No.	From	To	Fan Pressure (in.wg)	Fan Airflow (kcfm)	Fan Curve	Air Power (hp)	Operating Cost ($/yr)	Fan Description
1	17	18	6.669	633.22	On	665.44	579808	First Empl Shaft Fan
2	14	13	4.273	207.95	On	140.02	122000	Former Dev Shaft Fan
3	37	38	9.669	1688.71	On	2572.92	2241833	1st MidEmpShaft Fan
4	45	46	9.711	1685.96	On	2579.89	2247903	2nd MidEmpShaft Fan
5	52	53	9.991	1667.25	On	2624.82	2287058	3rd Mid EmpShaft Fan
6	59	60	10.026	1664.97	On	2630.40	2291920	4th MidEmpShaft Fan

APPENDIX H

JUSTIFICATION FOR LENGTH INPUTS TO VNETPC

APPENDIX H

JUSTIFICATION FOR LENGTH INPUTS TO VNETPC

The layouts depicted in Figures H-4, H-5, and H-6 were modeled in Vulcan version 3.3 (TBV) using inputs as outlined in Section 4.

Emplacement Raises

Node 402 to 502 is located in the block of raises between Raise 1 and Raise 24 (Figure H-1)

Distance from 402 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 502 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 1 length = 10.0 m (CRWMS M&O 1997f, p. 25)
Raise 24 length = 10.01 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10 + 10.01) / 2 = 10 m
Length from node 402 to 502 = 10 + 2.75 + 3.81 = 16.56 or approximately 16.6 m

Node 410 to 510 is located in the block of raises between Raise 1 and Raise 24 (Figure H-1)

Distance from 410 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 510 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 1 length = 10.0 m (CRWMS M&O 1997f, p. 25)
Raise 24 length = 10.01 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10 + 10.01) / 2 = 10 m
Length from node 410 to 510 = 10 + 2.75 + 3.81 = 16.56 or approximately 16.6 m

Node 415 to 515 is located in the block of raises between Raise 1 and Raise 24 (Figure H-1)

Distance from 415 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 515 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 1 length = 10.0 m (CRWMS M&O 1997f, p. 25)
Raise 24 length = 10.01 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10 + 10.01) / 2 = 10 m
Length from node 415 to 515 = 10 + 2.75 + 3.81 = 16.56 or approximately 16.6 m

Node 422 to 522 is located in the block of raises between Raise 1 and Raise 24 (Figure H-1)

Distance from 422 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 522 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 1 length = 10.0 m (CRWMS M&O 1997f, p. 25)
Raise 24 length = 10.01 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10 + 10.01) / 2 = 10 m
Length from node 422 to 522 = 10 + 2.75 + 3.81 = 16.56 or approximately 16.6 m

Node 430 to 530 is located in the block of raises between Raise 32 and Raise 2424 (Figure H-1)

Distance from 430 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 530 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 32 length = 10.12 m (CRWMS M&O 1997f, p. 25)
Raise 24 length = 10.01 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10.12 + 10.01) / 2 = 10.07 m
Length from node 430 to 530 = 10.07 + 2.75 + 3.81 = 16.63 or approximately 16.6 m

Node 438 to 538 is located in the block of raises between Raise 32 and Raise 40 (Figure H-1)

Distance from 438 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 538 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 32 length = 10.12 m (CRWMS M&O 1997f, p. 25)
Raise 40 length = 10.41 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10.12 + 10.41) / 2 = 10.27 m
Length from node 438 to 538 = 10.27 + 2.75 + 3.81 = 16.83 or approximately 16.8 m

Node 445 to 545 is located in the block of raises between Raise 40 and Raise 50 (Figure H-1)

Distance from 445 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 545 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 40 length = 10.41 m (CRWMS M&O 1997f, p. 25)
Raise 50 length = 10.57 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10.41 + 10.57) / 2 = 10.49 m
Length from node 445 to 545 = 10.49 + 2.75 + 3.81 = 17.05 or approximately 17.1 m

Node 453 to 553 is located in the block of raises between Raise 50 and Raise 88 (Figure H-2)

Distance from 453 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 553 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 50 length = 10.57 m (CRWMS M&O 1997f, p. 25)
Raise 88 length = 10.84 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10.57 + 10.84) / 2 = 10.71 m
Length from node 453 to 553 = 10.71 + 2.75 + 3.81 = 17.27 or approximately 17.3 m

Node 460 to 560 is located in the block of raises between Raise 50 and Raise 88 (Figure H-2)

Distance from 460 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 560 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 50 length = 10.57 m (CRWMS M&O 1997f, p. 25)
Raise 88 length = 10.84 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10.57 + 10.84) / 2 = 10.71 m
Length from node 460 to 560 = 10.71 + 2.75 + 3.81 = 17.27 or approximately 17.3 m

Node 466 to 566 is located in the block of raises between Raise 50 and Raise 88 (Figure H-2)

Distance from 466 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m

Distance from 566 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 50 length = 10.57 m (CRWMS M&O 1997f, p. 25)
Raise 88 length = 10.84 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10.57 + 10.84) / 2 = 10.71 m
Length from node 466 to 566 = 10.71 + 2.75 + 3.81 = 17.27 or approximately 17.3 m

Node 475 to 575 is located in the block of raises between Raise 50 and Raise 88 (Figure H-2)

Distance from 475 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 575 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 50 length = 10.57 m (CRWMS M&O 1997f, p. 25)
Raise 88 length = 10.84 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10.57 + 10.84) / 2 = 10.71 m
Length from node 475 to 575 = 10.71 + 2.75 + 3.81 = 17.27 or approximately 17.3 m

Node 495 to 595 is located in the block of raises between Raise 94 and Raise 120 (Figure H-2)

Distance from 495 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 595 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 94 length = 10.79 m (CRWMS M&O 1997f, p. 25)
Raise 120 length = 10.00 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10.79 + 10.00) / 2 = 10.40 m
Length from node 495 to 595 = 10.40 + 2.75 + 3.81 = 16.96 or approximately 17.0 m

Node 4105 to 5105 is located in the block of raises between Raise 94 and Raise 120 (Figure H-3)

Distance from 4105 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 5105 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 94 length = 10.79 m (CRWMS M&O 1997f, p. 25)
Raise 120 length = 10.00 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10.79 + 10.00) / 2 = 10.40 m
Length from node 4105 to 5105 = 10.40 + 2.75 + 3.81 = 16.96 or approximately 17.0 m

Node 4120 to 5120 is located in the block of raises between Raise 94 and Raise 120 (Figure H-3)

Distance from 4120 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 5120 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 94 length = 10.79 m (CRWMS M&O 1997f, p. 25)
Raise 120 length = 10.00 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10.79 + 10.00) / 2 = 10.40 m
Length from node 4120 to 5120 = 10.40 + 2.75 + 3.81 = 16.96 or approximately 17.0 m

ECRB and PC Raises

Node 467 to 567 is located in the block of raises between Raise 50 and Raise 88 (Figure H-2)

Distance from 467 to invert = 5.0 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.50 m
Distance from 567 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 50 length = 10.57 m (CRWMS M&O 1997f, p. 25)
Raise 88 length = 10.84 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10.57 + 10.84) / 2 = 10.71 m
Pillar = 20 m (Section 4.2.7)
Emplacement Drift = 5.5 m (Section 4.2.9)
Length from node 467 to 567 = 10.71 + 2.50 + 3.81 + 20 + 5.5 = 42.52 or approximately 42.5 m

Node 403 to 503 is located in the block of raises between Raise 1 and Raise 24 (Figure H-1)

Distance from 403 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 503 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 1 length = 10.00 m (CRWMS M&O 1997f, p. 25)
Raise 24 length = 10.01 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10.00 + 10.01) / 2 = 10.00 m
Pillar = 20 m (Section 4.2.7)
Emplacement Drift = 5.5 m (Section 4.2.9)
Length from node 403 to 503 = 10.00 + 2.75 + 3.81 + 20 + 5.5 = 42.06 or approximately 42.1 m

Node 433 to 533 is located in the block of raises between Raise 32 and Raise 40 (Figure H-1)

Distance from 433 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 533 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 32 length = 10.12 m (CRWMS M&O 1997f, p. 25)
Raise 40 length = 10.41 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10.12 + 10.41) / 2 = 10.27 m
Pillar = 20 m (Section 4.2.7)
Emplacement Drift = 5.5 m (Section 4.2.9)
Length from node 433 to 533 = 10.27 + 2.75 + 3.81 + 20 + 5.5 = 42.33 or approximately 42.3 m

Node 456 to 556 is located in the block of raises between Raise 50 and Raise 88 (Figure H-2)

Distance from 456 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 556 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 50 length = 10.57 m (CRWMS M&O 1997f, p. 25)
Raise 88 length = 10.84 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10.57 + 10.84) / 2 = 10.71 m
Pillar = 20 m (Section 4.2.7)
Emplacement Drift = 5.5 m (Section 4.2.9)
Length from node 456 to 556 = 10.71 + 2.75 + 3.81 + 20 + 5.5 = 42.77 or approximately 42.8 m

Node 480 to 580 is located in the block of raises between Raise 50 and Raise 88 (Figure H-2)

Distance from 480 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 580 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m

Raise 50 length = 10.57 m (CRWMS M&O 1997f, p. 25)
Raise 88 length = 10.84 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10.57 + 10.84) / 2 = 10.71 m
Pillar = 20 m (Section 4.2.7)
Emplacement Drift = 5.5 m (Section 4.2.9)
Length from node 480 to 580 = 10.71 + 2.75 + 3.81 + 20 + 5.5 = 42.77 or approximately 42.8 m

Node 4103 to 5103 is located in the block of raises between Raise 94 and Raise 120 (Figure H-3)

Distance from 4103 to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from 5103 to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Raise 94 length = 10.79 m (CRWMS M&O 1997f, p. 25)
Raise 120 length = 10.00 m (CRWMS M&O 1997f, p. 25)
Actual Length (Section 4.2.6) = (10.00 + 10.79) / 2 = 10.40 m
Pillar = 20 m (Section 4.2.7)
Emplacement Drift = 5.5 m (Section 4.2.9)
Length from node 4103 to 5103 = 10.4 + 2.75 + 3.81 + 20 + 5.5 = 42.77
or approximately 42.8 m

Raises From Mains to PC Drifts

Distance from node to invert = 5.5 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.75 m
Distance from node to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Pillar = 20 m (Section 4.2.7)
Length from node to node = 20 + 2.75 + 3.81 = 26.56 or approximately 26.6 m

Raises From Mains to ECRB

Distance from node to invert = 5.0 m (Section 4.2.9) / 2 (Section 4.2.8) = 2.50 m
Distance from node to crown = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Pillar = 20 m (Section 4.2.7)
Length from node to node = 20 + 2.50 + 3.81 = 26.31 or approximately 26.3 m

These distances are added to the horz. lengths of the PC drifts and ECRB

Added Distance to Intakes to Represent the Raise and Alcove

Horz. Dist from node in Main to Main wall/Start of Alcove = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Horz. Dist from Main wall/Start of Alcove to center of Raise = 10 m (Section 4.2.9) / 2 (Section 4.2.12) = 5 m
Vert. Dist from node to invert of main/start of raise = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Vert. Dist from node to crown of connector/start of raise = 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m

Length of Raise = Change in elevation (taken from Figures H-4, H-5, and H-6) - Height of connector (7.62 m (Section 4.2.9))

These addition distances are added to the distances shown on Figures H-4, H-5, and H-6 to represent the distance from the node at the Intake Shaft to the node in the West Main.

Distance to Represent the Raise and Alcove for Node in Exhaust Main to Node in Exhaust Connector

West Exhaust Main Node to Exhaust Connector Node

Horz. Dist from node in Main to Main wall/Start of Alcove - 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Horz. Dist from Main wall/Start of Alcove to center of Raise - 10 m (Section 4.2.9) / 2 (Section 4.2.12) = 5 m
Vert. Dist from node to invert of main/start of raise - 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Vert. Dist from node to crown of connector/start of raise - 7.00 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.5 m
Length of Raise = Pillar 10 m (Section 4.2.10)
West Exhaust Main node to Exhaust Connector node = 3.81 + 5 + 3.81 + 3.5 + 10 = 26.12 or approximately 26.1 m

East Exhaust Main Node to Exhaust Connector Node

Horz. Dist from node in East Main to Main wall/Start of Alcove - 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Horz. Dist from East Main wall/Start of Alcove to center of Raise - 10 m (Section 4.2.9) / 2 (Section 4.2.12) = 5 m
Vert. Dist from node to invert of East main/start of raise - 7.62 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Vert. Dist from center of connector to crown of conn./start of raise - 7.00 m (Section 4.2.9) / 2 (Section 4.2.8) = 3.5 m
Length of Raise = Pillar 10 m (Section 4.2.10)
Horz. Dist from node in East Main to Main wall/Start of Alcove (along connector)
= 7.62 (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Horz. Dist from East Main wall/Start of Alcove to center of Raise (along connector)
= 10 (Section 4.2.9) / 2 (Section 4.2.12) = 5 m
Horz. Dist from node in West Main to Main wall/Start of Alcove (along connector)
= 7.62 (Section 4.2.9) / 2 (Section 4.2.8) = 3.81 m
Horz. Dist from West Main wall/Start of Alcove to center of Raise (along connector)
= 10 (Section 4.2.9) / 2 (Section 4.2.12) = 5 m
Pillar between Exhaust Main = 3 (4.2.11) x 7.62 (Section 4.2.9) = 22.86 m
East Exhaust Main node to Exhaust Connector node
3.81 + 5 + 3.81 + 3.5 + 10 + 5 + 3.81 + 22.86 + 3.81 + 5 = 66.6 m

Exhaust Connector Length

The lengths shown on Figures H-4, H-5, and H-6 are from center of shaft to end of alcove
The nodes are located at the center of the shaft and at the center of the raise
Exhaust Connector length = length shown on figure + 5m (10 m (Section 4.2.9) / 2 (Section 4.2.12))

Shaft Length

Change in elevations shown on Figures H-4, H-5, and H-6 are from collar to sill
Exhaust Shaft Length = Change in elevation - 3.5 m (7 m (Section 4.2.9) / 2 (Section 4.2.12))
Intake Shaft Length = Change in elevation - 3.81 m (7.62 m (Section 4.2.9) / 2 (Section 4.2.12))
Both the Emplacement Shaft and Development Shaft are considered to be Exhaust Shafts for the length calculations.

List of Reference Points shown in Figures H-4, H-5 and H-6.

Ref. Point	Northing	Easting	Elevation	Reference
EXM NM	235,680.84	170,821.24	1,037.35	CRWMS M&O 1997f, pp.24, 26
EXM SM*	230,654.72	170,604.67	1,114.53	CRWMS M&O 1997f, pp.24, 27
EXM 24	234,507.24	170,820.02	1,048.02	CRWMS M&O 1997f, pp.23, 25
EXM 40	234,060.03	170,746.66	1,054.14	CRWMS M&O 1997f, pp.23, 25
EXM 50	233,776.60	170,712.86	1,058.00	CRWMS M&O 1997f, pp.23, 25
EXM 88	232,685.68	170,647.18	1,072.74	CRWMS M&O 1997f, pp.23, 25
EXM 94	232,510.44	170,622.86	1,075.11	CRWMS M&O 1997f, pp.23, 25
ED 40E	233,879.31	171,302.85	1,067.82	CRWMS M&O 1997f, p.21
ED 24W	234,672.01	170,312.92	1,061.56	CRWMS M&O 1997f, p.22
ED 40W	234,240.74	170,190.46	1,067.82	CRWMS M&O 1997f, p.22
ED 50W	233,963.37	170,138.03	1,071.73	CRWMS M&O 1997f, p.22
ED 88W	232,881.56	170,024.32	1,086.60	CRWMS M&O 1997f, p.22
ED 120W	231,897.77	170,152.61	1,099.12	CRWMS M&O 1997f, p.22
C7 PT	234,738.40	171,397.92	1,065.75	CRWMS M&O 1997f, pp.16, 24, 26

* Reference points EXM SM and C6 PT are the same point

Assumptions 4.2.2, 4.2.4, and 4.2.15 were used to develop the layouts in Figures H-4, H-5, and H-6.

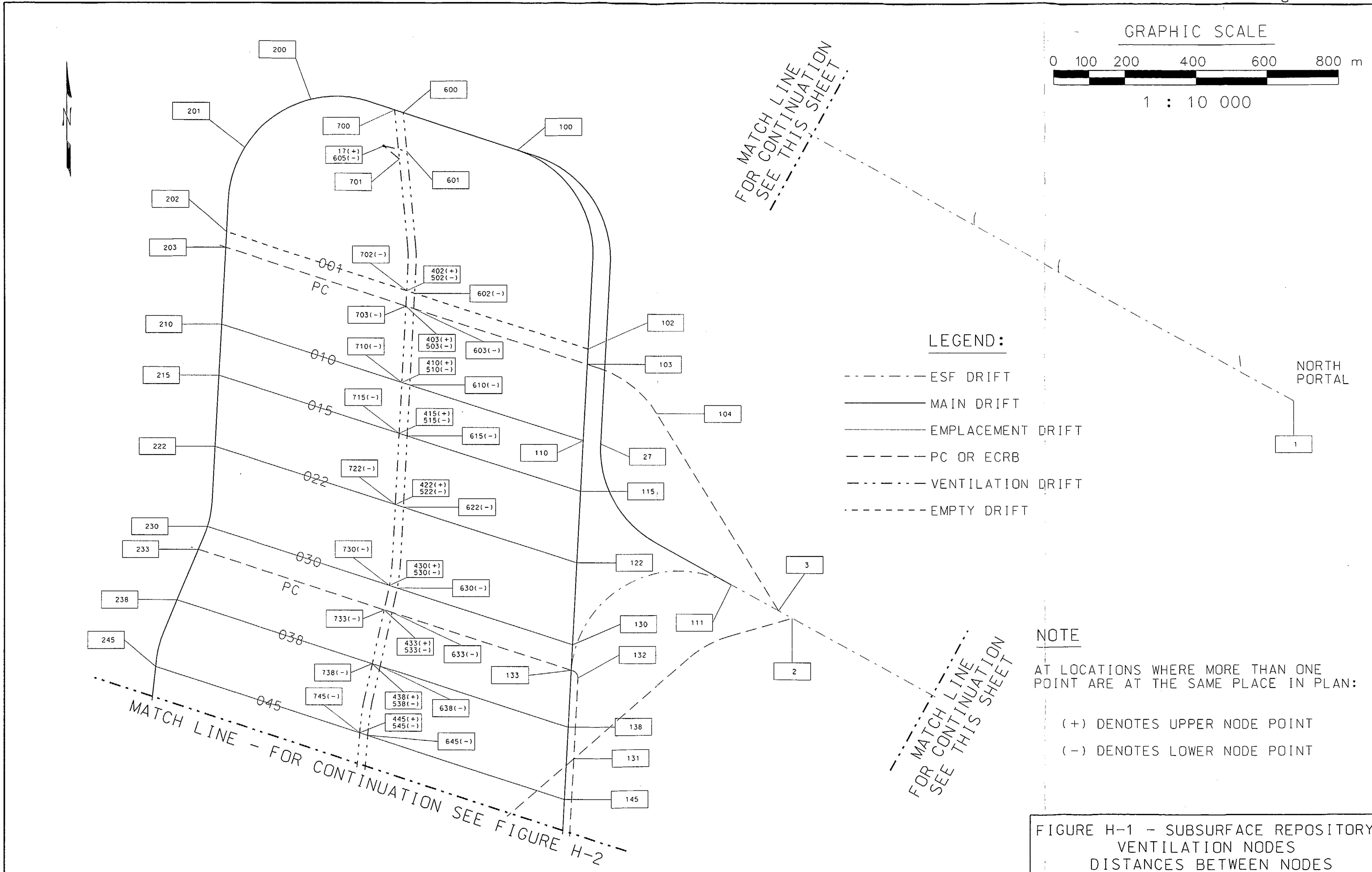


FIGURE H-1 - SUBSURFACE REPOSITORY VENTILATION NODES DISTANCES BETWEEN NODES

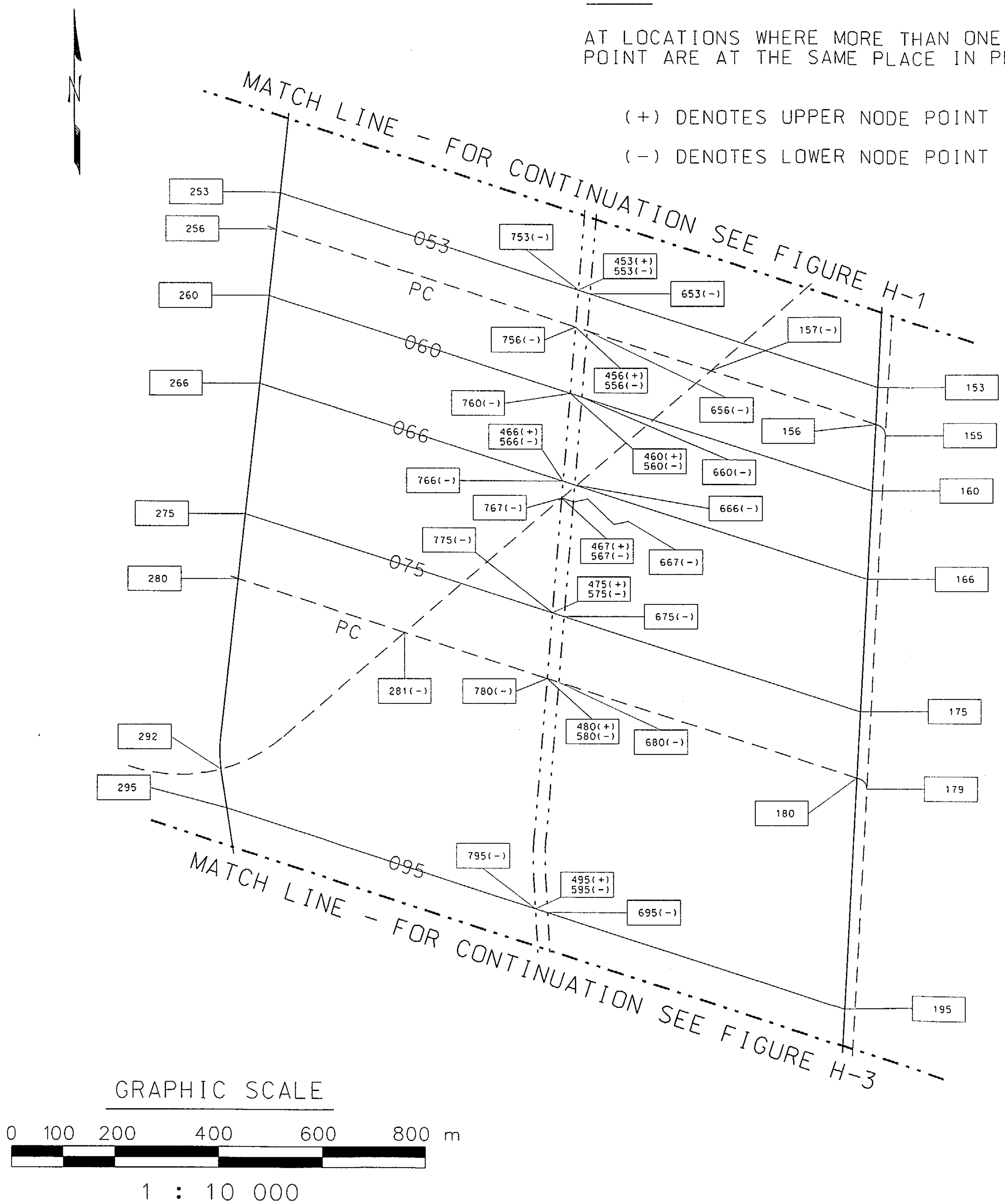
CHESTNEYR t:*repss*fa*fig*ssfa0038.fig 08-JUN-1999 08:31

NOTE

AT LOCATIONS WHERE MORE THAN ONE POINT ARE AT THE SAME PLACE IN PLAN:

(+) DENOTES UPPER NODE POINT

(−) DENOTES LOWER NODE POINT



NODE	DISTANCE
1	1992.0
2	43.6
3	151.4
111	582.4
27	960.6
100	336.5
600	25.1
700	241.7
200	236.1
201	246.5
202	43.5
203	217.4
210	144.9
215	202.9
222	230.1
230	70.1
233	154.5
238	197.1
245	228.9
253	71.5
256	128.7
260	171.7
266	257.5
275	128.7
280	376.2
292	75.9
295	235.2
2103	78.4
2105	470.3
2120	999.2
10	200.0
9	227.2
8	23.1
7	835.8
6	1093.1
1120	434.8
1105	72.5
1103	217.4
195	449.3
180	130.4
175	260.9
166	173.9
160	130.4
156	72.5
153	231.9
145	202.9
138	159.4
133	72.5
130	231.9
122	202.9
115	144.9
110	217.4
103	43.5
102	654.6
100	

NODE	DISTANCE
600	108.7
601	400.7
602	43.5
603	217.4
610	144.9
615	202.9
622	231.8
630	70.4
633	154.7
638	198.2
645	230.3
653	72.0
656	129.6
660	172.7
666	33.5
667	225.6
675	129.6
680	450.0
695	225.1
6103	75.1
6105	450.2
6120	860.1
23	213.4
7	
700	138.3
701	371.6
702	43.5
703	217.4
710	144.9
715	202.9
722	230.8
730	70.4
733	154.7
738	198.1
745	230.3
753	72.0
756	129.6
760	172.7
766	33.5
767	225.6
775	129.6
780	450.2
795	225.1
7103	75.1
7105	450.2
7120	865.8
22	214.9
8	
202	533.3
402	533.3
102	
502	23.8
602	

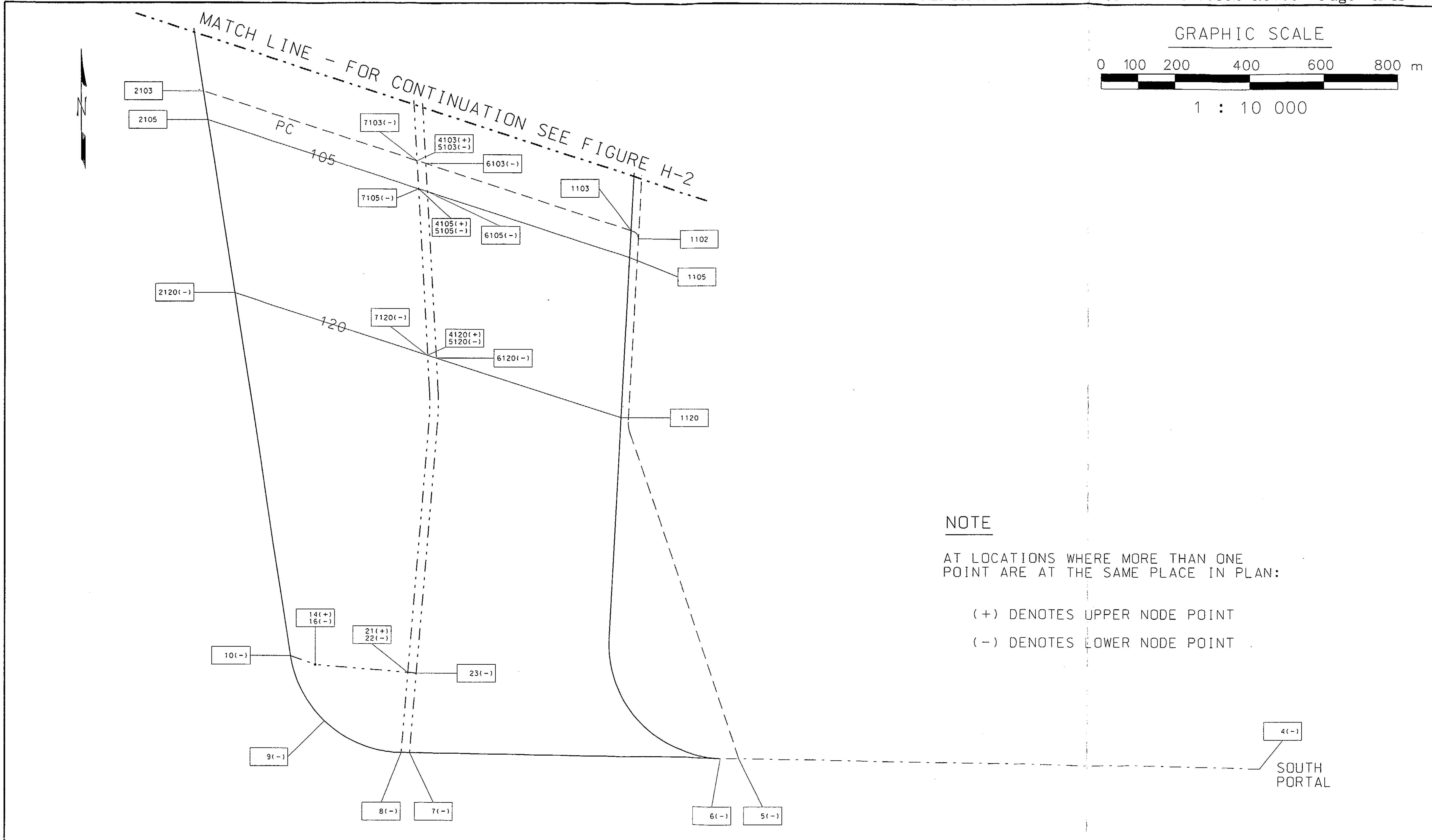
NODE	DISTANCE
203	533.3
403	533.3
103	
503	23.8
603	
210	533.3
410	533.3
110	
510	23.8
610	
215	533.3
415	533.3
115	
515	23.8
615	
222	533.3
422	533.3
122	
522	23.8
622	
230	538.3
430	538.3
130	
530	23.2
630	
233	549.8
433	549.8
133	
533	23.1
633	
567	23.6
667	

NODE	DISTANCE
238	576.3
438	576.3
138	
538	23.1
638	
245	601.9
445	601.9
145	
545	23.6
645	
253	608.4
453	608.4
153	
553	23.6
653	
256	610.5
456	
556	23.6
656	
260	614.1
460	614.1
160	
560	23.8
660	
266	619.0
466	619.0
166	
566	23.6
666	
275	626.4
475	626.4
175	

NODE	DISTANCE
575	23.6
675	
280	339.9
281	290.1
480	630.0
180	
580	23.8
680	
295	629.0
495	629.0
195	
595	24.7
695	
2103	604.2
4103	604.2
1103	
5103	24.7
6103	
2105	595.9
4105	595.9
1105	
5105	24.7
6105	
2120	546.3
4120	546.3
1120	
5120	24.7
6120	
10	69.7
16	249.3
21	

NODE	DISTANCE
601	67.0
605	57.5
701	
3	655.7
104	247.5
103	
5	1457.6
1102	666.7
179	695.7
155	
132	225.9
131	440.8
155	
2	745.0
131	479.4
157	380.9
467	403.0
281	450.0
292	
1102	31.6
1103	
179	31.6
180	
155	31.6
156	336.3
157	274.2
456	
132	31.6
133	
4	1402.6
5	49.2
6	
111	698.5
130	

FIGURE H-2 – SUBSURFACE REPOSITORY VENTILATION NODES DISTANCES BETWEEN NODES



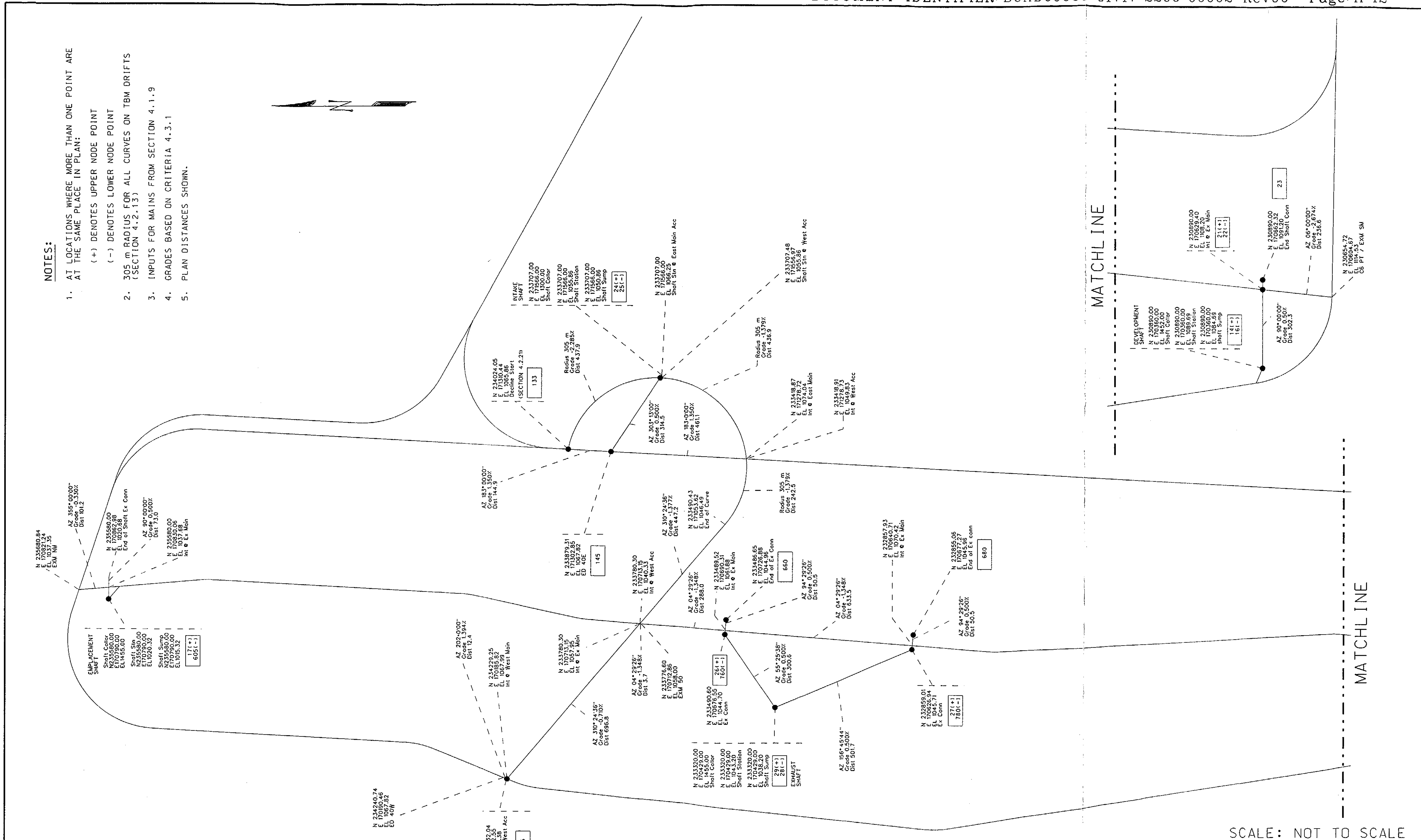
NOTE

AT LOCATIONS WHERE MORE THAN ONE POINT ARE AT THE SAME PLACE IN PLAN:

(+) DENOTES UPPER NODE POINT

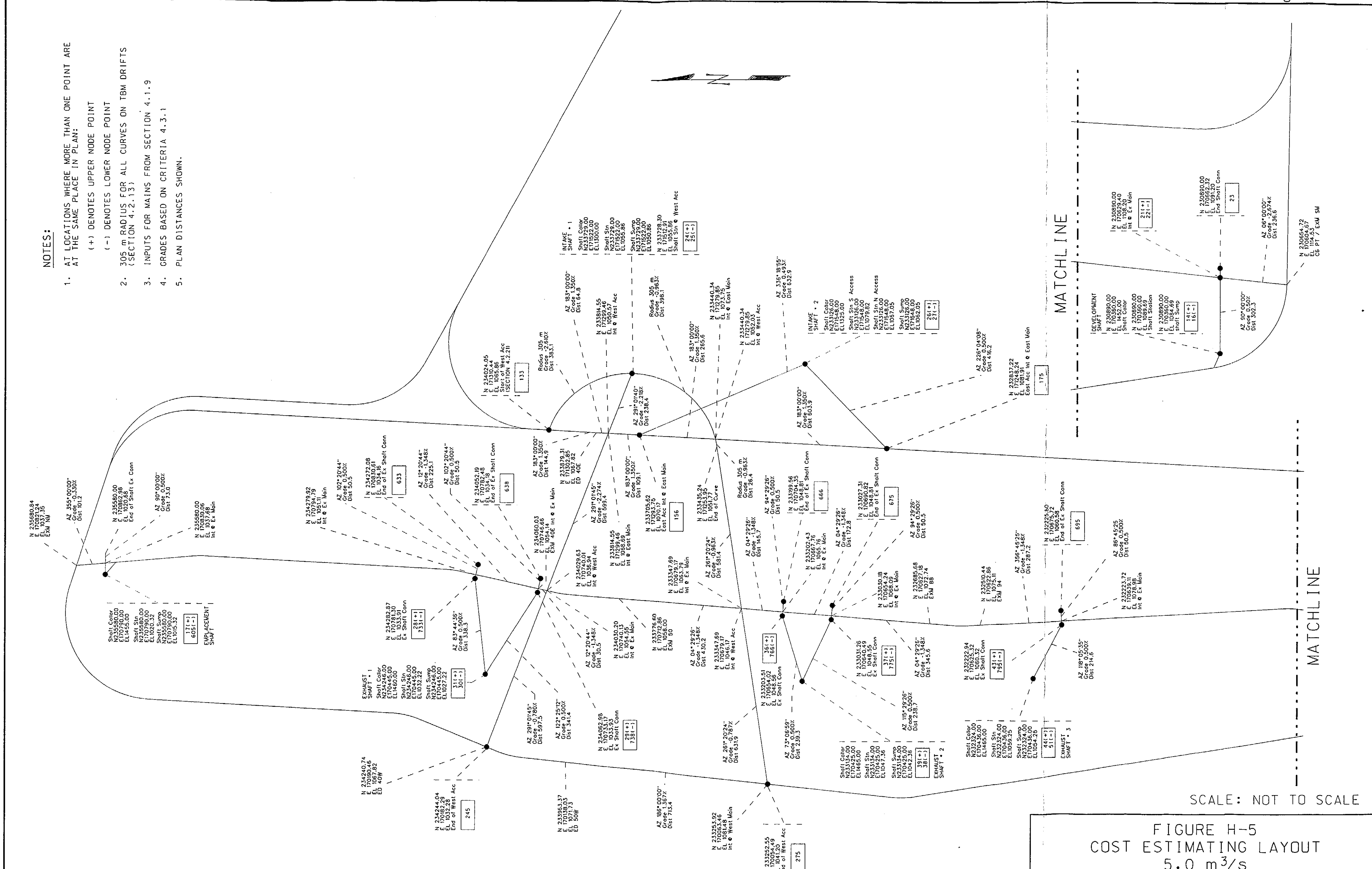
(-) DENOTES LOWER NODE POINT

FIGURE H-3 - SUBSURFACE REPOSITORY VENTILATION NODES DISTANCES BETWEEN NODES



SCALE: NOT TO SCALE

FIGURE H-4
COST ESTIMATING LAYOUT
1.0 m^3/s

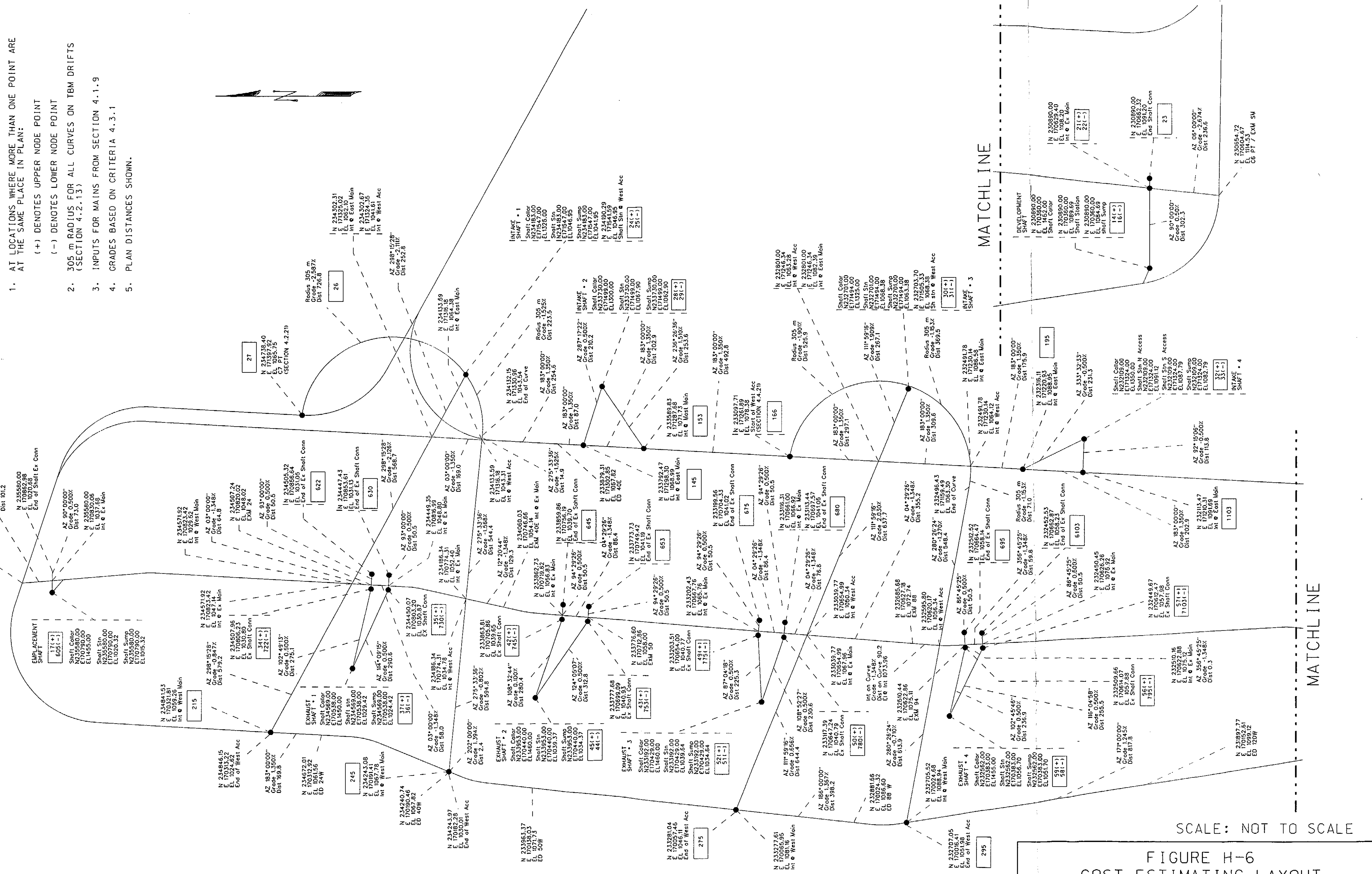


SCALE: NOT TO SCALE

FIGURE H-5
COST ESTIMATING LAYOUT
5.0 m^3/s

NOTES:

1. AT LOCATIONS WHERE MORE THAN ONE POINT ARE AT THE SAME PLACE IN PLAN:
   (+) DENOTES UPPER NODE POINT
   (–) DENOTES LOWER NODE POINT
2. 305 m RADIUS FOR ALL CURVES ON TBM DRIFTS (SECTION 4.2.13)
3. INPUTS FOR MAINS FROM SECTION 4.1.9
4. GRADES BASED ON CRITERIA 4.3.1
5. PLAN DISTANCES SHOWN.



SCALE: NOT TO SCALE

FIGURE H-6
COST ESTIMATING LAYOUT
10.0 m^3/s

APPENDIX I

COST ESTIMATE SUMMARY

APPENDIX I

COST ESTIMATE SUMMARY

Details in this appendix are not subject to *Quality Assurance Requirement Document* (QARD) (DOE 1998a) requirements.

This cost information transmitted by Design Input Transmittal (CRWMS M&O 1999e)

Table I-1 Cost Estimate

Estimate Title: DF-07 Preclosure Ventilation Estimate File Loc.: O:\\df07		**DF - 07 Continuous Preclosure Ventilation**									Date: 12/4/98 Estimated By: J. Steiger Product Author: J. Steinhoff	
Line No.	Account Code	Description	Qty	U/M	M/E $/Unit	M/E Total $	Unit Mhrs	Total Mhrs	$/Mhr	Total Labor $	Subcontract/ Other $	Grand Total
1												
2		**VA Baseline w/o M&I**										
3		Pre-emplacement Construction	1	LS		81464628				50062703	77576049	209,103,380
4		Emplacement	1	LS		108884001				93681933	64936063	267,501,997
5		Monitoring	1	LS		114277078				130926107	52160555	297,363,740
6		Closure and Decommissioning	1	LS		11439301				14723977	12146758	38,310,036
7		Total Cost w/o M&I				316065008				289394720	206819425	812,279,153
8												
9		Escalation to 1999 $ @ 1.023										**830,961,574**
10												
11		**System A - 1CMPS case**										
12		Pre-emplacement Construction	1	LS		112934766				91428010	102220942	306,583,718
13		Emplacement	1	LS		149408712				170084096	124801326	444,294,134
14		Monitoring	1	LS		78972583				98418132	36578135	213,968,850
15		Closure and Decommissioning	1	LS		24374689				30729559	30357193	85,461,441
16		Total Cost w/o M&I				365690750				390659797	293957596	1,050,308,143
17												
18		Escalation to 1999 $ @ 1.023										**1,074,465,230**
19												
20		**Change from VA Baseline for 1CMPS case**										**243,503,657**
21												
22		**System B - 5CMPS case**										
23		Pre-emplacement Construction	1	LS		113240096				91647024	102482033	307,369,153
24		Emplacement	1	LS		253607143				292624346	199145873	745,377,362
25		Monitoring	1	LS		217961794				227824742	90682773	536,469,309
26		Closure and Decommissioning	1	LS		31024886				38984273	39364276	109,373,435
27		Total Cost w/o M&I				615833919				651080385	431674955	1,698,589,259
28												
29		Escalation to 1999 $ @ 1.023										**1,737,656,812**
30												
31		**Change from VA Baseline for 5CMPS case**										**906,695,238**
32												

Table I-1 Cost Estimate (continued)

Estimate Title: DF-07 Preclosure Ventilation Estimate File Loc.: O:\\df07		DF - 07 Continuous Preclosure Ventilation									Date: 12/4/98 Estimated By: J. Steiger Product Author: J. Steinhoff	
Line No.	Account Code	Description	Qty	U/M	M/E $/Unit	M/E Total $	Unit Mhrs	Total Mhrs	$/Mhr	Total Labor $	Subcontract/ Other $	Grand Total
1												
2		**VA Baseline w/o M&I**										
3		Pre-emplacement Construction	1	LS		81464628				50062703	77576049	209,103,380
4		Emplacement	1	LS		108884001				93681933	64936063	267,501,997
5		Monitoring	1	LS		114277078				130926107	52160555	297,363,740
6		Closure and Decommissioning	1	LS		11439301				14723977	12146758	38,310,036
7		Total Cost w/o M&I				316065008				289394720	206819425	812,279,153
8												
9		Escalation to 1999 $ @ 1.023										**830,961,574**
10												
11		**System C - 10 CMPS case**										
12		Pre-emplacement Construction	1	LS		144877289				114965981	130953947	390,797,217
13		Emplacement	1	LS		363801318				444155891	271078741	1,079,035,950
14		Monitoring	1	LS		387937394				469244224	181854270	1,039,035,888
15		Closure and Decommissioning	1	LS		35696332				44534857	45331235	125,562,424
16		Total Cost w/o M&I				932312333				1072900953	629218193	2,634,431,479
17												
18		Escalation to 1999 $ @ 1.023										**2,695,023,403**
19												
20		**Change from VA Baseline for 10 CMPS case**										**1,864,061,829**
21												
22												
23		Pre-emplacement Construction										

APPENDIX J

DESIGN FEATURE EVALUATION

APPENDIX J

DESIGN FEATURE EVALUATION

The following questions are intended to solicit information for the Design Feature. This information is a subset of the overall LADS evaluation criteria (CRWMS M&O 1998g), which will be used for subsequent evaluations of the Enhanced Design Alternatives (EDA). In addition a confidence assessment is assigned (CRWMS M&O 1999g, p. 5).

SCALES OF CONFIDENCE (CRWMS M&O 1999g, p. 1)

- High level of confidence (A): the assessment is readily supported, defensible, and not subject to much uncertainty
- Moderately high (B): the assessment is supportable, reasonably defensible and only subject to moderate uncertainty
- Moderate (C): the assessment is supportable, reasonably defensible with some possible weaknesses, and subject to moderate levels of uncertainty
- Moderately low (D): the assessment is not well supported, has some weaknesses in terms of defensibility, and subject to uncertainty
- Low (E): the assessment is not well supported, has significant weaknesses in terms of defensibility, and subject to considerable uncertainty

The responses to the questions below are addressed in this Appendix.

1. Postclosure Performance

- What is the peak dose rate to an average individual of a critical group at a distance of 20 kilometers from the repository site and the time of the peak, considering two time periods?

  a) less than 10,000 years

  b) between 10,000 years and 1,000,000 years

  c) An evaluation of a figure of merit of the integrated dose should be included in the evaluation. This evaluation is given by the equation?

$$\text{Timing FOM} = 1/(\ln 10^6 - \ln 10^3) \int_0^{1My} \dot{D}(t) \frac{dt}{t}$$

[Note: this information should be based on a single realization (central value) calculation, in most cases].

- If the potential for juvenile failure exists, include the discussion of results using the juvenile failure scenario.

Scale - Quantitative estimates of expected peak dose and FOM in mrem/yr.

Lead Design Engineer: Moderately low (D) level of confidence. The PA model is not realistic. Data from a single borehole were used to build the model and a limitless reservoir of water is assumed. The influence of moisture is not included in the thermal modeling.

Performance Assessment Analyst: Moderate (C) level of confidence. Uncertainty in rock property effects, particularly rock re-wetting time after the thermal period is over.

Evaluation

Only the 10.0 m^3/s system has been evaluated for long term performance as a conservative bounding limit. Performance Assessment (PA) Operations, preliminary assessment indicates there is little discernable difference in the long term performance relative to the VA reference design. Since there is a strong correlation between fraction of waste packages failed as a function of time and dose as a function of time, there is no need to run the TSPA (RIP) calculations as there is not likely to be any noticeable difference from the TSPA-VA base case dose rates.(CRWMS M&O 1999d)

2. Preclosure Performance

What is your assessment of the preclosure performance of your DF or design alternative (DA) on a 1 to 5 scale? Please provide a 1 to 5 assessment of each question using this scale and a brief (one-to-two sentence) written basis for the evaluation. The overall evaluation should be the simple average of the assessments for each question.

- Would this DF or DA increase or decrease the probability of a Design Basis Event (DBE)?
- Would this DF or DA add a DBE? Is this DBE bounded by other DBEs?
- Would this DF or DA increase or decrease the consequences of a DBE?
- Does this DF or DA increase or decrease challenges to the repository safety systems?

Scale - Range from 1 to 5. A 1 would indicate that there are significant disadvantages in accommodating DBEs relative to the VA reference design; a 2 would indicate that there are moderate disadvantages in accommodating DBEs relative to the VA reference design; a 3 would indicate that the DBEs are accommodated comparably to the VA reference design; a 4 would indicate that there are moderate advantages in accommodating DBEs relative to the VA reference design; and a 5 would indicate that the DF or DA has significant advantages in accommodating DBEs relative to the VA reference design.

- What expected dose to the public at the preclosure area boundary is calculated?

Scale - Quantitative estimates of expected peak dose in milirems per year.

Summary - The following Table summarizes the results of these evaluations (All three systems).

A preclosure ventilation rate of 10 m^3/s per emplacement drift was assumed to be bounding. Of the cases examined by Dr. Danko (1.0, 5.0, and 10.0 m^3/s), 10 m^3/s would provide the most favorable postclosure conditions by removing the most water and providing the lowest emplacement drift temperature at the time of closure (CRWMS M&O 1999d).

The overall confidence rating is a high (A) level of confidence. This feature is similar to the VA reference design.

Table J-1. Summary of Preclosure Performance Evaluation

Criterion	Rating
Would your DF increase or decrease the probability of a DBE?	4
Would your DF add a DBE? Is this DBE bounded by other DBEs?	3
Would your DF increase of decrease the consequences of a DBE?	3
Does your DF increase or decrease challenges to the repository safety systems?	3
Overall assessment	3.25
What dose to the public at the preclosure area boundary is calculated?	Not calculated

Evaluation

- Would your DF or DA increase or decrease the probability of a DBE?
- A major DBE to be considered is the potential of a rockfall and in this case this DF would lower the temperature and dry out the rock more than the VA reference design. The rock and the ground support methods are affected in a negative way by higher temperatures and humidity. Therefore, by lowering the temperatures and humidity, the stability of the ground control system improves.

RATING: 4

- Would your DF or DA add a DBE? Is this DBE bounded by other DBEs?
- Would your DF or DA increase or decrease the consequences of a DBE?
- Does your DF or DA increase or decrease challenges to the repository safety systems?

There is no discernable difference between this DF and the VA reference design other than additional openings required for each of the systems to accommodate increased airflow.

RATING: 3 (For the above three criteria)

- What expected dose to the public at the preclosure area boundary is calculated?

There is not likely to be any noticeable difference from the Total System Performance Assessment VA reference design dose rates. There is little discernable difference in the fraction of waste packages breached versus time curves versus time curves between the ventilation case and the TSPA-VA (CRWMS M&O 1999d). Because of the similarity of the TSPA-VA to the bounding case no dosage calculation was made.

3. Assurance of Safety

What is your assessment of the assurance of safety of your DF or DA on a 1 to 5 scale? Please provide a 1 to 5 assessment of each question using this scale and a brief (one-to-two sentence) written basis for the evaluation. The overall evaluation should be the simple average of the assessments for each question

- Does this DF or DA have uncertainties in postclosure performance?
- What is the potential to reduce the uncertainties by the time of construction and of closure?

Scale - 1 to 5. A 1 would indicate that the design provides a low assurance of safety because there are large and significant uncertainties that are unlikely to be reduced, and/or that the design is particularly sensitive to disruptive events; a 2 would provide a moderately low assurance of safety comparable to the VA reference design; a 3 would indicate that there is a reasonable assurance of safety relative to uncertainties and disruptive events comparable to the VA reference design; a 4 would indicate a moderately high assurance of safety comparable to the VA reference design; and a 5 would indicate that the design provides very high assurance of safety comparable to the VA reference design, because the uncertainties are low or are likely to be significantly reduced, and/or the design is insensitive to disruptive events.

Summary - The following table summarizes the results of these evaluations (All three systems).

Overall rating is a moderately high (B) level of confidence. This feature is similar to the VA reference design.

Table J-2. Summary of Assurance of Safety Evaluation

Criterion	Rating
Does your DF have uncertainties in postclosure performance?	3
What is the potential to reduce the uncertainties by the time of construction and of closure?	3
Overall assessment	3

Evaluation

- Does this DF or DA have uncertainties in postclosure performance?

  RATING: 3.

  The same uncertainties exist for these three systems as exists for the VA reference design.

- What is the potential to reduce the uncertainties by the time of construction and of closure?

  RATING: 3

  The potential for decreasing the uncertainties will be consistent with the VA reference design.

4. Engineering Acceptance

What is the potential for acceptance of the engineering design of your DA or DF in a regulatory environment? Please provide a 1-5 assessment of each question using this scale and a brief (one-to-two sentence) written basis for the evaluation. The overall evaluation should be the simple average of the assessments for each question.

- Can the function of each element in the design be clearly communicated?
- Which of the four elements of the repository safety strategy does it support (limited water contacting waste packages, long waste package lifetime, low rate of release of radionuclides from breached waste packages, radionuclide concentration reduction during transport from the waste packages)?
- Does the engineering analysis follow accepted methods?
- Is the postclosure function simple to demonstrate?
- Are there regulatory and/or engineering precedence for your design?
- What is the availability of qualified data to support your design likely to be in the License Application (LA) time frame?
- Is the design constructable with proven methods?
- Are any high-level design goals for the mined geologic repository (MGR) (such as the CDA) violated by the use of this design?

Scale - 1 to 5. A 1 would indicate that the design has a very low potential for acceptance comparable to the VA reference design; a 2 would indicate a moderately low potential for acceptance comparable to the VA reference design; a 3 would indicate a moderate potential for acceptance comparable to the VA reference design; a 4 would indicate a moderately high potential for acceptance comparable to the VA reference design; and a 5 would indicate a very high potential for acceptance comparable to the VA reference design.

- If applicable, what is the effective lifetime of the feature or major component of the alternative in supporting the particular element of the repository safety strategy?

Scale - Quantitative estimate of the effective lifetime in years, or expected distribution of lifetime, if available.

Summary - The following table summarizes the results of these evaluations (All three systems).

Overall rating is a high (A) level of confidence. This is similar to the VA reference design with more openings; easy to demonstrate and defend.

Table J-3. Summary of Engineering Acceptance Evaluation

Criterion	Rating
Can the function of each element in the design be clearly communicated?	3
Which of the four elements of the repository safety strategy does it support?	3
Does the engineering analysis follow accepted methods?	3
Is the postclosure function simple to demonstrate?	3
Are there regulatory and/or engineering precedence for your design?	3
What is the availability of qualified data to support your design likely to be in the LA time frame?	3
Is the design constructable with proven methods?	3
Overall assessment	3
If applicable, what is the effective lifetime of the feature or major component of the alternative in supporting the particular element of the repository safety strategy?	100 years

Evaluation

- Can the function of each element in the design be clearly communicated?

  RATING: 3.

  The design and function will not depart from recognized standards and practices.

- Which of the four elements of the repository safety strategy does it support (limited water contacting waste packages, long waste package life, low rate of release of radionuclides from breached waste packages, radionuclide concentration reduction during transport from the waste packages)?

  The only element that applies to this DF is limited water contacting waste packages. The long term postclosure performance shows that there is no discernable difference between this DF and the VA reference design except that the system enters into the waste package corrosion regime a little earlier (CRWMS M&O 1999d). There is no discernable difference between this DF and the VA reference design for preclosure performance.

  RATING: 3

- Does the engineering analysis follow accepted methods?

- Is the postclosure function simple to demonstrate?

- Is there regulatory and/or engineering precedence for your design?

- What is the availability of qualified data to support your design likely to be in the LA time frame?

- Is the design constructable with proven methods?

  RATING: 3.

  This rating applies to the above five criteria as in general accepted methods and industrial/construction practices will be followed.

- If applicable, what is the effective lifetime of the feature or major component of the alternative in supporting the particular element of the repository safety strategy?

  The DF limiting water contacting waste packages is 100 years because it is strictly a preclosure activity.

5. Construction, Operations, and Maintenance

Are there any particular difficulties or advantages that your DF or DA has relative to the VA reference design for the following construction, operations, and maintenance characteristics?

- Would this DA or DF increase or decrease worker radiation safety and/or industrial safety?

- Would this DA or DF increase or decrease reliability, availability, maintainability, and inspectability of manufactured and constructed items?

- Would this DA or DF increase or decrease throughput capability?

- Would this DA or DF improve or decrease the ability to perform performance confirmation activities?

Scale - 1 to 5. A 1 would indicate that the design has significant disadvantages or difficulties in construction, operations, and maintenance issues comparable to the VA reference design; a 2 would indicate moderate disadvantages or difficulties in construction, operations, and maintenance issues comparable to the VA reference design; a 3 would indicate that the construction, operations, and maintenance issues are comparable to those of the VA reference design; a 4 would indicate moderate advantages in construction, operations, and maintenance issues relative to the VA reference design; and 5 would indicate that there are significant advantages in construction, operations, and maintenance issues relative to the VA reference design.

Summary - The following table summarizes the results of these evaluations(All three systems)

Overall rating is a moderately high (B) level of confidence. No special equipment will be required. There will be more openings to construct and inspect. There are more fans, but they lie within the range of existing systems.

Table J-4. Summary of Construction, Operations, and Maintenance Evaluation

Criterion	Rating
Would this DF increase or decrease worker radiation safety and/or industrial safety?	2.5
Would this DF increase or decrease reliability, availability, maintainability, and inspectability of manufactured and constructed items?	3
Would this DF increase or decrease throughput capability?	3
Would this DF improve or decrease the ability to perform performance confirmation activities?	4
Overall assessment	3.12

Evaluation

- Would this DA or DF increase or decrease worker radiation safety and/or industrial safety?

  RATING: 2.5

  Industrial safety will be affected in this DF because of the number and complexity of the tasks involved in this DF in comparison with the VA reference design. The probability of industrial accidents occurring during construction is likely to increase simply because of the longer schedule time or the multiple activities.

- Would this DA or DF increase or decrease reliability, availability, maintainability, and inspectability of manufactured and constructed items?

  RATING: 3

  Manufactured items, and constructed items will in general not depart from the recognized industry standards and applicable regulations. There is no difference in the items to be considered for these systems because of the similarity to the VA reference design.

- Would this DA or DF increase or decrease throughput capability?

  RATING: 3.

  These three systems are similar to the VA reference design.

- Would this DA or DF improve or decrease the ability to perform performance confirmation activities?

  The increased amount of openings below the repository block in this DF increases the potential locations to test performance confirmation without interference.

RATING: 4

6. Schedule

For this DF or DA, how does the LA schedule compare to that for the VA reference design.

Scale - Difference in time required for changes to site characterization, design, licensing, and construction relative to the VA reference design.

Evaluation

This DF can meet the same construction schedule as the VA reference design if more equipment and labor coupled with concurrent activities is utilized. With such utilization, there is no change in the overall construction schedule and therefore no impact is realized to site characterization, design and licensing.

The overall rating is a moderately high (B) level of confidence. Assuming that two TBMs are used there would be no impact on the existing schedule. The advance rates are aggressive, but possible.

7. Cost

What is the difference in estimated total cost relative to the VA reference design? (conceptual design estimating is applicable ±50 percent.)

Scale - Cost in 1999 dollars. Costs, which occur significantly later than the current schedule for the VA reference design, should be noted where possible.

The cost differential of System A, 1.0 m^3/s, with respect to the VA reference design is +$244 Million (CRWMS M&O 1999e).

The cost differential of System B, 5.0 m^3/s, with respect to the VA reference design is +$907 Million (CRWMS M&O 1999e).

The cost differential of System C, 10.0 m^3/s, with respect to the VA reference design is +$1,864 Million (CRWMS M&O 1999e).

Overall rating is a high (A) level of confidence. Key cost components are electrical power and additional ventilation shafts to be excavated. These costs are not difficult to estimate within the ±50 percent for conceptual design.

8. Environmental Considerations

What are the environmental considerations associated with this DF or DA relative to the VA reference design (pending completion of the formal evaluation of the environmental considerations by the EIS Contractor)?

Because there are additional openings required for this DF, there will be additional environmental considerations to account for impacts to landform and vegetation. The environmental considerations are discussed in Appendix K.

APPENDIX K

ENVIRONMENTAL CONSIDERATIONS

Details in this appendix are not subject to *Quality Assurance Requirement Document* (QARD) (DOE 1998a) requirements.

APPENDIX K

EVALUATION OF ENVIRONMENTAL CONSIDERATIONS FOR FEATURE #7: CONTINUOUS PRECLOSURE VENTILATION

Interview Notes: Chris Gorrell

DESCRIPTION:

This feature evaluates continuous preclosure ventilation airflow quantities of 1.0, 5.0, and 10.0 m^3/s for the emplacement drifts; the VA reference design preclosure ventilation rate is 0.1 m^3/s. The purpose of this feature is to determine if the use of continuous ventilation in the preclosure period could remove moisture from the rock mass and lower the temperature in the emplacement drifts to enhance the long term performance of the waste packages.

To accommodate the increased ventilation, additional excavation is required. The mains at the repository level and the ramps will stay the same as the VA reference design. The Exhaust Main will not change in size, but an additional main would be added. Emplacement drifts will be removed within the block (the number varies for each system) for shaft siting, and drifts in the contingency area will be used to replace them. The actual number of emplacement drifts to be used will not change for emplacement. Additional shafts will have to be added. Access drifts and additional ventilation raises will also have to be added to connect the mains to the shafts.

Impacts to Land Use and Ownership

Land Use–For 1.0 m^3/s, two additional shafts will have to be excavated: one for intake and one for exhaust. For 5.0 m^3/s, five additional shafts will have to be excavated: three for intake and two for exhaust. For 10.0 m^3/s, eight additional shafts will have to be excavated: four for intake and four for exhaust. The sizes of the shafts will have to be large to accommodate the increase airflow. The two VA reference design shafts will also have to increase in size. Each of the systems will increase the size of the muck piles.

For 1.0 m^3/s, the excavated diameter of the VA reference design shafts will be 7.5 meters and the two new shafts will be 10.5 meters. The amount of additional muck from the shafts will be approximately 59,668 m^3. Each shaft site will be approximately 260 meters by 130 meters. Additional roads will have to be built to reach the new intake shaft on the east side of the repository. The new exhaust shaft will be located within the repository on top of Yucca Mountain so that particular road will need more improvements.

For 5.0 m^3/s, the excavated diameter of the VA reference design shafts will be 7.5 meters, one of the new shafts will be 7.5 meters, and the other four of the new shafts will be 10.5 meters. The amount of additional muck from the shafts will be approximately 130,398 m^3. Each shaft site will be approximately 260 meters by 130 meters. Additional roads will have to be built to reach the new intake shafts on the east side of the repository. The new exhaust shafts will be located within the repository on top of Yucca Mountain so that particular road will need more improvements.

For 10.0 m^3/s, the excavated diameter of the VA reference design shafts will be 7.5 meters and the eight new shafts will be 10.5 meters. The amount of additional muck from the shafts will be approximately 217,436 m^3. Each shaft site will be approximately 260 meters by 130 meters. Additional roads will have to be built to reach the new intake shafts on the east side of the repository. The exhaust shafts will be located within the repository on top of Yucca Mountain so that particular road will need more improvements.

More drifting will have to be excavated to handle the additional airflow quantities. For all scenarios, an additional Exhaust Main of equal size will be excavated. Small horizontal drifts will connect the two Exhaust Mains via the ventilation raises from the emplacement drifts. From alcoves off the Exhaust Mains, large raises will connect portions of the Exhaust Mains to other access drifts that lead to the exhaust shafts. The intake shafts will also require additional drifting since the shaft has to provide air to both sides of the repository. For 1.0 m^3/s, the additional drifting excavation will be approximately 427,611 m^3. For 5.0 m^3/s, the additional drifting excavation will be approximately 565,189 m^3. For 10.0 m^3/s, the additional drifting excavation will be approximately 777,510 m^3.

Land ownership–Not applicable.

Impacts to Air Quality

Nonradiological impacts–This feature will have an increased amount of fugitive dust due to the additional excavation required. There also may be increased gaseous emissions from the excavation of the exhaust shafts because they will have to be excavated by drill-and-blast. The muck piles will require increased dust control.

Radiological impacts–The changes in repository ventilation would increase emissions of naturally occurring radon-222 and its radioactive decay products in the air exhausted from the subsurface.

Impacts to Hydrology, Including Surface Water and Groundwater

The continuous ventilation mixed with the high temperatures could potentially remove a large quantity of water. This could have an impact on the infiltration rates. If located within the repository block, the additional shafts could increase water flow through the block and keep it from collecting in the emplacement drifts. This could, however, change the natural course of water flow within the repository horizon and impact the groundwater table below. The surface locations of the additional shafts could potentially alter surface drainage patterns.

Impacts to biological Resources and Soils

Additional excavation of shafts and drifts will require larger muck piles than the current VA reference design. Since the exhaust shafts will have to be excavated by drill-and-blast, the muck piles may potentially be located at the shaft site or be transported overland to the main muck pile either by conveyor or haulage vehicle. With increased shaft pad sites, there will need to be more roads and utility rights-of-way. Noise levels, ground vibration, temperatures, and outdoor lighting will all increase. Larger muck piles can be controlled by standard means to ensure there are no impacts to surface water drainage.

Impacts to Cultural Resources

Additional shaft pad sites will have the potential to impact cultural sites because there are limited locations to site shafts. Noise levels will increase.

Socioeconomic Impacts

This feature is not expected to increase the number of workers beyond 10 percent.

Impacts to Occupational and Public Health and Safety

Increased excavation activities could potentially increase the risk of operational hazards. The higher the continuous airflow volume, the greater the risk of affecting the dispersion rates at the exhaust locations for potential radiological events compared with the VA reference design.

Noise Impacts

Additional excavation and increased number of fans for ventilation will increase the noise levels. Drill-and-blast excavation of the new exhaust shafts will increase noise levels. The movement of muck from these locations could also increase noise levels if muck cannot be stored at the shaft pad sites and have to be taken to the main muck pile by way of overland conveyor or haulage vehicle.

Impacts on Aesthetics

Additional shafts and excavation could affect landform, vegetation, views, and night lighting.

Impacts to Utilities, Energy, Materials, and Site Services

Additional excavation and the use of continuous ventilation will have a higher demand for utilities and power than the VA reference design. Since the shafts are larger than the VA reference design and with an increase in drifting, more ground control materials will be needed.

For 1.0 m^3/s, the power consumption will approximately double during pre-emplacement construction and about one year of development. The power consumption during emplacement operations will increase by approximately a factor of two and during monitoring operations will increase by approximately a factor of 5.5. For 5.0 m^3/s, the power consumption will approximately double during pre-emplacement construction and about five years of development. The power consumption during emplacement operations will increase by approximately a factor of six and during monitoring operations will increase by approximately a factor of 17. For 10.0 m^3/s, the power consumption will approximately double during pre-emplacement construction and about eight years of development. The power consumption during emplacement operations will increase by approximately a factor of 11 and during monitoring operations will increase by approximately a factor of 31.

Impacts to Management of Repository Generated Waste and the Use of Hazardous Materials

No impact.

Impacts to Environmental Justice

Not applicable.

Summary of Primary Impacts on Three Thermal Loads (High, Medium, Low)

This feature could significantly reduce the temperature and moisture in the emplacement drifts with high thermal loading. These benefits become progressively less with medium and low thermal loading.

Summary of Primary Impacts on Packaging Options for Transportation:

No impact.

Summary of Primary Short Term Impacts (Including Operations, Retrieval, and Closure)

Operations are more complex with additional excavation and ventilation. Retrieval is potentially easier since the drift temperatures are kept lower thereby decreasing the amount of blast cooling needed to re-enter an emplacement drift. Closure is more difficult with additional openings to seal.

Summary of Primary Long Term Impacts (After Closure)

This feature could potentially reduce the rock wall and air temperature and remove enough moisture to allow the repository to pass through the corrosion regime of the waste packages in less time than the VA reference design. A waste package may fail either through localized corrosion processes (pitting or crevice corrosion), leading to pinhole perforations, or through general corrosion processes leading to much larger patch perforations (Section 4.1.2).