CRWMS/M&O

Calculation Cover Sheet

Complete only applicable items.

1. QA: L
Page: 1 Of: 21

2. Calculation Title Post Closure Open-Loop Natural Ventilation			
3. Document Identifier (including Revision Number) BCAD00000-01717-0210-00002, Rev. 00			4. Total Pages 21
5. Total Attachments 9	6. Attachment Numbers - Number of pages in each I-8, II-24, III-29, IV-3, V-1, V!-1, VII-1, IX-3		
	Print Name	Signature	Date
7. Originator	Romeo Jurani Norman E. Kramer	[signature] NE Kramer	29 July 99 29 JULY 99
8. Checker	John F. Beesley	O. A. Zuasnur J. Peters for J. Beesley	29 July 99
9. Lead	Jeff Steinhoff	Jeff Steinhoff	July 29, 1999

10. Remarks

The authors shared equally in the preparation of this calculation. Attachment I was contributed by Alan Linden.

The following TBVs were used in the calculation:

TBV-276
TBV-333

Revision History

11. Revision No.	12. Description of Revision
00	Initial Issue

WM-11
NM5507

1. PURPOSE

The purpose of this calculation is to provide information to the Performance Assessment organization. The Performance Assessment organization will be requested to determine the waste package degradation, over 10,000 years, under the following conditions:

- Repository is not sealed and ventilation air can circulate in the emplacement drifts (open-loop conditions).
- Ventilation pressure provided by the heat of the waste packages (natural ventilation).

In order to provide the waste package degradation, the Performance Assessment organization requires the expected ventilation air temperature, the relative humidity of the ventilation air, and the waste package skin temperature over the 10,000 year period. This information is required at points 100, 300, 500 and 600 m from the start of the emplacement area in the emplacement drifts. This calculation serves as the basis for this information.

2. METHOD

This calculation will be a combination of previously published analyses and new information developed in this calculation. However, information from prior analyses must be adapted or expanded for the specific conditions mentioned above.

A recent analysis, *Repository Subsurface Waste Emplacement and Thermal Management Strategy* (CRWMS M&O 1998e), determined the expected air temperature in the emplacement drifts for a period of 300 years. This information has been extended to 10,000 years by using engineering judgement as explained in Section 5.3.

The *Multiple WP Emplacement Thermal Response- Suite 1* (CRWMS M&O 1998c) calculation determined the waste package side temperature over 10,000 years, but for the no ventilation condition. This information has been adjusted for natural ventilation conditions. Natural ventilation will allow air movement through the emplacement drifts and thus the information in *Multiple WP Emplacement Thermal Response- Suite 1* (CRWMS M&O 1998c) has been adjusted downward to reflect the cooling effect of the air.

The amount of moisture carried by the air in the repository is composed of the moisture of the air outside the repository and moisture added to the outside air from the drift walls. The moisture from the drift walls is due to infiltration of precipitation from the surface. The relative humidity of the air in the emplacement drifts is determined by the amount of moisture and the air temperature.

To check the reasonableness of the airflows within the repository, the natural ventilation pressure expected was calculated. As a necessary step in the airflow reasonability determination, the ventilation network within the repository was simulated using the VNETPC ventilation program.

3. ASSUMPTIONS

3.1 Repository Layout

The repository layout is similar to the VA reference design and contains the following features, as shown in Figure 1. The layout is more fully described in the *Repository Subsurface Layout Configuration Analysis* (CRWMS M&O 1997b). The page numbers below reflect the specific information source in the reference.

- Long parallel emplacement drifts with 28m center-to-center spacing (TBV-276) (pg 33) and 5.5m in diameter (TBV-333) (pg 74);
- In-drift waste package emplacement (pg 65);
- Two ventilation shafts (6.7m diameter) (TBV-333) (pg 80) and two ramps (7.62m diameter) (TBV-333) (pg 66 & 67);
- A thermal loading of 85 metric tonnes of uranium/acre (mtu/acre) (pg 11);
- Ventilation raises (2.0m diameter) (TBV-333) between Exhaust Main (7.62m diameter) (TBV-333) and Emplacement Drifts (pg 79); and
- Five (5) performance confirmation drifts (5.5m diameter) (TBV-333) (pg 59).

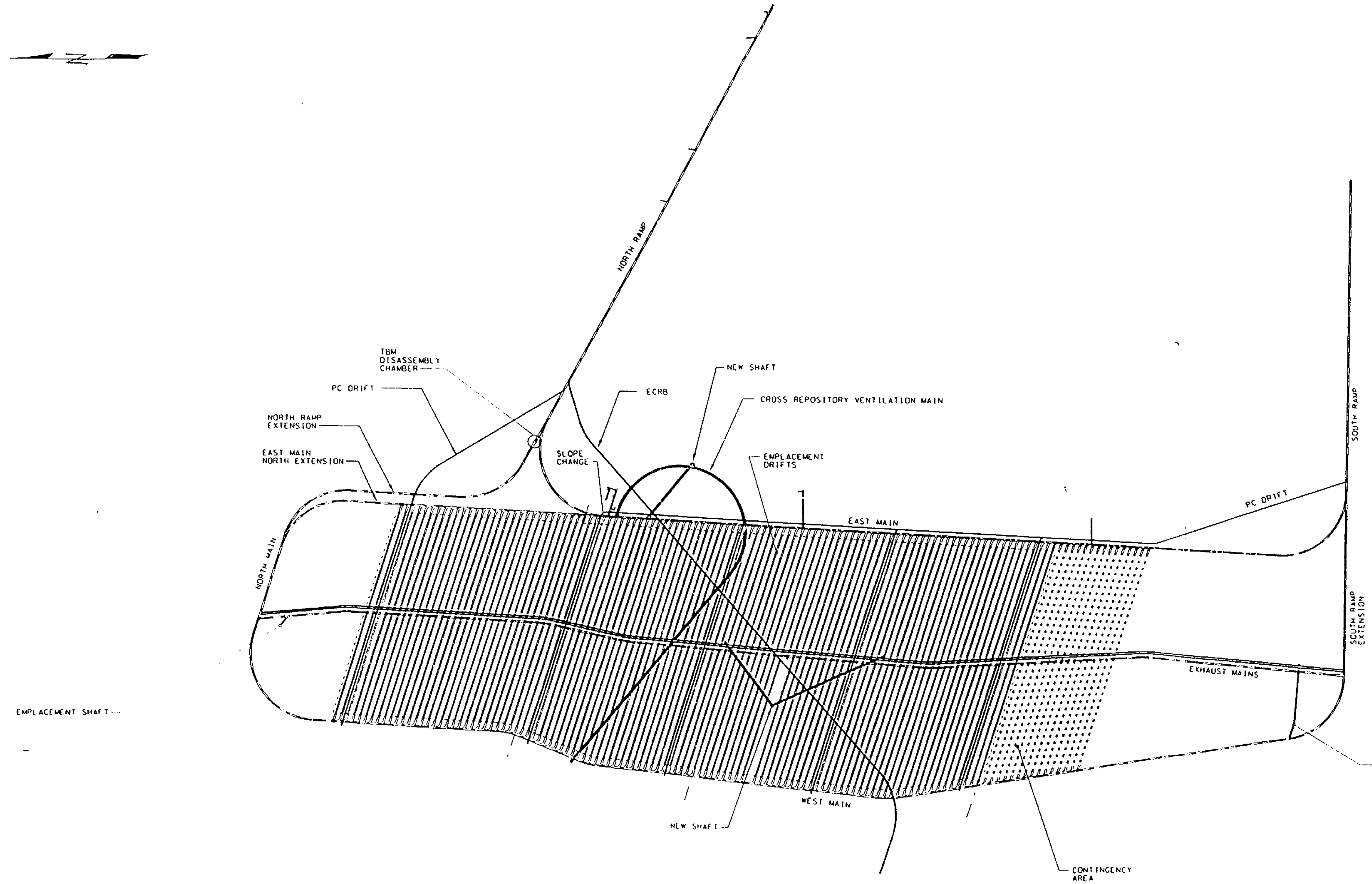
Included on Figure 1 is the Enhanced Characterization of the Repository Block (ECRB) Drift from the *East-West Cross Drift Starter Tunnel Layout Analysis* (CRWMS M&O 1998f). The ventilation model has assumed certain connections based on engineering judgement, such as, connections between the ECRB (5.0m diameter) (CRWMS M&O 1998f, pg 12) and the Exhaust Main. An additional Exhaust Main, additional shafts, and mains have also been included based on engineering judgement. [Used Throughout]

3.2 Nodes and Lengths Used for Modeling

Attachment I shows the nodes and lengths used in the ventilation modeling for this calculation. The number and location of the nodes is based on engineering judgement. The nodes are located at the midpoint of the drift between the crown and invert. All distances are measure from node-to-node to allow the ventilation circuits to be closed. The node-to-node lengths are based on the *Repository Subsurface Layout Configuration Analysis* (CRWMS M&O 1997b) as shown in Figure 1. In order to preclude inconsistencies between the ventilation network and other layout drawings, the figures used are included in Attachment I. All horizontal node-to-node lengths can be determined from these figures. Vertical node-to-node lengths are calculated as shown in Attachment I. [Used in Attachments I, II, and III]

3.3 Airway Resistance, Effective Area, and Perimeter of Mains and Drifts

Table 1 shows the airway resistance (K-factor), effective area, and perimeter of mains and drifts used in the model. The values are based on engineering judgement and the references cited beneath Table 1. [Used in Attachments II, and III]



OVERALL REPOSITORY LAYOUT

NOTES:

1. THIS FIGURE IS FROM CRWMS M&O 1997b PGS. 33 AND 59.
2. NUMBER OF EMPLACEMENT DRIFTS = 105
   NUMBER OF CONTINGENCY DRIFTS = 15
3. ECRB DRIFT FROM CRWMS M&O 1998f PG. 10.
4. ITEMS ADDED BY ENGINEERING JUDGEMENT SHOWN AS "———"

ALL DIMENSIONS ARE SHOWN IN METERS UNLESS OTHERWISE NOTED

FIGURE 1
SUBSURFACE REPOSITORY LAYOUT

Table 1. Airway Resistance, Effective Area, and Perimeter

General Description of Repository Airway	Applicability	Airway Resistance K-Factor		Airway Effective Area (d)		Effective Radius or Dimension (e)		Calculated Perimeter
		(kg/m³)	(lb min/ft⁴ x10⁻¹⁰)	(m²)	(ft²)	(m)	(ft)	(ft)
Waste Ramp	North Ramp & North Ramp Ext	0.0056(a)	30	36.1700	389.33	r=3.51	11.516	72.36
Tuff Ramp	South Ramp & South Ramp Ext	0.0111(a)	60	36.1700	389.33	r=3.51	11.516	72.36
Service Main Drifts	East Main & Extension, West Main, & North Main	0.0130(a)	70	36.1700	389.33	r=3.51	11.516	72.36
Exhaust Main (Typ)	East & West Exhaust Mains	0.0111(a)	60	37.3000	401.49	r=3.51	11.516	72.36
Service Drift	Perf Con (PC) Main & PC Drifts	0.0130(a)	70	19.6300	211.30	r=2.55	8.366	52.57
Service Drift	Enhanced Char Repository Block	0.0130(a)	70	16.5000	177.60	r=2.35	7.710	48.44
Emplacement Drift (Typ)	Emplacement Drifts	0.0158(a)	85	15.6200	168.13	r=2.55	8.366	52.57
Emplacement Drift Empty (Typ)	Empty Emplacement Drifts	0.0158(a)	70	18.7600	201.93	r=2.55	8.366	52.57
Service Drift	Cross-block Drift	0.0130(a)	70	19.6300	211.30	r=2.55	8.366	52.57
Service Drift	Stand-by Drift	0.0130(a)	70	18.7600	201.93	r=2.55	8.366	52.57
Emplacement Raise	Exhaust Main to Emplacement Drift	0.0037	20 (b)	2.2700	24.43	r=0.85	2.789	17.52
Service/Vent Raise	Exhaust Main to PC/Stand-by/ Cross-block Drifts	0.0037	20 (b)	2.2700	24.43	r=0.85	2.789	17.52
Horiz. Raise (Same as above)	Exhaust Main Connector	0.0037	20 (b)	2.2700	24.43	r=0.85	2.789	17.52
VA Emplacement Shaft	Emplacement Vent Shaft	0.0046	25 (c)	29.0300	312.48	r=3.05	10.007	62.87
VA Development Shaft	Development Man/Materials Shaft	0.0176(a)	95 (h)	29.0300	312.48	r=3.05	10.007	62.87
Access Drift	7m x 8m Horse-shoe Shaped Shaft Connecting Drift (g)	0.0046	25 (c)	41.4842(g)	446.53(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)	80.13
LADS-EDA Shaft 6.9m	Emplacement Vent Shaft	0.0046	25 (c)	37.3900(f)	402.49(f)	3.45(f)	11.319(f)	71.12
LADS-EDA Shaft 6.9m	Development Shaft	0.0176	95(h)	37.3900(f)	402.49(f)	3.45(f)	11.319(f)	71.12
LADS-EDA Shaft 9.9m	LADS-EDA Shaft	0.0046	25 (c)	76.9771(f)	828.57(f)	r=4.95(f)	16.240(f)	102.04
Connector Drift	Access Drift to Exhaust Main/ West Main/ East Main	0.0046	25 (c)	36.1700(f)	389.33(f)	r=3.51(f)	11.516(f)	72.36

Notes:

a) From *Controlled Design Assumptions Document* (CRWMS M&O 1998b, pg 7-16).
b) From Hartman (1997, pg 155) for straight, smooth lined, slightly obstructed.
c) From Hartman (1997, pg 155) for straight, smooth lined, slightly obstructed, maximum value.
d) Effective areas from *Calculation of Effective Areas of Subsurface Openings During Emplacement Mode* (CRWMS M&O 1999b, pg50) except as noted.
e) Radius or Dimension from (CRWMS M&O 1999b, pgs 27, 31, 34, 37, 43, 46, and 47) except as noted.
f) Assumption for LADS-EDA items is based on engineering judgement and is consistent with airways sized to handle projected requirements.
g) The horse-shoe shaped access drift is 7m high x 8m wide and is sized by engineering judgement to ensure it does not restrict the air flow from the shaft. The drift is reduced to 6.4m x 7.4m after installation of ground support.
h) The "K" factor value for the man/materials shaft during preclosure is used continually for postclosure. The fixtures for the men and materials capability of the shaft are retained to accommodate transition and future use of the shaft.

3.4 Relative Humidity of Air and Barometric Pressure

The relative humidity of air reporting to the entrance to the emplacement drifts varies from 20 to 40% in the *Overall Development and Emplacement Ventilation Systems* (CRWMS M&O 1997a, pg 20). This is based on current experience of the ESF and NTS tunnels during the winter and summer season. This calculation will use a representative value of 30% relative humidity.

Barometric pressure at the repository horizon of about 1100m *Repository Subsurface Layout Configuration Analysis* (CRWMS M&O 1997b, pg 33) is about 26.2 inches of Hg (88.72 kPa) (Hartman et al., pg 663). These values are existing data and do not require confirmation as they will not be used for construction, fabrication, or procurement of an item. [Used in Attachments VI, VII, VIII and Section 5.5]

3.5 Equivalent Resistance of Stoppings/ Regulators/ Doors

The VNETPC model requires input of the resistance units expected for stoppings or ventilation control devices. These units are equivalent to 1/10 $in.min^2/ft^6$ = $0.1117 \times 10^9\ Ns^2/m^8$. The specific values used in this calculation range from 0.001 to 99,000 units (see the Attachment for specific values). Note that for dummy branches a zero (0) resistance is assumed. [Used in Attachments II & III]

3.6 Average Underground Air Temperature

The average underground air temperature, before the ventilation air has entered the emplacement drifts, is 25°C. An average air temperature value of 23.5°C was calculated in *Air Quality Control Design Analysis* (CRWMS M&O 1998a, pg 19). This analysis will use a slightly higher value because heat from the waste packages will have increased the rock temperature. This value is existing data and does not require confirmation as it will not be used for construction, fabrication, or procurement. [Used in Section 5.1 and Attachment VIII]

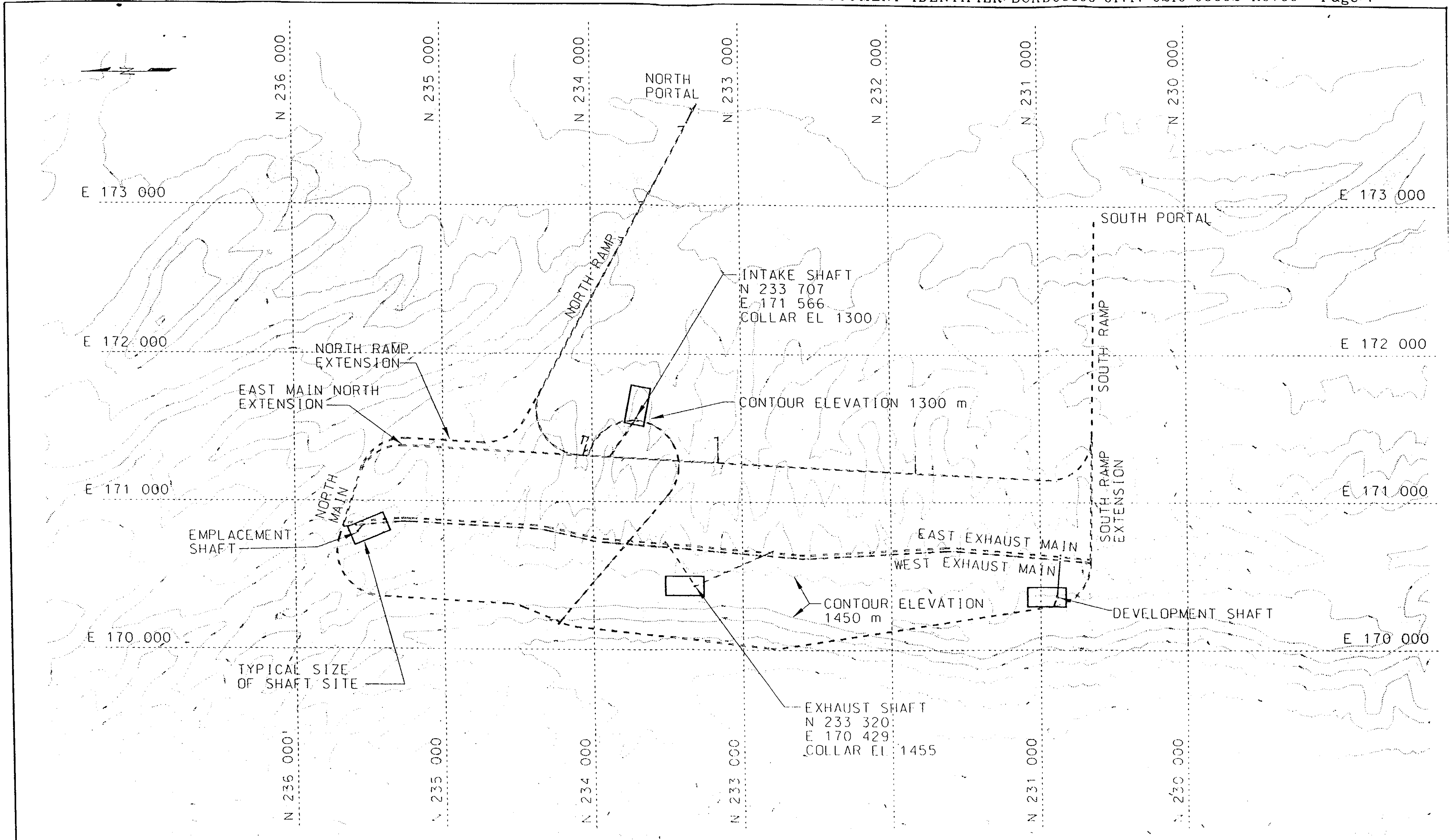
3.7 Emplacement Drift Flow Rates

Flow rates of 0.1 and 1.0 m^3/sec were assumed to flow in each emplacement drift. If a flow rate of 0.1 m^3/sec is assumed then additional shafts and an exhaust main (3.1) will not be required. Additional shafts and an exhaust main will be required for a flow rate of 1.0 m^3/sec. These values are considered reasonable for this calculation. [Used in Attachments II, III, and Sections 5.2 and 5.5.1]

3.8 Elevations of Shafts and Ramps

The following elevations are assumed for shaft collars and ramp portals:

Item	Elevation (m)	Source for Elevation
North Ramp	1123	CRWMS M&O 1996a, pg 27
South Ramp	1160	CRWMS M&O 1996a, pg 27
Development Shaft	1452	CRWMS M&O 1997b, Fig. 7-1
Emplacement Shaft	1455	CRWMS M&O 1997b, Fig. 7-1
Additional Intake Shaft	1300	Estimated from Figure 2
Additional Exhaust Shaft	1455	Estimated from Figure 2



SCALE : NOT TO SCALE

ALL DIMENSIONS ARE SHOWN IN METERS UNLESS OTHERWISE NOTED

NOTE:
CONTOURS FROM "DETERMINATION OF AVAILABLE VOLUME FOR REPOSITORY SITING" (CRWMS M&O 1997c)

FIGURE 2
SURFACE SHAFT LOCATIONS
1.0 m^3/S

This calculation used the software package Vulcan Version 3.3 (TBV) to develop the layouts for the repository for both the VA reference design and the 1 m^3/sec per emplacement drift ventilation models. The Vulcan Model used the *Subsurface Repository Slopes* analysis (CRWMS M&O 1997d) as input for the layout and the *Repository Subsurface Layout Configuration Analysis* (CRWMS M&O 1997b) as input for the shaft coordinates. The following elevations are assumed based on the Vulcan Model:

Item	Elevation (m)
Development Shaft	1089.69
Emplacement Shaft	1020.32
Additional Intake Shaft	1055.86
Additional Exhaust Shaft	1043.20

The elevations for the North and South Ramps are from the Exploratory Study Facilities (ESF) design. The other elevations are existing data and do not require confirmation as they will not be used for construction, fabrication, or procurement. [Used in Section 5.5.1 and Attachment I]

3.9 Average Infiltration Rate

The average infiltration rate for the repository is 5-10 mm/yr from the *Near-Field/Altered-Zone Models Report* (Hardin et al., pg 1-5). This range of flux values is existing data and does not require confirmation. It is conservative to equate the average seepage flux into an emplacement drift to the average infiltration flux at the surface. A range of values is provided because there is variability in the measurement of infiltration flux over an area the size of the repository. [Used in Section 5.5]

3.10 Average Length of Emplacement Drift

An average emplacement drift is 600m long. This value is approximate and is based on a review of the *Repository Subsurface Layout Configuration Analysis* (CRWMS M&O 1997b, Table I-3). This value is existing data and does not require confirmation as it will not be used for construction, fabrication, or procurement. [Used Throughout]

3.11 Psychrometric Properties of Air

Psychrometric properties of air, under various conditions, have been calculated in the *Overall Development and Emplacement Ventilation Systems* (CRWMS M&O

1997a, pg V-3). The relative humidity (30%), specific humidity moisture (52.263 gr/lb of air), and specific volume (15.7 ft^3/lb air) values are existing data and do not require confirmation as they will not be used for construction, fabrication, or procurement. [Used in Attachments VI, VII, & Section 5.5.1]

3.12 Precipitation Over 10,000 Year Period (To Be Verified) (TBV)

This calculation will use an influx rate of 60 mm/yr as representative of the worst case expected and will base its conclusions upon this value. As shown in Assumption 3.9 the current precipitation is in the range of 5-10 mm/yr. The choice of the 60mm/yr value is an engineering judgement as to the worst case conditions expected over the 10,000 year period and is considered conservative. [Used in Section 5.5 and Attachment VIII]

3.13 Control of Ventilation Air

Ventilation air will be controlled by regulators. Regulators will be required in order to split the air as needed to ventilate the emplacement drifts and other repository areas (Hartman et al., pg 255). For this calculation, ventilation air will be assumed to travel the shortest path from entrance to exit. That is, entrance and exit for ventilation air will be relatively close to each other. For example, the air from the North Ramp will generally exit at the Emplacement Shaft and not at other locations. This assumption is a reasonable one as it would be impractical to transfer the ventilation air long distances in the repository. [Used in Attachments II, III, and Section 5.1]

3.14 Rock Wall Temperature Over 10,000 Years (TBV)

An estimate of the drift wall and air temperatures for years 1 through 300 with a ventilation rate of 1 m^3/s is available from *Repository Subsurface Emplacement and Thermal Management Strategy* (CRWMS M&O 1998e, Pg I-42). This data for locations 100, 300, 500 and 600 meters from the intake end of the emplacement drift is shown in Attachment IV, Table IV-1. An estimate of the temperatures on the side of the waste packages and at the rock wall for years 1 through 10,000 (with no ventilation) are available from *Multiple WP Emplacement Thermal Response – Suite 1* (CRWMS M&O 1998c, pg 28). The data in these two tables are used as input to estimate the air and drift wall temperatures that would exist if the emplacement drift were ventilated from 300 to 10,000 years after emplacement. The assumption used in the estimation is that the data can be plotted and the curves for data from Assumption 3.20 can be extended by a hand sketch to be parallel to the unventilated Assumption 3.21 data. The results of the plots are shown in Attachment IV, Figures IV-1 and IV- 2. The output of the estimation is shown in Attachment IV, Table IV-1.The method is considered adequate for this conceptual work. Methods using computer models may appear to be more accurate. However, there is a great deal of uncertainty in the inputs for the computer models when a prediction of conditions 10,000 years in the future is required. [Used throughout]

3.15 Waste Package Side Temperatures (TBV)

The assumption used to determine the waste package side temperature is that the ratio of the waste package skin temperature over the wall rock temperature is constant whether it occurs under no ventilation conditions or under ventilated conditions. The assumption is based on engineering judgement. The input for the waste package side temperature calculation is contained in Assumption 3.21. [Used in Attachment V and Section 5.4]

3.16 Minimum Pillar Width

Drifts crossing underneath one another will have a minimum pillar width of 10 m, similar to the pillar between the emplacement drifts and the Exhaust Main shown in the *Repository Subsurface Layout Configuration Analysis* (CRWMS M&O 1997b, pg 79). Performance Confirmation drifts, including the ECRB, shall be located 15-20m above the emplacement drifts as per the *Subsurface Facility System Description Document* (CRWMS M&O 1998g, Volume I, Item 1.2.1.19). This calculation will use 20m for conservative reasons. This information is existing data and does not have to be confirmed as it will not be used for construction, fabrication or procurement. [Used in Attachments I, II, and III]

3.17 Alcove Dimensions

Alcoves can be many different sizes. For this calculation, alcove dimensions for intake and exhaust raises are 7m high x 8m wide x 10m long to accommodate raise-boring equipment. Raises are located in the center of the alcoves to take into account any deviation of the pilot hole. All dimensions are based on engineering judgement. This information is existing data and does not have to be confirmed as it will not be used for construction, fabrication, or procurement. [Used in Attachments I, II, and III]

3.18 Gas Constant

The gas constant "R" is 53.35 ft lb/ lb mass ^{o}R from Hartman et al., pg 13. [Used in Section 5.5]

3.19 Distance Between Exhaust Mains

The center-to-center distance between Exhaust Mains shall be at least three drift diameters for ground stability (or about 23m for this calculation). This assumption conforms to the advice in Jaeger & Cook (1976, pg. 497). This information is existing data and does not have to be confirmed as it will not be used for construction, fabrication, or procurement. [Used in Attachments I, II, and III]

3.20 Emplacement Drift Air and Rock Wall Temperature (TBV)

Table 2 is from *Repository Subsurface Waste Emplacement and Thermal Management Strategy* (CRWMS M&O 1998e, pg I-42).

Table 2. Emplacement Drift Air and Rock Wall Temperatures with Ventilation

Time after Emplm't (Years)	Temperature °C							
	Air @ 100m	Wall @ 100m	Air @ 300m	Wall @ 300m	Air @ 500m	Wall @ 500m	Air @ 600m	Wall @ 600m
1	34.53	74.19	44.93	77.92	49.44	79.54	50.62	79.96
5	46.81	88.37	72.85	101.67	86.00	109.52	89.80	111.65
10	50.47	93.10	84.79	114.80	104.64	126.49	110.93	130.11
20	51.46	93.47	90.44	121.08	114.81	136.84	123.03	141.91
30	50.86	89.97	91.31	119.84	118.3	137.74	127.83	143.85
40	49.33	85.57	88.87	115.95	116.71	135.33	126.90	142.15
50	47.60	81.09	85.44	111.25	113.37	131.64	123.91	138.98
60	45.93	76.91	81.87	106.39	109.51	127.56	120.21	135.26
70	44.39	73.15	78.38	101.55	105.56	123.40	116.31	131.35
80	43.01	69.80	75.18	97.52	101.74	119.37	112.46	127.47
90	41.80	66.88	72.33	93.71	98.18	115.59	108.82	123.81
100	40.73	64.30	69.74	90.26	94.81	111.98	105.37	120.32
150	38.58	55.80	64.62	79.48	88.01	99.96	98.47	109.66
200	35.97	50.83	58.06	71.60	78.90	90.16	88.87	99.58
250	34.41	47.71	53.58	66.07	72.14	82.97	81.16	91.26
300	33.37	45.51	50.45	62.07	67.23	77.65	75.35	85.09

[Used in Section 5.4 and Attachments IV, V, VII, and VIII]

3.21 Waste Package Side and Rock Wall Temperature (TBV)

Table 3 is from *Multiple WP Emplacement Thermal Response – Suite 1* (CRWMS M&O 1998c, pg 28).

Table 3. Waste Package Side and Rock Wall Temperature w/o Ventilation

Year After Emplacement	WP Side (°C)	Rock Wall (°C)
1	135	97
5	166	139
10	184	163
20	198	181
30	198	184
40	197	185
50	195	183
60	192	182
70	189	180
80	185	177
90	183	175
100	180	173
200	170	165
300	164	160
400	160	156
500	157	154
1000	146	144
1500	139	137
2000	133	132
3000	128	127
4000	129	128
5000	130	129
6000	130	129
7000	130	129
8000	129	129
10000	127	127

[Used in Attachment IV and Section 5.4]

3.22 Bottom of Shaft Elevation for VA Design

The bottom of the emplacement shaft elevation for the VA design is 1038.09m as shown in *Repository Subsurface Layout Configuration Analysis* (CRWMS M&O 1997b, pg IV-2). The bottom of the development shaft is 1110.27m (CRWMS M&O 1997b, pg IV-1). [Used in Attachment I]

3.23 10% Added to All Lengths

A 10% factor has been added to all lengths used in the ventilation models to account for joints and minor misalignments. The factor is based on the lower range specified in Hartman et al., pg 160 for shock losses and ensures a conservative calculation. [Used in Attachments II & III]

3.24 Fan Curves

A Joy-M144-79-590 type fan is used in the VA ventilation model. A Joy-M132-79-710 type fan is used in the 1 m^3/sec ventilation model. The choice of these fans is by engineering judgement. Fan curves from the *Joy Axivane Fans Mining Catalog J-670* are included in Attachments II and III. The permission letter is included in Attachment IX.

3.25 Fan Efficiency and Power Cost

A fan efficiency of 75% has been allowed in the ventilation models. This fan efficiency is conservative and is industry experience for primary fan estimation purposes. A power cost of \$0.10 per kilowatt hour has been allowed in the ventilation models. This value is considered reasonable for estimation purposes. Both values are existing data and do not have to be confirmed as they will not be used for construction, fabrication, or procurement. [Used in Attachments II and III]

3.26 Maximum Grade for Excavation

The maximum grade for excavation is ± 3 % from the *Subsurface Facility System Description Document* (CRWMS M&O 1998g, Item 1.2.4.2). [Used in Attachment I]

3.27 Turning Radius for a Tunnel Boring Machine (TBM)

The minimum turning radius for a TBM is 305m from the *Subsurface Construction and Development Analysis* (CRWMS M&O 1998i, pg II-5). This value provides the radius for curves used in Figure I-4. This radius is existing data and does not have to be confirmed as it will not be used for construction, fabrication, or procurement.

4. USE OF COMPUTER SOFTWARE

Word processing (Microsoft Word) and spreadsheet (Microsoft Excel) software were used for the main body of this calculation. The use of common, off-the-shelf computer programs do not require validation and verification under the applicable M&O procedures.

A simulation of the repository ventilation network was constructed using VNETPC Software, Windows Version 1.0a. The software was appropriate for this use and used only within its validated range as described in the *Software Qualification Report for VNETPC for Windows: Version 1.0a* (CRWMS M&O 1999a). This software was obtained from and designated by the Software Configuration Manager with an identifier of CSCI 30029 V1.0a. This program was run on a Gateway 2000 computer, model P5-166. The input and output for this program are shown in Attachments I, II, III, and are discussed in Section 5.2.

The conceptual layouts in this calculation 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 to be 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.

5. CALCULATION

This calculation is divided into several sections. The first section discusses how the natural ventilation pressure is determined. The next section discusses the output and other aspects of the VNETPC ventilation simulation. A section is devoted to a discussion of how the air temperature, thermal information was extended from the *Repository Subsurface Waste Emplacement and Thermal Management Strategy* (CRWMS M&O 1998e). A section discusses how the waste package skin temperature, calculated in the *Multiple WP Emplacement Thermal Response- Suite I* (CRWMS M&O 1998c) (with no ventilation), was modified to the present situation that does include ventilation. A section is included that discusses how the air moisture was determined. The final section summarizes the air temperature, air moisture, and waste package skin temperature over a 10,000 year period.

5.1 Determination of Natural Ventilation Pressure

A determination of natural ventilation pressure can be made using the formula contained in Hartman et al., p 298.

$$H_n = 44\ \text{Pa}/\ 10^{o}\text{C}/\ 100\text{m} \qquad \text{or} \qquad H_n = 0.03\ \text{in}/\ 10^{o}\text{F}/\ 100\ \text{ft} \qquad \text{(Equation \#1)}$$

This means that 44 Pascals of natural ventilation pressure will be developed for each difference in air temperature of 10°C and each 100m difference in elevation.

Natural ventilation pressure (NVP) can change with the temperature differences caused by the seasons. For this calculation, ambient conditions of natural rock temperature, seasonal surface temperature and barometric fluctuations will be neglected. These simplifications ensure the calculation will be conservative, as only the temperature

difference in the emplacement drift and elevation change between intake and exhaust will be considered. Table 4 is a simplified version of the NVP expected in the repository.

Table 4. Simplified Natural Ventilation Pressure Table

Path	Δ Elev (m) (3.8)	Δ Temperature (°C)	NVP (Pa)	Calculation
N. Ramp-E. Shaft	1455-1123=332	35	511	44(35/10)(332/100)
S. Ramp-D. Shaft	1452-1160=292	35	450	44(35/10)(292/100)
New I. Shaft –New E. Shaft	1455-1300=155	35	239	44(35/10)(155/100)

Note: For this example, intake temperature = 25°C (3.6) and exhaust temperature = 60°C. The 60°C air temperature is used as an example in Table 4. The air temperature at the exit will vary over time because the heat generated by the waste package will change. Attachment VIII shows how NVP will vary over time.

5.2 Ventilation Simulation

The repository layout (3.1) shown in Figure 1 was used for this calculation. A simplified version of the layout is shown in Attachment I. The repository layout can be simplified because of the parallel and similar nature of the emplacement drifts. The 105 drifts shown in Figure 1 has been reduced to 19 drifts.

A VNETPC simulation was run that distributed a relatively equal volume of air to the emplacement drifts. This simulation used mechanical fans to power the system (see Attachment III). The same layout configuration was analyzed using NVP as the driving force. This simulation revealed that a volume of at least 0.1 m^3/sec could be achieved in each emplacement drift. However, a volume of 1 m^3/sec could not be achieved with the VA reference design (3.7) over the 10,000 year period for this calculation.

A new layout design was developed by the addition of new intake and exhaust shafts to achieve 1.0 m^3/sec per emplacement drift . In addition a new Exhaust Main was added parallel and adjacent to the original Exhaust Main. This additional Exhaust Main will accept all flow from the emplacement drifts, the other Exhaust Main will accept all airflow's from the rest of the repository. The exhaust tubes in the Exhaust Main were removed to reduce the resistance in the main for the new layout.

The air entering the repository under natural ventilation conditions will need to be regulated to ensure that the correct amount of air flows in each emplacement drift (3.13). Although the design of these air regulators is outside the scope of this analysis, it is noted that they will be required to function for up to 10,000 years.

5.3 Determination of Temperatures Over 10,000 Years

Attachment IV is developed using Assumption 3.14. Attachment IV plots temperature information for the period 1-10,000 years from the *Multiple WP Emplacement Thermal Response- Suite 1* (CRWMS M&O 1998c) calculation. This information is for emplacement drifts with no ventilation. This information is used to extend the

emplacement drift temperatures (with ventilation) found in the *Repository Subsurface Waste Emplacement and Thermal Management Strategy* (CRWMS M&O 1998e) analysis.

5.4 Determination of Waste Package Side Temperature

Waste package side temperature has been determined for the first 10,000 years of repository life with no ventilation (Assumption 3.21). Table 5 shows the calculation of the ratio of WP side temperature over rock wall temperature (Assumption 3.15). Attachment V takes the rock wall temperature shown in Attachment IV and multiplies it by the ratio shown below for 100m, 300m, and 500m intervals for the period 1-10,000 years.

Table 5. Calculation of Waste Package Side Temperature

	Temperature °C – 600 m				
Year	**Rock Wall[1] with vent.**	**WP Side[2] w/o vent.**	**Rock Wall[2] w/o vent.**	**Ratio (WP/RW)**	**WP Side Temperature with ventilation**
1	79.96	135	97	1.3918	111
5	111.65	166	139	1.1942	133
10	130.11	184	163	1.1288	147
20	141.91	198	181	1.0939	155
30	143.85	198	184	1.0761	155
40	142.15	197	185	1.0649	151
50	138.98	195	183	1.0656	148
60	135.26	192	182	1.0549	143
70	131.35	189	180	1.0500	138
80	127.47	185	177	1.0452	133
90	123.81	183	175	1.0457	129
100	120.32	180	173	1.0405	125
150	109.66	174*	168*	1.0357	114
200	99.58	170	165	1.0303	103
250	91.26	167*	163*	1.0245	93
300	85.09	164	160	1.0250	87
400	79	160	156	1.0256	81
500	74	157	154	1.0195	75
1000	65	146	144	1.0139	66
1500	59	139	137	1.0146	60
2000	55	133	132	1.0076	55
3000	54	128	127	1.0079	54
4000	53	129	128	1.0078	53
5000	52	130	129	1.0078	52
6000	51	130	129	1.0078	51
7000	50	130	129	1.0078	50
8000	50	129	129	1	50
10000	50	127	127	1	50

Notes: 1) Rock Temperatures from Table 2 (3.20) for the period 1-300 years. Rock Temperatures from Table IV-1 for the period 400-10,000 years.

2) Waste Package Side and Rock Wall temperature from Assumption 3.21. Values shown with an "*" are estimated.

5.5 Air Moisture Determination

A determination of the moisture in the air can be made by adding the moisture contained in the outside air to the moisture picked up by the air as it travels through the repository. This is accomplished as will be described below. This section of this calculation will be calculated in English units and then converted to SI units as this matches the information in Attachments VI and VII.

5.5.1 Mass of Water Added to Air

The average precipitation over the repository is 5-10 mm/year (3.9). This section will use 10 mm/yr as an example. In addition an average emplacement drift is 600m long (3.10) and 5.5m in diameter (3.1) (TBV-333). The ventilation rate is assumed to be 1.0 m^3/sec (3.7).

Step	Name	Calculation	Result
1)	Influx of water		10 mm/yr
2)	Influx of water (inches)	10mm/ 25.4mm/in	0.3937 in/yr
3)	Influx of water (feet)	0.3937in/ 12in/ft	0.03281 ft/yr
4)	Area (ft^2)	(600m)(5.5m)/$(0.3048)^2$$ft^2$/$m^2$	36,000 ft^2
5)	Volume of Water	0.03281ft/yr x 36,000ft^2	1181.1 ft^3/yr
6)	Mass of Water/Year	1181.1ft^3/yr x 62.4 lb/ft^3	73,700 lb/yr
7)	Mass of Water/Minute	73700lb.yr/(365 x 24 x 60)	0.14022 lb/min
8)	Grains of Water/Minute	0.14022lb/min x 7000 gr/lb	981.54 gr/min
9)	Volume of Air in Drift/Min	1 m^3/sec = 2119 ft^3/min	2119 ft^3/min
10)	Mass of Air in Drift/Minute	2119ft^3/min /15.7ft^3/lb air*	134.968 lb/min
11)	Grains Water/Pound Air	981.54/134.968	7.272 gr/lb of air
12)	Mass of Water @ 30% RH		52.263 gr/lb of air**
13)	Total Mass of Water	7.272 + 52.263	59.5 gr/lb of air

Notes:
1) * 15.7 ft^3/lb of air (3.11)
2) ** 52.263 gr/lb of air (3.4 & 3.11)

3) Attachment VI is an expansion of this calculation and uses 60 mm/yr precipitation (3.12).
4) The unit "grains" is used because of the small masses involved in this calculation.

Information from Attachment VI will provide input to Attachment VII to determine the relative humidity of air in the emplacement drifts.

5.5.2 Development of Psychrometric Chart

The following equations are from Hartman et al., pgs 14-16.

$$P_b = P_a + P_v \qquad \text{(Equation \#2)}$$

P_b = Barometric Pressure in inches of Hg
P_a = Partial Pressure of Dry Air (in. Hg)
P_v = Water Vapor Pressure (in. Hg)

The specific humidity is calculated:

$$W = 0.622\ [P_v/\ (P_b - P_v)]\ \text{lb/lb of dry air} \qquad \text{(Equation \#3)}$$

If Equation #3 is multiplied by 7000 the result will be expressed in grains/ lb dry air. An example how to calculate the grains/ lb of dry air was done in Section 5.5.1.

The specific volume is calculated:

$$v = RT_d/\ P_a\ \ (\text{ft}^3/\text{lb}) \qquad \text{(Equation \#4)}$$

v = Volume per unit weight of Air
T_d = Absolute Dry-Bulb Temperature (^oR)
R = Gas Constant (53.35 ft lb/lb mass ^oR) (3.18)
P_a = Partial Pressure of Dry Air (lb/in^2)

The saturation vapor pressure at the dry bulb temperature is calculated:

$$P_s = 0.18079 \exp((17.27t_d - 552.64)/(t_d + 395.14)) \qquad \text{(Equation \#5)}$$

P_s = Saturation Vapor Pressure- Dry Bulb (in. Hg)
t_d = Dry Bulb Temperature (^oF)

The saturation vapor pressure at the wet bulb temperature is calculated:

$$P_s' = 0.18079 \exp((17.27t_w - 552.64)/(t_w + 395.14)) \qquad \text{(Equation \#6)}$$

P_s' = Saturation Vapor Pressure- Wet Bulb (in. Hg)
t_w = Wet Bulb Temperature (^oF)

The partial pressure of water vapor is calculated:

$$P_v = P_s' - ((P_b - P_s')(t_d - t_w)/ (2800 - 1.3t_w)) \text{ in. Hg} \qquad \text{(Equation \#7)}$$

Equation #6 can be substituted into Equation #7. Given that Partial Pressure of Water Vapor (P_v) has already been calculated, the Wet Bulb Temperature (t_w)can be determined. This equation is not shown.

The relative humidity is calculated:

$$\text{Relative Humidity} = (P_v/P_s) \times 100\% \qquad \text{(Equation \#8)}$$

Enthalpy is calculated:

$$h = 0.24t_d + W(1060 + 0.45t_d) \qquad \text{(Equation \#9)}$$

h = Btu/ lb dry air

Attachment VII uses these formulas to determine the relative humidity over the 10,000 year period. Some of the numbers in Attachment VII are not exact, due to rounding of some values.

Attachment VI uses a relative humidity of 30% and a precipitation amount of 60 mm/year. The 30% relative humidity of the emplacement drift inlet air was chosen as per Assumption 3.4. The 60 mm/yr value (3.12) was chosen in order to be very conservative. This precipitation amount introduces more moisture into the emplacement drift.

The total mass of water calculated in Attachment VI does not exactly match the moisture shown in column "M" of Attachment VII. Attachment VI was based on the formulas detailed above. The wet bulb temperature (Attachment VII, column "e") was adjusted until the moisture content in column "M" nearly matched the value calculated in Attachment VI. The relative humidity that was determined in Attachment VII (column "K") was the basis for the relative humidity shown in Attachment VIII.

6. RESULTS

A summary of results can be found in Attachment VIII. All results from this calculation are TBV because of the number of assumptions made and because of inputs that are also TBV. The results from this calculation will not be added to the formal To Be Verified/ To Be Determined (TBV/TDB) tracking process because of the conceptual and preliminary nature of the information

7. REFERENCES

CRWMS M&O (Civilian Radioactive Waste Management System Management and Operating Contractor) 1996a. *ESF Layout Calculation.* BABEAD000-01717-0200-00003 REV 04. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19960930.0095.

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

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

CRWMS M&O 1998a. *Air Quality Control Design Analysis.* BCAD00000-01717-0200-00008 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980729.0044.

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

CRWMS M&O 1998c. *Multiple WP Emplacement Thermal Response – Suite 1.* BBA000000-01717-0210-00001 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980807.0311.

CRWMS M&O 1998d. Not Used.

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

CRWMS M&O 1998h. Not Used.

CRWMS M&O 1998i. *Subsurface Construction and Development Analysis*. BCA000000-01717-0200-00014 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19981124.0367.

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

CRWMS M&O 1999b. *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.

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

Hardin, E.L.; Blair, S.C.; Bourcier, W.L.; Buscheck, T.A.; Chesnut, D.A.; DeLoach, L.D.; Glassley, W.E.; Johnson, J.W.; Knapp, R.B.; Knauss, K.G.; Lee, K.; Meike, A.; Myers, K.; Nitao, J.J.; Palmer, C.E.; Rogers, L.L.; Rosenberg, N.D.; Viani, B.E.; Wittwer, C.; and Wolery, T.J. *Near-Field/ Altered-Zone Models Report*. UCRL-ID-129179. Milestone Report SP3100M3. Livermore, California: Lawrence Livermore National Laboratory. ACC: MOL.19980630.0560.

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.

Jaeger, J.C. and Cook, N.G.W. 1976. *Fundamentals of Rock Mechanics, Second Edition*. John Wiley & Sons, Inc. New York, New York. TIC: 209863.

8. ATTACHMENTS

Attachment I (8 pages)	VNETPC Items Common to Both Attachment II & III
Attachment II (24 pages)	VNETPC Ventilation Model for VA Layout
Attachment III (29 pages)	VNETPC Developed Ventilation Model for Airflow at 1.0 m^3/s per emplacement drift
Attachment IV (3 pages)	Air and Rock Wall Temperatures Over 10,000 Years
Attachment V (1 page)	Rock Wall and WP Side Temperatures Over 10,000 Years

Attachment VI (1 page)	Prediction of Moisture Content for Ventilation Air at Intermediate Location in Emplacement Drift @ Natural Ventilation Airflow = 1.0 m^3/s
Attachment VII (5 pages)	Predicted Psychrometric Properties of Ventilation Air in Repository Emplacement Side
Attachment VIII (1 page)	Air and Drift Wall Temperature, Relative Humidity (RH), and WP Skin Temp Output
Attachment IX (3 pages)	Permission Letter to use Curves

Attachment I

VNETPC Items Common to Both Attachments II & III

This attachment includes Figures showing the ventilation layouts for the no ventilation (VA reference design) and the $1m^3$/sec per emplacement drift ventilation simulations. Horizontal distances used in this calculation have been noted on Figure I-2. The vertical distances and certain other nodes are described below.

1) Emplacement Drift (ED) to Exhaust Main (EM) Raises:

   Applies to Nodes : 402-502; 410-510; 415-515; 422-522; 430-530; 438-538; 445-545; 453-553; 460-560; 466-566; 475-575; 495-595; 4105-5105; 4120-5120

   Node-to-Node Length:

   ½ ED diameter (Assumption 3.1) + ED to EM pillar (3.16) + ½ EM diameter (3.1) = ½ (5.5) + 10 + ½ (7.62) = 16.56, varies between 16.6 and 17.3m to maintain line and grade on the mains.

2) Performance Confirmation (PC) to EM Raises

   Applies to Nodes: 403-503; 433-533

   Node-to-Node Length:

   ½ PC Drift diameter (3.1) + PC to ED pillar (3.16) + ED diameter (3.1) + ED to EM pillar (3.16) + ½ EM diameter (3.1)
   ½ (5.5) + 20 + 5.5 + 10 + ½ (7.62) = 42.06m, varies between 42.1 and 42.3m to maintain line and grade on the mains.

3) PC and ECRB to EM Raises

   Applies to Nodes: 456-556; 467-567; 480-580; 4103-5103

   Node-to-Node Length

   ½ PC Drift diameter (3.1) + PC to ED pillar (3.16) + ED diameter (3.1) + ED to EM pillar (3.16) + ½ EM diameter (3.1)
   ½ (5.5) + 20 + 5.5 + 11 + ½ (7.62) = 43.06m, varies between 42.5 and 42.8m to maintain line and grade on the mains. The ED to EM pillar slightly larger than minimum to preserve line & grade on ED or EM.

4) Horizontal Raise Connector of Exhaust Mains (connects between E & W EM)

Applies to Nodes: 502-602; 503-603; 510-610; 515-615; 522-622; 530-630; 533-633; 538-638; 545-645; 553-653; 556-656; 560-660; 566-666; 567-667; 575-675; 580-680; 595-695; 5103-6103; 5105-6105; 5120-6120
Node-to-Node Length:

Node-to-node lengths are developed on Figure I-2.

5) Emplacement Shaft for 1 m^3/sec Simulation

Applies to Nodes: 17-605

Node-to-Node Length:

Surface Elevation (3.8) – Bottom of Shaft (3.8)- ½ Access Drift height (3.3)
1455- 1020.32- ½ (7) = 431.18 rounds to 431.2m

5a) Emplacement Shaft for VA reference design

Applies to Nodes: 17-605

Node-to-Node Length:

Surface Elevation (3.8) – Bottom of Shaft (3.22) – ½ Access Drift height (3.3)
1455- 1038.09- ½ (7) = 413.41 rounds up to 413.5m

6) Development Shaft for 1 m^3/sec Simulation

Applies to Nodes: 16-14

Node-to-Node Length:

Surface Elevation (3.8) – Bottom of Shaft (3.8) – ½ Access Drift height (3.3)
1452-1089.69 – ½ (7) = 358.81 rounds to 358.8m

6a) Development Shaft for VA reference design

Applied to Nodes: 16-14

Node-to-Node Length:

Surface Elevation (3.8) - Bottom of Shaft (3.22) – ½ Access Drift height (3.3)
1452-1110.27- ½ (7) = 338.23 rounds to 338.2m

7) Intake Shaft for 1m^3/sec Simulation

Applies to Nodes: 24-25

Node-to-Node Length:

Surface Elevation (3.8) – Bottom of Shaft (3.8) – ½ Access Drift height (3.3)
1300- 1055.86- ½ (7) = 240.64 rounds down to 240.3m

8) Exhaust Shaft for 1m^3/sec Simulation:

Applies to Nodes: 28-29

Node-to-Node Length:

Surface Elevation (3.8) – Bottom of Shaft (3.8) – ½ Access Drift height (3.3)
1455- 1043.20- ½ (7) = 408.3m

9) East EM to West EM Raise (see sketch at bottom)

Applies to Nodes: 660-26; 680-27; 23-21

Node-to-Node Length:

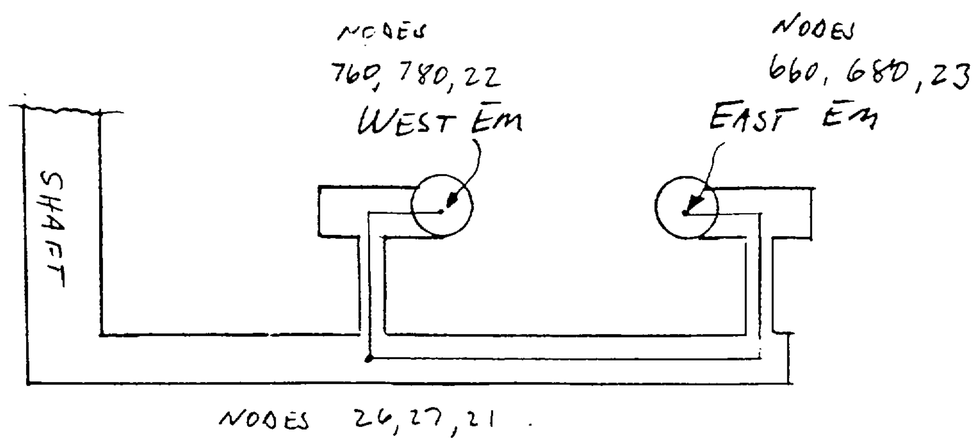
½ East EM diameter (3.1) + ½ Alcove length (3.17) + ½ East EM diameter (3.1) + EM to Access Drift pillar (3.16) + ½ Access Drift height (3.3) + ½ Alcove length (3.17) + ½ East EM diameter (3.1) + distance between East & West EM (3.19) + ½ West EM diameter (3.1) + ½ Alcove length (3.17)
½ (7.62) + ½ (10) + ½ (7.62) + 10 + ½ (7) + ½ (10) + ½ (7.62) + 23 + ½ (7.62) + ½ (10) = 66.74, varies between 66.6 and 67.0m to maintain line and grade on the mains.

10) West EM to Drift Connector (see sketch at bottom)

Applies to Nodes: 22-21; 760-26; 780-27

Node-to-Node Length:

½ West EM diameter (3.1) + ½ Alcove length (3.17) + ½ West EM diameter (3.1) + EM to Access Drift pillar (3.16) + ½ Access Drift height (3.3)
½ (7.62) + ½ (10) + ½ (7.62) + 10 + ½ (7) = 26.12 rounds to 26.1m



11) Connecting Access Drift

Applies to Nodes: 26-28

Node-to-Node Length:

Distance from Figure I-4 + ½ Alcove length (3.17)
300.6 + 5 = 305.6m

12) Connecting Access Drift

Applies to Nodes: 27-28

Node-to-Node Length:

Distance from Figure I-4 + ½ Alcove length (3.17)
501.7 + 5 = 506.7m

13) Shaft Connecting Drift

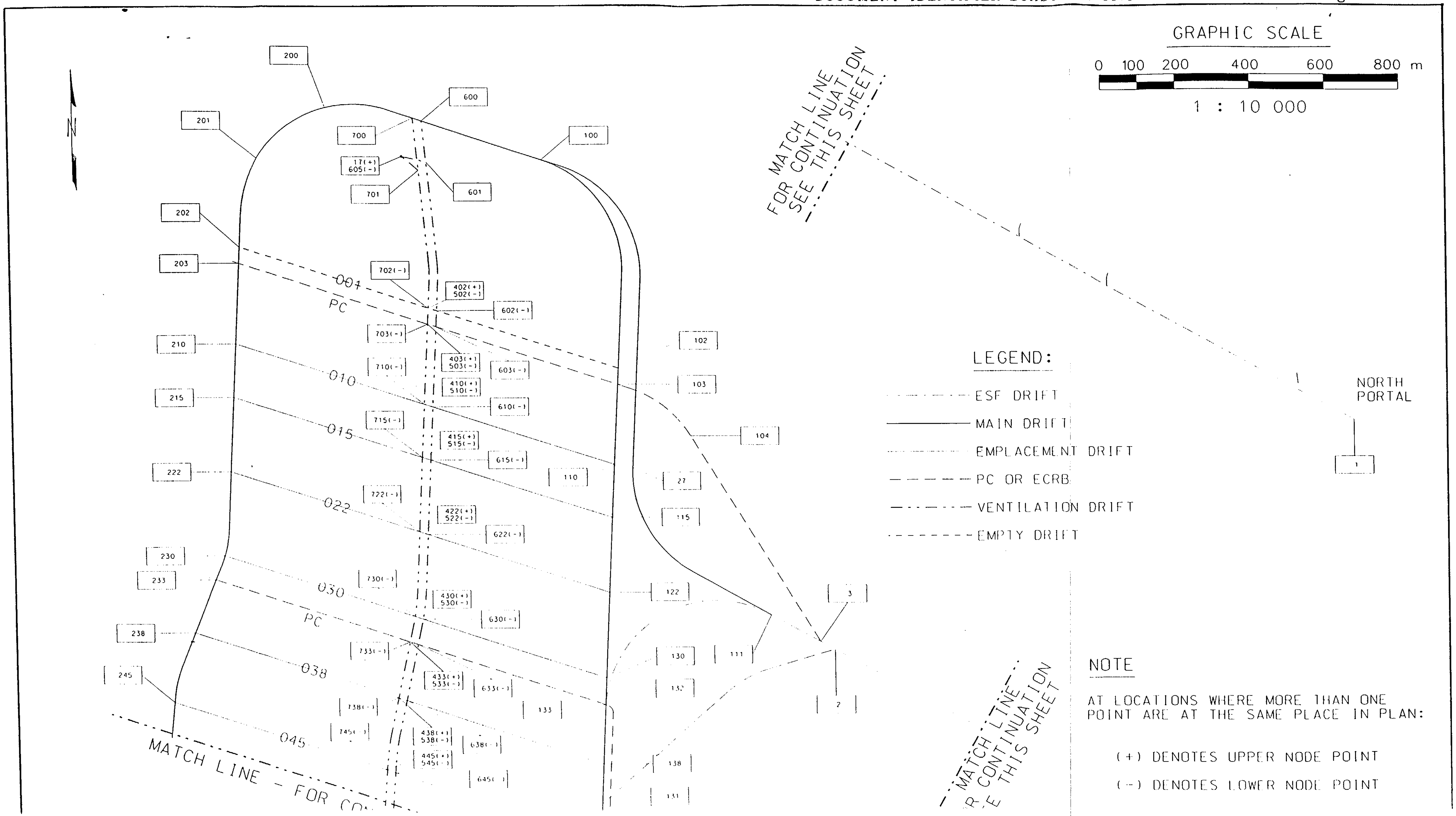
Applies to Nodes: 25-245

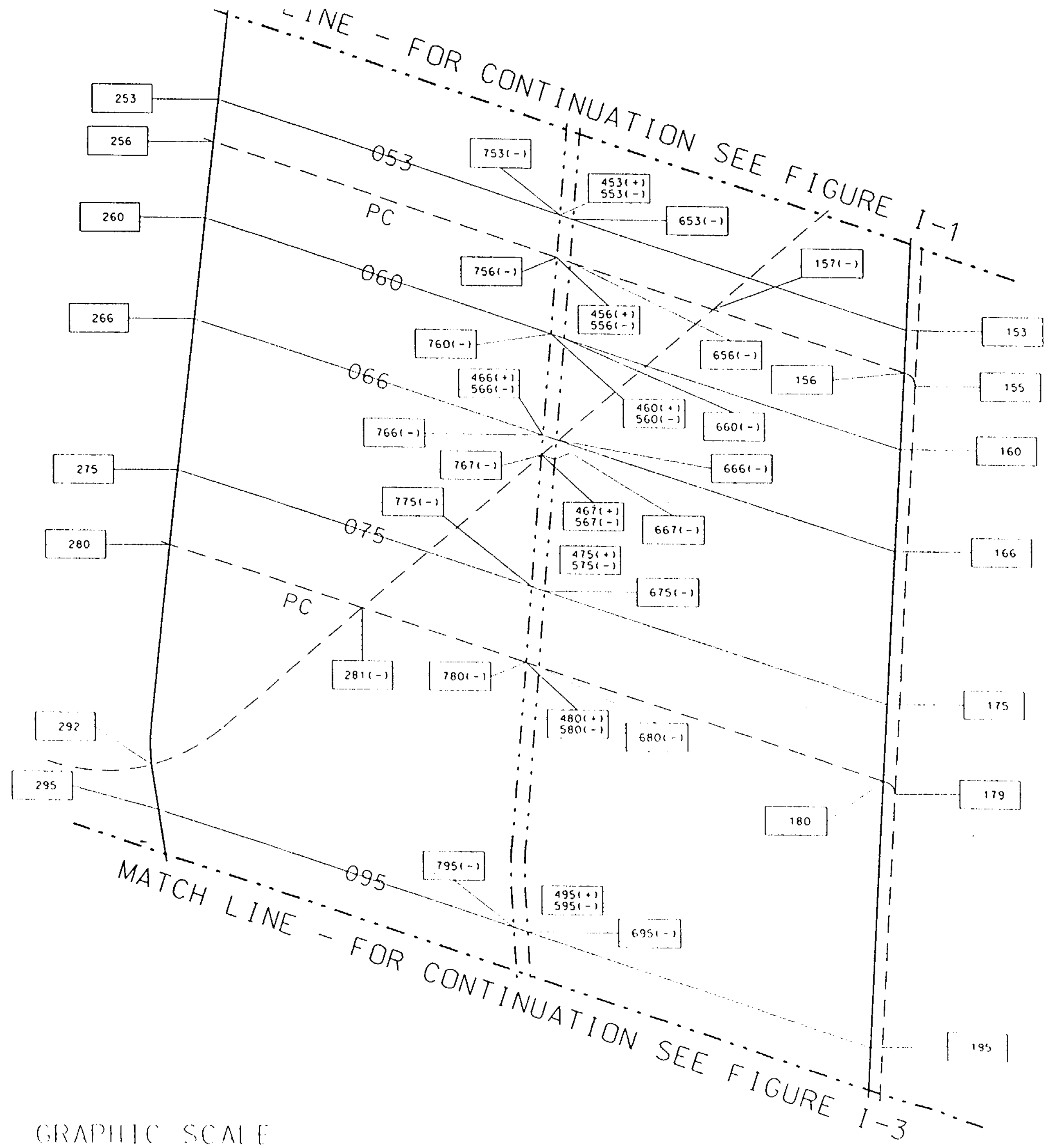
Node-to-Node Length:

Distances from Figure I-4 + approximate elevation difference from Figure I-4 + ½ Alcove length (3.17) + ½ Drift diameter (3.1)
(696.8+447.2+242.5+436.9) + (1067.99-1035.38) + ½ (10) + ½ (7.62) = 1864.8m

Note for Items 9 & 10:

A pattern of drift or raise construction is shown in the calculation to determine the length of the airway. To simplify the VNETPC simulation, the average feature of a horseshoe shaped connector for nodes 23-21, and 22-21 is used. The other connectors for nodes 660-26, 760-26, 680-27, and 780-27 used an equivalent round access drift similar to a 7.62m diameter main.


GRAPHIC SCALE
0 100 200 400 600 800 m
1 : 10 000
MATCH LINE FOR CONTINUATION SEE THIS SHEET
LEGEND:
ESF DRIFT
MAIN DRIFT
EMPLACEMENT DRIFT
PC OR ECRB
VENTILATION DRIFT
EMPTY DRIFT
NORTH PORTAL
NOTE
AT LOCATIONS WHERE MORE THAN ONE POINT ARE AT THE SAME PLACE IN PLAN:
(+) DENOTES UPPER NODE POINT
(-) DENOTES LOWER NODE POINT
MATCH LINE - FOR CO
001
PC
010
015
022
030
PC
038
045
200
201
202
203
210
215
222
230
233
238
245
600
700
100
17(+)
605(-)
701
601
702(-)
402(+)
502(-)
602(-)
703(-)
403(+)
503(-)
603(-)
710(-)
410(+)
510(-)
610(-)
715(-)
415(+)
515(-)
615(-)
722(-)
422(+)
522(-)
622(-)
730(-)
430(+)
530(-)
630(-)
733(-)
433(+)
533(-)
633(-)
738(-)
745(-)
438(+)
538(-)
445(+)
545(-)
638(-)
645(-)
102
103
104
110
27
115
122
3
130
111
132
133
2
138
1



GRAPHIC SCALE

0 100 200 400 600 800 m

1 : 10 000

NOTE

* DIMENSION INCLUDE VENT RAISE

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	

	[illegible]
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	

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	
	576.4 *
433	
	576.4 *
133	
533	
	23.1
633	
567	
	23.6
667	

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	
	637.1 *
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	

	366.5 *
281	
	290.1
480	
	656.6 *
180	
580	
	23.8
680	
295	
	629.0
495	
	629.0
195	
595	
	24.7
695	
2103	
	630.8 *
4103	
	630.8 *
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	

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	
	476.3 *
292	
1102	
	31.6
1103	
179	
	31.6
180	
155	
	31.6
156	
	362.9 *
157	
	274.2
456	
132	
	31.6
133	
4	
	1402.6
5	
	49.2
6	
100	
	1543.0
111	
	698.5
130	

FIGURE I-2 - SUBSURFACE REPOSITORY VENTILATION NODES - SYSTEM A DISTANCES BETWEEN NODES

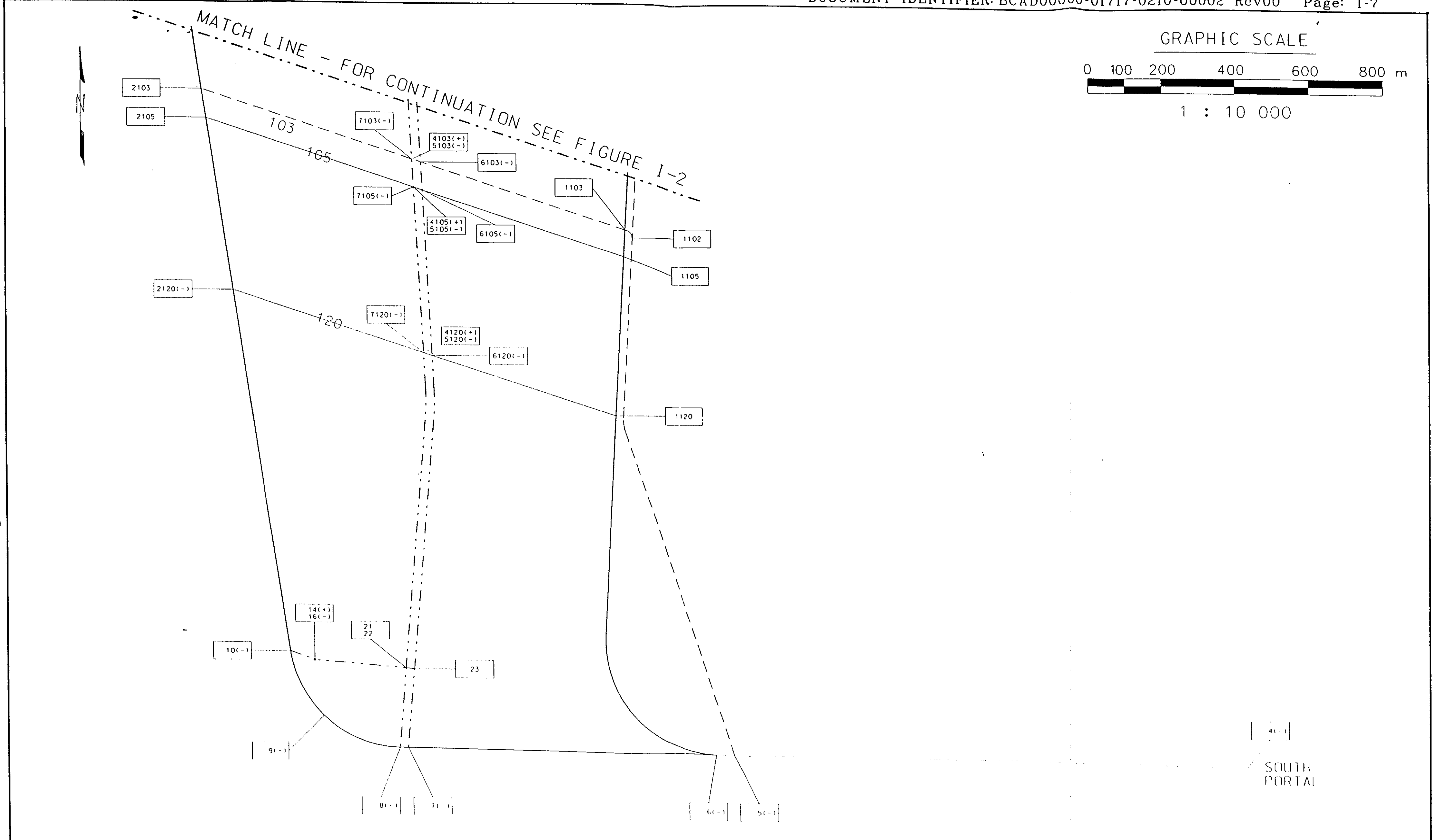
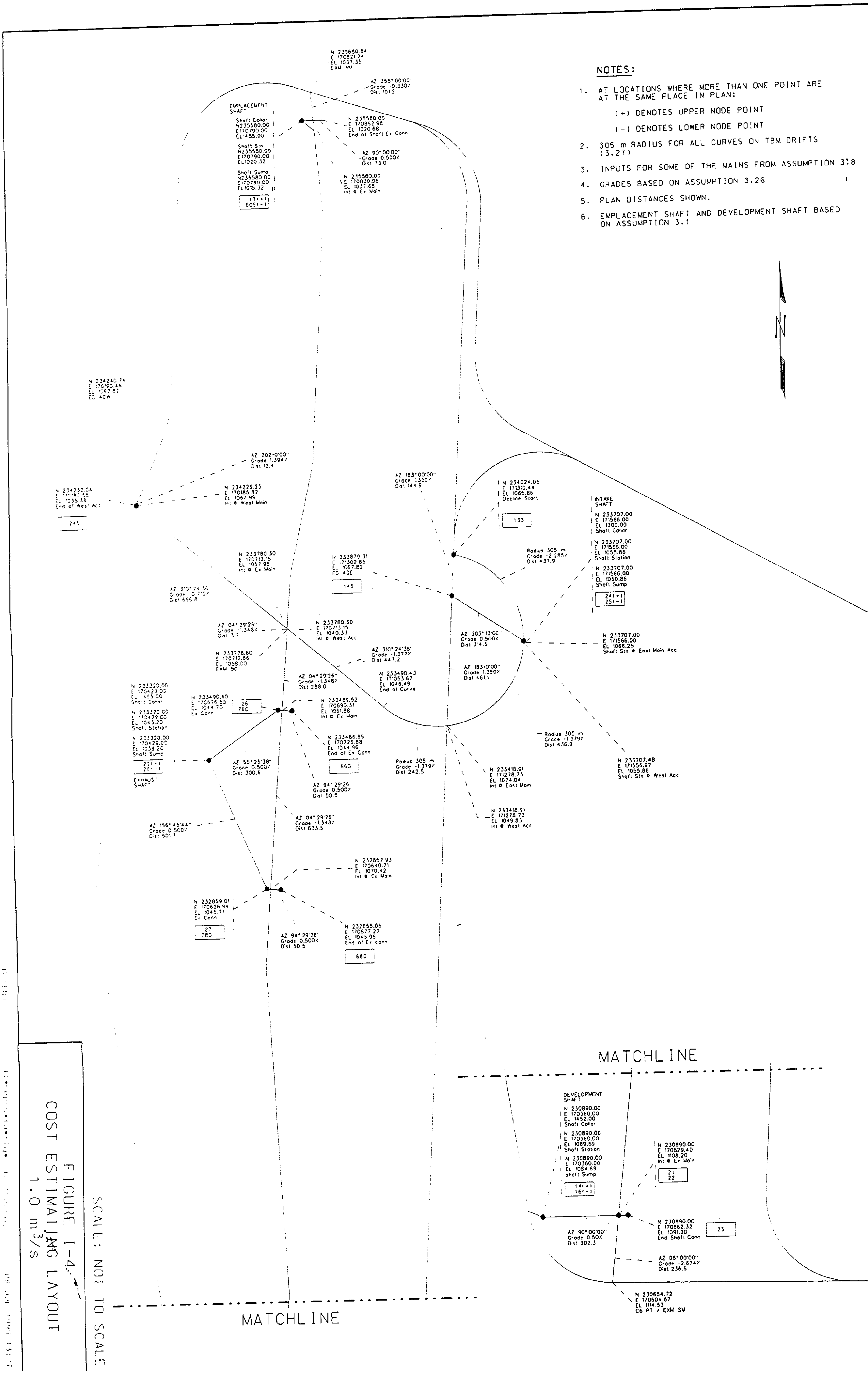


FIGURE I-3 - SUBSURFACE REPOSITORY
VENTILATION NODES - SYSTEM A
DISTANCES BETWEEN NODES



Title: Post Closure Open - Loop Natural Ventilation

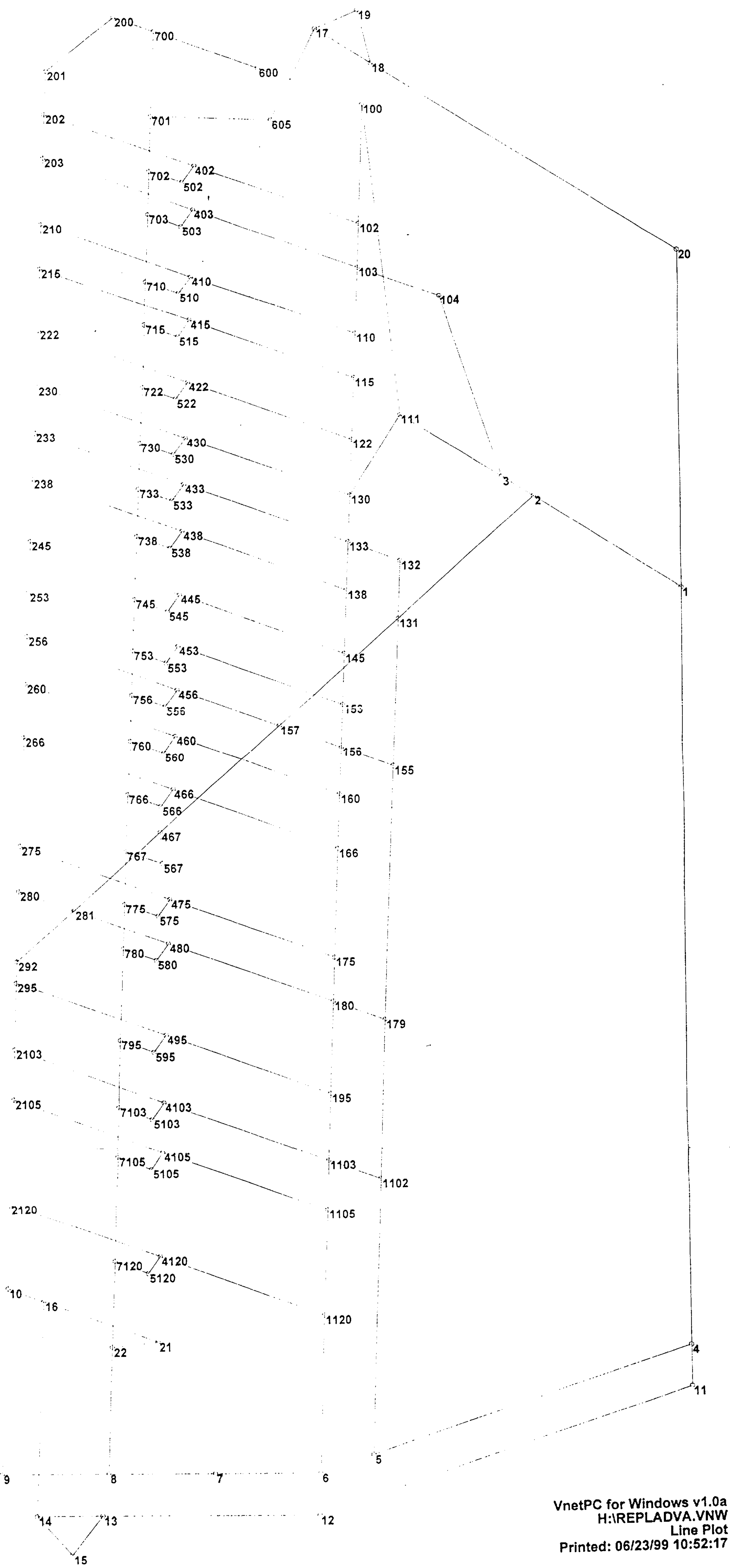
DOCUMENT IDENTIFIER: BCAD0000-01717-0210-00002 Rev00 Page: I-8

VNETPC Ventilation Model for VA Layout

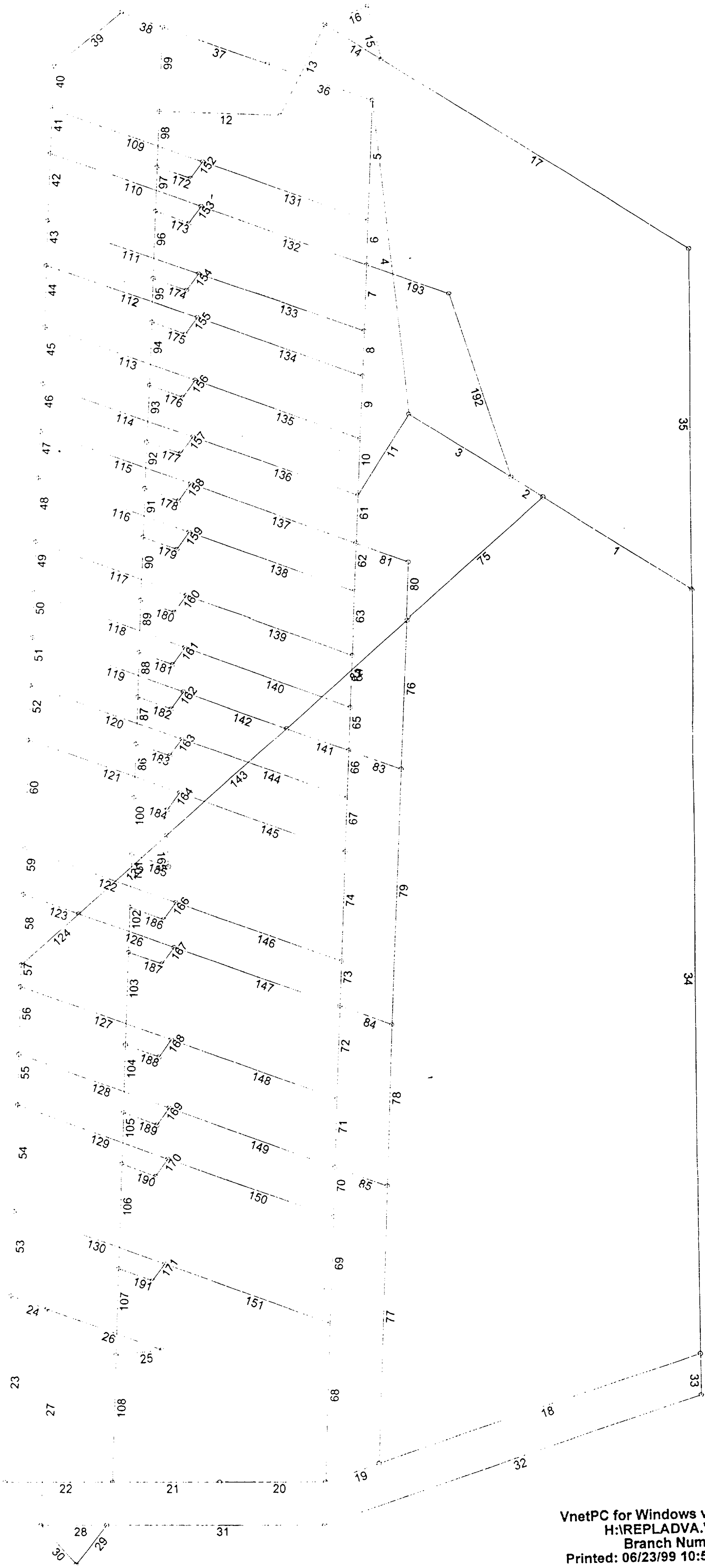
A ventilation model was created in preparation for postclosure natural ventilation mode. At this stage, a projected normal mechanical ventilation balance was established with the two exhaust ducts taken out. A diagram of the model was prepared with assigned nodes and branches. Resistance of the branch representing the airways were calculated through Microsoft Excel Spreadsheet and used as input to VNETPC. The ventilation model was simulated with a selected fan curve on the primary ventilation system. From the performance shown by the primary fan output of VNETPC, the overall system resistance was calculated. The overall resistance was correlated and applied to natural ventilation pressure of 124 and 248 Pa (0.5 and 1.0 inch Water Gage) postclosure mode. The results are tabulated below:

Calculation for R from VNETPC file: REPLADVA.VNW							
	With Mechanical Power				Predicted Air at NVP Case		
	H	Q	R		H	Nat Vent Q	Air Flow
	Pressure	Air Quan	Resistance				
	inch WG	cfm/100000	R = H/Q^2		inch WG	Q=(H/R)^.5	q=Qx100000
					(NVP)		cfm
Case NVP = 0.5"							
Fan 1	7.192	6.1043	0.1930092		0.5	1.61	160952
Fan 2	8.436	5.4822	0.2806899		0.5	1.33	133466
					Total		294418
				Average cfm per drift for 240 split			1227
Case NVP = 1.0"							
Fan 1	7.192	6.1043	0.1930092		1	2.28	227620
Fan 2	8.436	5.4822	0.2806899		1	1.89	188750
					Total		416370
				Average cfm per drift for 240 split			1735

Observation: VA design can not reach the 1.0 m^3/s (2119 cfm) average airflow per emplacemenrt drift at NVP of 0.5 to 1.0 inch WG.



VnetPC for Windows v1.0a
H:\REPLADVA.VNW
Line Plot
Printed: 06/23/99 10:52:17



VnetPC for Windows v1.0a
H:\REPLADVA.VNW
Branch Numbers
Printed: 06/23/99 10:53:24

Note: Obliteration of characters in this plot is not quality affecting and

VnetPC for Windows v1.0a
C:\VNETWIN\REPLADVA.VNW

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

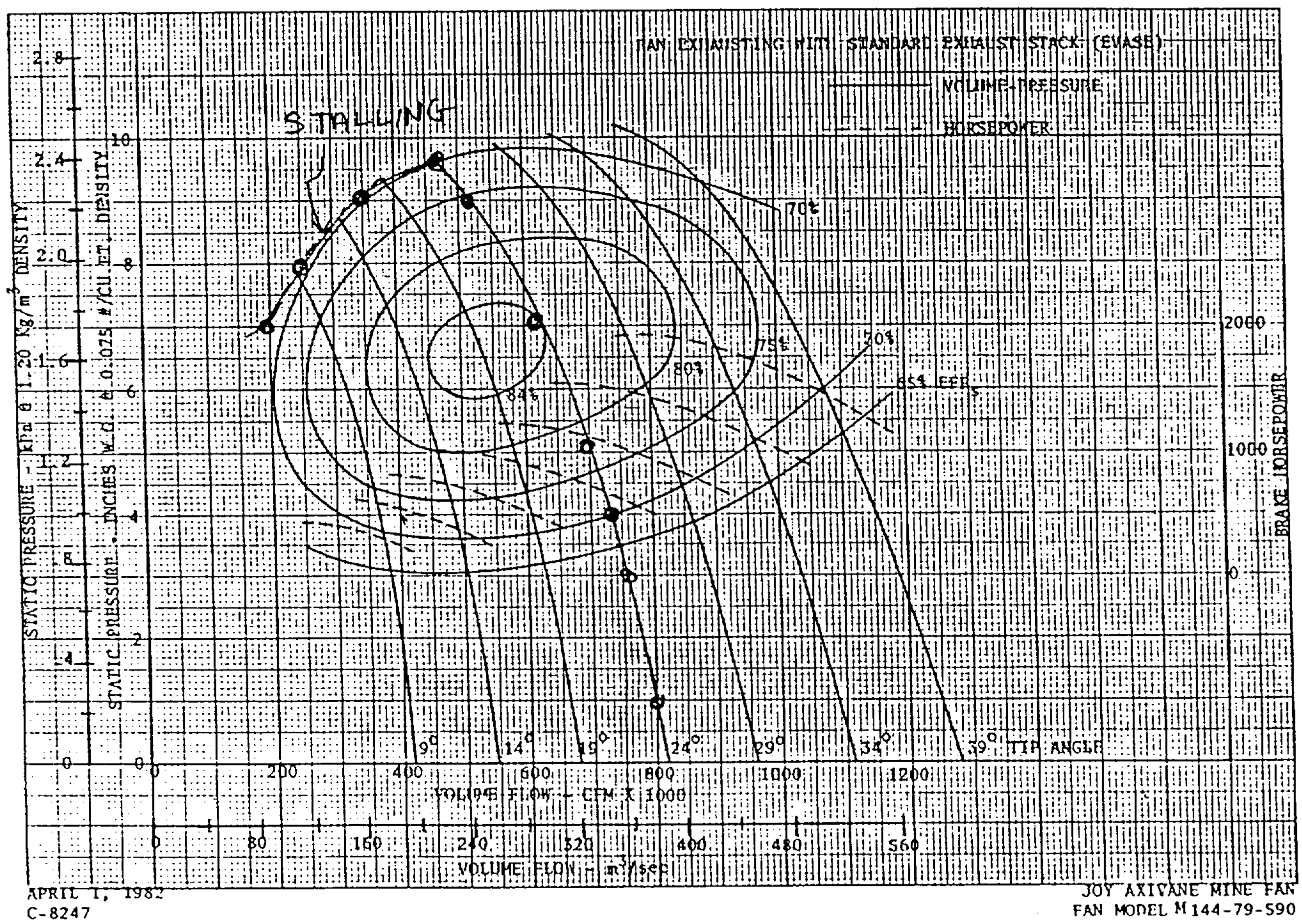
Fan Name: Joy 144-79-590
Fan Setting: 4
Comments: Fan curve #40 (JOY C-8247)
Points: 10

Quantity	Pressure	
200.00	7.000	Stalling
250.00	8.000	Stalling
350.00	9.000	Stalling
470.00	9.500	Max normal operation
520.00	9.000	Normal operation
620.00	7.000	Normal operation
700.00	5.000	Normal operation
740.00	4.000	Normal operation
760.00	3.000	Normal operation
800.00	1.000	Normal operation

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

Fan Name: Joy 144-79-590
Fan Setting: 4
Comments: Fan curve #40 (JOY C-8247)
Points: 10

Quantity	Pressure	
200.00	7.000	Stalling
250.00	8.000	Stalling
350.00	9.000	Stalling
470.00	9.500	Max normal operation
520.00	9.000	Normal operation
620.00	7.000	Normal operation
700.00	5.000	Normal operation
740.00	4.000	Normal operation
760.00	3.000	Normal operation
800.00	1.000	Normal operation


FAN EXHAUSTING WITH STANDARD EXHAUST STACK (EVASE)
VOLUME-PRESSURE
HORSEPOWER
STALLING
STATIC PRESSURE - kPa @ 1.20 Kg/m3 DENSITY
STATIC PRESSURE - INCHES W.G. @ 0.075 #/CU. FT. DENSITY
VOLUME FLOW - CFM X 1000
VOLUME FLOW - m3/sec
BRAKE HORSEPOWER
70%
75%
80%
84%
65% EFF.
9°
14°
19°
24°
29°
34°
39° TIP ANGLE
APRIL 1, 1982
C-8247
JOY AXIVANE MINE FAN
FAN MODEL M144-79-590

Calculation of Airway Resistances (VA)

FILE # Replad01-05-10-va.xls; Folder - Repladva: VNETPC INPUT, Design Feature Development, Case VA. (Data prepared by RS Jurani & A Linden

Line No.	BRANCH FROM	TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb (3.5)	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 (3.3)	X-SECT AREA A (Ft^2)	PERIMETER P (Ft) (3.3)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L=L'+10% (Ft) (3.23)	NOTES FOR BRANCH DESCRIPTION
1	1	2	0.0051		0.0051	0.0509	30	389.33	72.36	1992.0	6535	7189	North Ramp
2	2	3	0.0001		0.0001	0.0011	30	389.33	72.36	43.6	143	157	North Ramp
3	3	111	0.0004		0.0004	0.0039	30	389.33	72.36	151.4	497	546	North Ramp
4	111	100	0.0039		0.0039	0.0394	30	389.33	72.36	1543.0	5062	5569	North Ramp Ext
5	100	102	0.0039		0.0039	0.0390	70	389.33	72.36	654.6	2148	2362	East Main Drift Ext.
6	102	103	0.0003		0.0003	0.0026	70	389.33	72.36	43.5	143	157	East Main Drift
7	103	110	0.0013		0.0013	0.0130	70	389.33	72.36	217.4	713	785	East Main Drift
8	110	115	0.0009		0.0009	0.0086	70	389.33	72.36	144.9	475	523	East Main Drift
9	115	122	0.0012		0.0012	0.0121	70	389.33	72.36	202.9	666	732	East Main Drift
10	122	130	0.0014		0.0014	0.0138	70	389.33	72.36	231.9	761	837	East Main Drift
11	111	130	0.0018		0.0018	0.0178	30	389.33	72.36	698.5	2292	2521	North Ramp Curve
12	701	605	0.0001		0.0001	0.0009	25	446.53	80.13	57.5	189	208	West Exhaust Main Connector to Emp Shaft
13	605	17	0.0015		0.0015	0.0148	25	312.48	62.87	413.5	1357	1492	Emplacement VA Shaft
14	17	18	0.0020	0.0020	0.0000	0.0000	0	0	0	0.0	0	0	Primary Fan- Emplacement Shaft
15	18	19	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage Loop-1st leg
16	19	17	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage Loop-2nd leg
17	18	20	0.0040	0.0040	0.0000	0.0000	0	0	0	0.0	0	0	Surface Discharge - Evase (Outlet Cone)
18	4	5	0.0072		0.0072	0.0716	60	389.33	72.36	1402.6	4602	5062	South Ramp to PC
19	5	6	0.0003		0.0003	0.0025	60	389.33	72.36	49.2	161	178	South Ramp
20	6	7	0.0043		0.0043	0.0427	60	389.33	72.36	835.8	2742	3016	South Ramp
21	7	8	0.0001		0.0001	0.0012	60	389.33	72.36	23.1	76	83	South Ramp
22	8	9	0.0012		0.0012	0.0116	60	389.33	72.36	227.2	745	820	South Ramp
23	9	10	0.0010		0.0010	0.0102	60	389.33	72.36	200.0	656	722	South Ramp Ext Curve
24	10	16	50.0001	50.0000	0.0001	0.0011	25	446.53	80.13	69.7	229	252	West Main to Development Shaft Drift
25	22	21	0.0000		0.0000	0.0000	25	446.53	80.13	0.0	0	0	Exhaust Main Connector (Dummy)
26	21	16	0.0004		0.0004	0.0039	25	446.53	80.13	249.3	818	900	Exhaust Main Connecting Drift to Dev Shaft
27	16	14	0.0046		0.0046	0.0459	95	312.48	62.87	338.2	1110	1221	Development VA Shaft
28	14	13	0.0020	0.0020	0.0000	0.0000	0	0	0	0.0	0	0	Primary Fan- Development Shaft
29	13	15	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage 1st leg
30	15	14	1000.0000	1000.0000	0.0000	0.0000	0	0	0	0.0	0	0	Leakage 2nd leg
31	13	12	0.0040	0.0040	0.0000	0.0000	0	0	0	0.0	0	0	Surface Outlet - Evase
32	12	11	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Dummy Connector
33	11	4	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Dummy Connector
34	4	1	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Dummy Connector
35	20	1	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Surface Dummy Connector
36	100	600	0.0020		0.0020	0.0200	70	389.33	72.36	336.5	1104	1214	North Main
37	600	700	0.0001		0.0001	0.0015	70	389.33	72.36	25.1	82	91	North Main
38	700	200	0.0014		0.0014	0.0144	70	389.33	72.36	241.7	793	872	North Main
39	200	201	0.0014		0.0014	0.0141	70	389.33	72.36	236.1	775	852	West Main
40	201	202	0.0015		0.0015	0.0147	70	389.33	72.36	246.5	809	890	West main

Calculation of Airway Resistances (VA)

FILE # Replad01-05-10-va.xls; Folder - Repladva: VNETPC INPUT, Design Feature Development, Case VA. (Data prepared by RSJurani & A Linden)

Line No.	BRANCH FROM	TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb (3.5)	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 (3.3)	X-SECT AREA A (Ft^2)	PERIMETER P (Ft) (3.3)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L=L'+10% (Ft) (3.23)	NOTES FOR BRANCH DESCRIPTION
41	202	203	0.0003		0.0003	0.0026	70	389.33	72.36	43.5	143	157	West main
42	203	210	0.0013		0.0013	0.0130	70	389.33	72.36	217.4	713	785	West main
43	210	215	0.0009		0.0009	0.0086	70	389.33	72.36	144.9	475	523	West main
44	215	222	0.0012		0.0012	0.0121	70	389.33	72.36	202.9	666	732	West main
45	222	230	0.0014		0.0014	0.0137	70	389.33	72.36	230.1	755	830	West main
46	230	233	0.0004		0.0004	0.0042	70	389.33	72.36	70.1	230	253	West main
47	233	238	0.0009		0.0009	0.0092	70	389.33	72.36	154.5	507	558	West main
48	238	245	0.0012		0.0012	0.0117	70	389.33	72.36	197.1	647	711	West main
49	245	253	0.0014		0.0014	0.0136	70	389.33	72.36	228.9	751	826	West main
50	253	256	500.0004	500.0000	0.0004	0.0043	70	389.33	72.36	71.5	235	258	West main
51	256	260	0.0008		0.0008	0.0077	70	389.33	72.36	128.7	422	464	West main
52	260	266	0.0010		0.0010	0.0102	70	389.33	72.36	171.7	563	620	West main
53	10	2120	0.0060		0.0060	0.0595	70	389.33	72.36	999.2	3278	3606	West main
54	2120	2105	0.0028		0.0028	0.0280	70	389.33	72.36	470.3	1543	1697	West main
55	2105	2103	0.0005		0.0005	0.0047	70	389.33	72.36	78.4	257	283	West main
56	2103	295	0.0014		0.0014	0.0140	70	389.33	72.36	235.2	772	849	West main
57	295	292	0.0005		0.0005	0.0045	70	389.33	72.36	75.9	249	274	West main
58	292	280	0.0022		0.0022	0.0224	70	389.33	72.36	376.2	1234	1358	West main
59	280	275	0.0008		0.0008	0.0077	70	389.33	72.36	128.7	422	464	West main
60	275	266	0.0015		0.0015	0.0153	70	389.33	72.36	257.5	845	929	West main
61	130	133	0.0004		0.0004	0.0043	70	389.33	72.36	72.5	238	262	East Main
62	133	138	0.0009		0.0009	0.0095	70	389.33	72.36	159.4	523	575	East Main
63	138	145	0.0012		0.0012	0.0121	70	389.33	72.36	202.9	666	732	East Main
64	145	153	0.0014		0.0014	0.0138	70	389.33	72.36	231.9	761	837	East Main
65	153	156	500.0004	500.0000	0.0004	0.0043	70	389.33	72.36	72.5	238	262	East Main
66	156	160	0.0008		0.0008	0.0078	70	389.33	72.36	130.4	428	471	East Main
67	160	166	0.0010		0.0010	0.0104	70	389.33	72.36	173.9	571	628	East Main
68	6	1120	0.0065		0.0065	0.0651	70	389.33	72.36	1093.1	3586	3945	East Main
69	1120	1105	0.0026		0.0026	0.0259	70	389.33	72.36	434.8	1427	1569	East Main
70	1105	1103	0.0004		0.0004	0.0043	70	389.33	72.36	72.5	238	262	East Main
71	1103	195	0.0013		0.0013	0.0130	70	389.33	72.36	217.4	713	785	East Main
72	195	180	0.0027		0.0027	0.0268	70	389.33	72.36	449.3	1474	1621	East Main
73	180	175	0.0008		0.0008	0.0078	70	389.33	72.36	130.4	428	471	East Main
74	175	166	0.0016		0.0016	0.0155	70	389.33	72.36	260.9	856	942	East Main
75	2	131	0.0313		0.0313	0.3130	70	177.60	48.44	745.0	2444	2689	ECRB
76	131	155	500.0119	500.0000	0.0119	0.1193	70	211.30	52.57	440.8	1446	1591	PC Main
77	5	1102	0.0395		0.0395	0.3946	70	211.30	52.57	1457.6	4782	5260	PC Main
78	1102	179	0.0180		0.0180	0.1805	70	211.30	52.57	666.7	2187	2406	PC Main
79	179	155	0.0188		0.0188	0.1883	70	211.30	52.57	695.7	2282	2511	PC Main
80	131	132	0.0061		0.0061	0.0612	70	211.30	52.57	225.9	741	815	PC Main

Calculation of Airway Resistances (VA)

FILE # Replad01-05-10-va.xls; Folder - Repladva: VNETPC INPUT, Design Feature Development, Case VA. (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 (3.5)	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 (3.3)	X-SECT AREA A (Ft^2)	PERIMETER P (Ft) (3.3)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L=L'+10% (Ft) (3.23)	NOTES FOR BRANCH DESCRIPTION
81	132	133	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 2
82	131	157	500.0201	500.0000	0.0201	0.2014	70	177.60	48.44	479.4	1573	1730	ECRB
83	155	156	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 3
84	179	180	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 4
85	1102	1103	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 5
86	766	760	0.0008		0.0008	0.0080	60	401.49	72.36	172.7	567	623	Exhaust Main
87	760	756	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	Exhaust Main
88	756	753	500.0003	500.0000	0.0003	0.0034	60	401.49	72.36	72.0	236	260	Exhaust Main
89	753	745	0.0011		0.0011	0.0107	60	401.49	72.36	230.3	756	831	Exhaust Main
90	745	738	0.0009		0.0009	0.0092	60	401.49	72.36	198.1	650	715	Exhaust Main
91	738	733	0.0007		0.0007	0.0072	60	401.49	72.36	154.7	508	558	Exhaust Main
92	733	730	0.0003		0.0003	0.0033	60	401.49	72.36	70.4	231	254	Exhaust Main
93	730	722	0.0011		0.0011	0.0107	60	401.49	72.36	230.8	757	833	Exhaust Main
94	722	715	0.0009		0.0009	0.0094	60	401.49	72.36	202.9	666	732	Exhaust Main
95	715	710	0.0007		0.0007	0.0067	60	401.49	72.36	144.9	475	523	Exhaust Main
96	710	703	0.0010		0.0010	0.0101	60	401.49	72.36	217.4	713	785	Exhaust Main
97	703	702	0.0002		0.0002	0.0020	60	401.49	72.36	43.5	143	157	Exhaust Main
98	702	701	0.0017		0.0017	0.0173	60	401.49	72.36	371.6	1219	1341	Exhaust Main
99	700	701	1000.0006	1000.0000	0.0006	0.0064	60	401.49	72.36	138.3	454	499	Exhaust Main Reg (North Ramp Side)
100	766	767	0.0002		0.0002	0.0016	60	401.49	72.36	33.5	110	121	Exhaust Main
101	767	775	0.0011		0.0011	0.0105	60	401.49	72.36	225.6	740	814	Exhaust Main
102	775	780	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	Exhaust Main
103	780	795	0.0021		0.0021	0.0210	60	401.49	72.36	450.2	1477	1625	Exhaust Main
104	795	7103	0.0010		0.0010	0.0105	60	401.49	72.36	225.1	739	812	Exhaust Main
105	7103	7105	0.0003		0.0003	0.0035	60	401.49	72.36	75.1	246	271	Exhaust Main
106	7105	7120	0.0021		0.0021	0.0210	60	401.49	72.36	450.2	1477	1625	Exhaust Main
107	7120	22	0.0040		0.0040	0.0403	60	401.49	72.36	865.8	2841	3125	Exhaust Main
108	8	22	1000.0010	1000.0000	0.0010	0.0100	60	401.49	72.36	214.9	705	776	Exhaust Main Reg (South Ramp Side)
109	202	402	0.0348		0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift West Side
110	203	403	0.0152		0.0152	0.1516	70	211.30	52.57	559.9	1837	2021	PC 1 West Side
111	210	410	0.0348		0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift West Side
112	215	415	0.0165		0.0165	0.1654	70	201.93	52.57	533.3	1750	1925	Emplacement Drift West Side (Empty)
113	222	422	0.0348		0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift West Side
114	230	430	0.0146		0.0146	0.1457	70	211.30	52.57	538.3	1766	1943	Cross Block 30 West Side
115	233	433	0.0156		0.0156	0.1560	70	211.30	52.57	576.4	1891	2080	PC 2 West Side
116	238	438	0.0376		0.0376	0.3760	85	168.13	52.57	576.3	1891	2080	Emplacement Drift West Side
117	245	445	0.0187		0.0187	0.1867	70	201.93	52.57	601.9	1975	2172	Emplacement Drift West Side (Empty)
118	253	453	0.0397		0.0397	0.3970	85	168.13	52.57	608.4	1996	2196	Emplacement Drift West Side
119	256	456	0.0172		0.0172	0.1725	70	211.30	52.57	637.1	2090	2299	PC 3 West Side
120	260	460	0.0166		0.0166	0.1662	70	211.30	52.57	614.1	2015	2216	Cross Block 60

Calculation of Airway Resistances (VA)

FILE # Replad01-05-10-va.xls; Folder - Repladva: VNETPC INPUT, Design Feature Development, Case VA. (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 (3.5)	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 (3.3)	X-SECT AREA A (Ft^2)	PERIMETER P (Ft) (3.3)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L=L'+10% (Ft) (3.23)	NOTES FOR BRANCH DESCRIPTION
121	266	466	0.0404		0.0404	0.4039	85	168.13	52.57	619.0	2031	2234	Emplacement Drift West Side
122	275	475	0.0409		0.0409	0.4087	85	168.13	52.57	626.4	2055	2261	Emplacement Drift West Side
123	280	281	0.0099		0.0099	0.0992	70	211.30	52.57	366.5	1202	1323	PC 4 West Side 1st leg
124	292	281	0.0200		0.0200	0.2001	70	177.60	48.44	476.3	1563	1719	ECRB West Side
125	281	467	0.0169		0.0169	0.1693	70	177.60	48.44	403.0	1322	1454	ECRB West Side
126	281	480	0.0079		0.0079	0.0785	70	211.30	52.57	290.1	952	1047	PC 4 West Side 2nd leg
127	295	495	0.0410		0.0410	0.4104	85	168.13	52.57	629.0	2064	2270	Emplacement Drift West Side
128	2103	4103	0.0171		0.0171	0.1708	70	211.30	52.57	630.8	2070	2277	PC 5 West Side
129	2105	4105	0.0161		0.0161	0.1613	70	211.30	52.57	595.9	1955	2151	Cross Block 105
130	2120	4120	0.2356	0.2000	0.0356	0.3565	85	168.13	52.57	546.3	1792	1972	Emplacement Drift West Side
131	102	402	0.5348	0.5000	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift East Side
132	103	403	0.5152	0.5000	0.0152	0.1516	70	211.30	52.57	559.9	1837	2021	PC 1 East Side
133	110	410	0.6348	0.6000	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift East Side
134	115	415	0.7165	0.7000	0.0165	0.1654	70	201.93	52.57	533.3	1750	1925	Emplacement Drift East Side (Empty)
135	122	422	0.7348	0.7000	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift East Side
136	130	430	0.7146	0.7000	0.0146	0.1457	70	211.30	52.57	538.3	1766	1943	Cross Block 30
137	133	433	0.6156	0.6000	0.0156	0.1560	70	211.30	52.57	576.4	1891	2080	PC 2 East
138	138	438	0.6376	0.6000	0.0376	0.3760	85	168.13	52.57	576.3	1891	2080	Emplacement Drift East Side
139	145	445	0.6187	0.6000	0.0187	0.1867	70	201.93	52.57	601.9	1975	2172	Emplacement Drift East Side (Empty)
140	153	453	0.6397	0.6000	0.0397	0.3970	85	168.13	52.57	608.4	1996	2196	Emplacement Drift East Side
141	156	157	0.0098		0.0098	0.0982	70	211.30	52.57	362.9	1191	1310	PC 3 East Side 1st leg
142	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
143	157	467	0.0160		0.0160	0.1600	70	177.60	48.44	380.9	1250	1375	ECRB
144	160	460	0.3166	0.3000	0.0166	0.1662	70	211.30	52.57	614.1	2015	2216	Cross Block 60
145	166	466	0.3404	0.3000	0.0404	0.4039	85	168.13	52.57	619.0	2031	2234	Emplacement Drift East Side
146	175	475	0.3409	0.3000	0.0409	0.4087	85	168.13	52.57	626.4	2055	2261	Emplacement Drift East Side
147	180	480	0.3178	0.3000	0.0178	0.1778	70	211.30	52.57	656.6	2154	2370	PC 4 East Side
148	195	495	0.3410	0.3000	0.0410	0.4104	85	168.13	52.57	629.0	2064	2270	Emplacement Drift East Side
149	1103	4103	0.3171	0.3000	0.0171	0.1708	70	211.30	52.57	630.8	2070	2277	PC 5 East Side
150	1105	4105	0.3161	0.3000	0.0161	0.1613	70	211.30	52.57	595.9	1955	2151	Cross Block 105
151	1120	4120	0.3356	0.3000	0.0356	0.3565	85	168.13	52.57	546.3	1792	1972	Emplacement Drift East Side
152	402	502	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Empl Level to Exhaust Main
153	403	503	0.0702		0.0702	0.7022	20	24.43	17.52	42.1	138	152	Raise Connector, PC Level to Exhaust Main
154	410	510	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Empl Level to Exhaust Main
155	415	515	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Empl Level to Exhaust Main
156	422	522	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Empl Level to Exhaust Main
157	430	530	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Empl Level to Exhaust Main
158	433	533	0.0706		0.0706	0.7055	20	24.43	17.52	42.3	139	153	Raise Connector, PC Level to Exhaust Main
159	438	538	0.0280		0.0280	0.2802	20	24.43	17.52	16.8	55	61	Raise Connector, Empl Level to Exhaust Main
160	445	545	0.0285		0.0285	0.2852	20	24.43	17.52	17.1	56	62	Raise Connector, Empl Level to Exhaust Main

Calculation of Airway Resistances (VA)

FILE # Replad01-05-10-va.xls; Folder - Repladva: VNETPC INPUT, Design Feature Development, Case VA. (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 (3.5)	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 (3 3)	X-SECT AREA A (Ft^2)	PERIMETER P (Ft) (3 3)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L=L'+10% (Ft) (3.23)	NOTES FOR BRANCH DESCRIPTION
161	453	553	0.0289		0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Empl Level to Exhaust Main
162	456	556	0.0714		0.0714	0.7139	20	24.43	17.52	42.8	140	154	Raise Connector, PC Level to Exhaust Main
163	460	560	0.0289		0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Empl Level to Exhaust Main
164	466	566	0.0289		0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Empl Level to Exhaust Main
165	467	567	0.0709		0.0709	0.7089	20	24.43	17.52	42.5	139	153	Raise Connector, ECRB Level to Exhaust Main
166	475	575	0.0289		0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Empl Level to Exhaust Main
167	480	580	0.0714		0.0714	0.7139	20	24.43	17.52	42.8	140	154	Raise Connector, PC Level to Exhaust Main
168	495	595	0.0284		0.0284	0.2835	20	24.43	17.52	17.0	56	61	Raise Connector, Empl Level to Exhaust Main
169	4103	5103	0.0714		0.0714	0.7139	20	24.43	17.52	42.8	140	154	Raise Connector, PC Level to Exhaust Main
170	4105	5105	0.0284		0.0284	0.2835	20	24.43	17.52	17.0	56	61	Raise Connector, Empl Level to Exhaust Main
171	4120	5120	0.0284		0.0284	0.2835	20	24.43	17.52	17.0	56	61	Raise Connector, Empl Level to Exhaust Main
172	502	702	0.2000	0.2000	0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
173	503	703	0.2000	0.2000	0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
174	510	710	0.1800	0.1800	0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
175	515	715	0.1500	0.1500	0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
176	522	722	0.1000	0.1000	0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
177	530	730	0.0300	0.0300	0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
178	533	733	0.0100	0.0100	0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
179	538	738	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
180	545	745	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
181	553	753	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
182	556	756	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
183	560	760	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
184	566	766	0.0000		0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
185	567	767	0.1000	0.1000	0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
186	575	775	0.0500	0.0500	0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
187	580	780	0.0900	0.0900	0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
188	595	795	0.1000	0.1000	0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
189	5103	7103	0.1500	0.1500	0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
190	5105	7105	0.2000	0.2000	0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
191	5120	7120	0.2000	0.2000	0.0000	0.0000	0	0	0	0.0	0	0	Door/Reg from Raise to Exhaust Main
192	3	104	0.0178		0.0178	0.1775	70	211.30	52.57	655.7	2151	2366	PC 1 North Ramp Side 1st leg
193	104	103	0.0067		0.0067	0.0670	70	211.30	52.57	247.5	812	893	PC 1 North Ramp Side 2nd leg

VnetPC for Windows v1.0a
H:\REPLADVA.VNW

Model Information
06/23/99 10:46:14

YMP LA DESIGN FEATURE(VA Layout)
Preclosure, Remove Exh.Ducts
M&0/MK/RSJURANI- Prep Natural Vent Mode
Period 0.1cms to Postclosure Open Loop

Avg. Fan Efficiency: 75.0 %
Cost of Power: 10.00 c/kWh
Reference Junction: 1 ASSUMPTION (3.25)
Units: British

Number of Branches: 193
Number of Junctions: 137
Number of Fans: 2
Fixed Quantities: 1

Last Airflow Analysis NFK 28JULY99
Date: 06/23/99
Time: 10:46 AM
Elapsed Time: 00:00:00

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

VnetPC for Windows v1.0a
H:\REPLADVA.VNW

Branch Input
06/23/99 10:46:14

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)
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	0.00000				
11	111	130		R	0.00180				
12	701	605		R	0.00010				
13	605	17		R	0.00150				
14	17	18	F	R	0.00200				
15	18	19		R	1000.00000				
16	19	17		R	1000.00000				
17	18	20		R	0.00400				
18	4	5		R	0.00720				
19	5	6		R	0.00030				
20	6	7		R	0.00430				
21	7	8		R	0.00010				
22	8	9		R	0.00120				
23	9	10		R	0.00100				
24	10	16		R	50.00010				
25	22	21		R	0.00000				
26	21	16		R	0.00040				
27	16	14		R	0.00460				
28	14	13	F	R	0.00200				
29	13	15		R	1000.00000				
30	15	14		R	1000.00000				
31	13	12		R	0.00400				
32	12	11		R	0.00000				
33	11	4		R	0.00000				
34	4	1		R	0.00000				
35	20	1	Q	R	0.00000				
36	100	600		R	0.00200				
37	600	700		R	0.00010				
38	700	200		R	0.00140				
39	200	201		R	0.00140				
40	201	202		R	0.00150				
41	202	203		R	0.00030				
42	203	210		R	0.00130				
43	210	215		R	0.00090				
44	215	222		R	0.00120				
45	222	230		R	0.00140				
46	230	233		R	0.00040				
47	233	238		R	0.00090				
48	238	245		R	0.00120				
49	245	253		R	0.00140				
50	253	256		R	500.00040				
51	256	260		R	0.00080				
52	260	266		R	0.00100				
53	10	2120		R	0.00600				
54	2120	2105		R	0.00280				
55	2105	2103		R	0.00050				
56	2103	295		R	0.00140				
57	295	292		R	0.00050				

VnetPC for Windows v1.0a
H:\REPLADVA.VNW

Branch Input
06/23/99 10:46:14

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)
58	292	280		R	0.00220				
59	280	275		R	0.00080				
60	275	266		R	0.00150				
61	130	133		R	0.00040				
62	133	138		R	0.00090				
63	138	145		R	0.00120				
64	145	153		R	0.00140				
65	153	156		R	500.00040				
66	156	160		R	0.00080				
67	160	166		R	0.00100				
68	6	1120		R	0.00650				
69	1120	1105		R	0.00260				
70	1105	1103		R	0.00040				
71	1103	195		R	0.00130				
72	195	180		R	0.00270				
73	180	175		R	0.00080				
74	175	166		R	0.00160				
75	2	131		R	0.03130				
76	131	155		R	500.01190				
77	5	1102		R	0.03950				
78	1102	179		R	0.01800				
79	179	155		R	0.01880				
80	131	132		R	0.00610				
81	132	133		R	0.00090				
82	131	157		R	500.02010				
83	155	156		R	0.00090				
84	179	180		R	0.00090				
85	1102	1103		R	0.00090				
86	766	760		R	0.00080				
87	760	756		R	0.00060				
88	756	753		R	500.00030				
89	753	745		R	0.00110				
90	745	738		R	0.00090				
91	738	733		R	0.00070				
92	733	730		R	0.00030				
93	730	722		R	0.00110				
94	722	715		R	0.00090				
95	715	710		R	0.00070				
96	710	703		R	0.00100				
97	703	702		R	0.00020				
98	702	701		R	0.00170				
99	700	701		R	1000.00060				
100	766	767		R	0.00020				
101	767	775		R	0.00110				
102	775	780		R	0.00060				
103	780	795		R	0.00210				
104	795	7103		R	0.00100				
105	7103	7105		R	0.00030				
106	7105	7120		R	0.00210				
107	7120	22		R	0.00400				
108	8	22		R	1000.00100				
109	202	402		R	0.03480				
110	203	403		R	0.01520				
111	210	410		R	0.03480				
112	215	415		R	0.01650				
113	222	422		R	0.03480				
114	230	430		R	0.01460				

VnetPC for Windows v1.0a
H:\REPLADVA.VNW

Branch Input
06/23/99 10:46:1

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)
115	233	433		R	0.01560				
116	238	438		R	0.03760				
117	245	445		R	0.01870				
118	253	453		R	0.03970				
119	256	456		R	0.01720				
120	260	460		R	0.01660				
121	266	466		R	0.04040				
122	275	475		R	0.04090				
123	280	281		R	0.00990				
124	292	281		R	0.02000				
125	281	467		R	0.01690				
126	281	480		R	0.00790				
127	295	495		R	0.04100				
128	2103	4103		R	0.01710				
129	2105	4105		R	0.01610				
130	2120	4120		R	0.23560				
131	102	402		R	0.53480				
132	103	403		R	0.51520				
133	110	410		R	0.63480				
134	115	415		R	0.71650				
135	122	422		R	0.73480				
136	130	430		R	0.71460				
137	133	433		R	0.61560				
138	138	438		R	0.63760				
139	145	445		R	0.61870				
140	153	453		R	0.63970				
141	156	157		R	0.00980				
142	157	456		R	0.20740				
143	157	467		R	0.01600				
144	160	460		R	0.31660				
145	166	466		R	0.34040				
146	175	475		R	0.34090				
147	180	480		R	0.31780				
148	195	495		R	0.34100				
149	1103	4103		R	0.31710				
150	1105	4105		R	0.31610				
151	1120	4120		R	0.33560				
152	402	502		R	0.02770				
153	403	503		R	0.07020				
154	410	510		R	0.02770				
155	415	515		R	0.02770				
156	422	522		R	0.02770				
157	430	530		R	0.02770				
158	433	533		R	0.07060				
159	438	538		R	0.02800				
160	445	545		R	0.02850				
161	453	553		R	0.02890				
162	456	556		R	0.07140				
163	460	560		R	0.02890				
164	466	566		R	0.02890				
165	467	567		R	0.07090				
166	475	575		R	0.02890				
167	480	580		R	0.07140				
168	495	595		R	0.02840				
169	4103	5103		R	0.07140				
170	4105	5105		R	0.02840				
171	4120	5120		R	0.02840				

VnetPC for Windows v1.0a
H:\REPLADVA.VNW

Branch Input
06/23/99 10:46:1[illegible]

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)
172	502	702		R	0.20000				
173	503	703		R	0.20000				
174	510	710		R	0.18000				
175	515	715		R	0.15000				
176	522	722		R	0.10000				
177	530	730		R	0.03000				
178	533	733		R	0.01000				
179	538	738		R	0.00000				
180	545	745		R	0.00000				
181	553	753		R	0.00000				
182	556	756		R	0.00000				
183	560	760		R	0.00000				
184	566	766		R	0.00000				
185	567	767		R	0.10000				
186	575	775		R	0.05000				
187	580	780		R	0.09000				
188	595	795		R	0.10000				
189	5103	7103		R	0.15000				
190	5105	7105		R	0.20000				
191	5120	7120		R	0.20000				
192	3	104		R	0.01780				
193	104	103		R	0.00670				

VnetPC for Windows v1.0a
H:\REPLADVA.VNW

Branch Results
06/23/99 10:46:14

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	612.48	1913.2	184.65	160886
2	2	3		0.00010	537.02	28.8	2.44	2123
3	3	111		0.00040	444.45	79.0	5.53	4821
4	111	100		0.00390	201.66	158.6	5.04	4391
5	100	102		0.00390	-78.39	-24.0	0.30	258
6	102	103		0.00030	-110.86	-3.7	0.06	56
7	103	110		0.00130	-51.11	-3.4	0.03	24
8	110	115		0.00090	-82.64	-6.1	0.08	69
9	115	122		0.00120	-112.93	-15.3	0.27	237
10	122	130		0.00000	-144.10	0.0	0.00	0
11	111	130		0.00180	242.79	106.1	4.06	3537
12	701	605		0.00010	608.63	37.0	3.55	3092
13	605	17		0.00150	608.63	555.6	53.29	46428
14	17	18	F	0.00200	610.43	745.2	71.68	62456
15	18	19		1000.00000	1.80	3223.1	0.91	797
16	19	17		1000.00000	1.80	3223.1	0.91	797
17	18	20		0.00400	608.63	1481.7	142.10	123817
18	4	5		0.00720	542.39	2118.2	181.04	157741
19	5	6		0.00030	434.76	56.7	3.88	3385
20	6	7		0.00430	216.87	202.2	6.91	6021
21	7	8		0.00010	216.87	4.7	0.16	140
22	8	9		0.00120	215.20	55.6	1.89	1643
23	9	10		0.00100	215.20	46.3	1.57	1368
24	10	16		50.00010	7.46	2784.7	3.27	2852
25	22	21		0.00000	538.78	0.0	0.00	0
26	21	16		0.00040	538.78	116.1	9.86	8588
27	16	14		0.00460	546.24	1372.5	118.14	102935
28	14	13	F	0.00200	548.22	601.1	51.93	45245
29	13	15		1000.00000	1.98	3917.2	1.22	1065
30	15	14		1000.00000	1.98	3917.2	1.22	1065
31	13	12		0.00400	546.24	1193.5	102.73	89510
32	12	11		0.00000	546.24	0.0	0.00	0
33	11	4		0.00000	546.24	0.0	0.00	0
34	4	1		0.00000	3.85	0.0	0.00	0
35	20	1	R	0.00001	608.63	5.0	0.48	418
36	100	600		0.00200	280.05	156.9	6.92	6033
37	600	700		0.00010	280.05	7.8	0.34	300
38	700	200		0.00140	278.62	108.7	4.77	4158
39	200	201		0.00140	278.62	108.7	4.77	4158
40	201	202		0.00150	278.62	116.4	5.11	4453
41	202	203		0.00030	244.14	17.9	0.69	600
42	203	210		0.00130	216.92	61.2	2.09	1823
43	210	215		0.00090	191.58	33.0	1.00	868
44	215	222		0.00120	167.47	33.7	0.89	775
45	222	230		0.00140	145.37	29.6	0.68	591
46	230	233		0.00040	114.89	5.3	0.10	84
47	233	238		0.00090	98.22	8.7	0.13	117
48	238	245		0.00120	63.86	4.9	0.05	43
49	245	253		0.00140	29.63	1.2	0.01	0
50	253	256		500.00040	0.28	38.4	0.00	1
51	256	260		0.00080	-18.61	-0.3	0.00	0
52	260	266		0.00100	-56.74	-3.2	0.03	25
53	10	2120		0.00600	207.74	258.9	8.48	7384
54	2120	2105		0.00280	177.69	88.4	2.48	2157
55	2105	2103		0.00050	151.99	11.6	0.28	242
56	2103	295		0.00140	128.03	22.9	0.46	403
57	295	292		0.00050	97.97	4.8	0.07	65

VnetPC for Windows v1.0a Branch Results
H:\REPLADVA.VNW 06/23/99 10:46:14

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	292	280		0.00220	82.66	15.0	0.20	170
59	280	275		0.00080	114.98	10.6	0.19	167
60	275	266		0.00150	91.07	12.4	0.18	155
61	130	133		0.00040	66.51	1.8	0.02	0
62	133	138		0.00090	105.17	10.0	0.17	144
63	138	145		0.00120	70.35	5.9	0.07	57
64	145	153		0.00140	35.54	1.8	0.01	0
65	153	156		500.00040	1.05	549.6	0.09	79
66	156	160		0.00080	-47.08	-1.8	0.01	0
67	160	166		0.00100	-74.69	-5.6	0.07	57
68	6	1120		0.00650	217.89	308.6	10.60	9232
69	1120	1105		0.00260	180.36	84.6	2.40	2095
70	1105	1103		0.00040	150.95	9.1	0.22	189
71	1103	195		0.00130	161.56	33.9	0.86	752
72	195	180		0.00270	132.33	47.3	0.99	859
73	180	175		0.00080	129.68	13.5	0.28	240
74	175	166		0.00160	102.74	16.9	0.27	238
75	2	131		0.03130	75.46	178.2	2.12	1846
76	131	155		500.01190	1.10	602.9	0.10	91
77	5	1102		0.03950	107.63	457.6	7.76	6762
78	1102	179		0.01800	67.56	82.2	0.88	762
79	179	155		0.01880	43.98	36.4	0.25	220
80	131	132		0.00610	73.19	32.7	0.38	329
81	132	133		0.00090	73.19	4.8	0.06	48
82	131	157		500.02010	1.17	689.9	0.13	111
83	155	156		0.00090	45.08	1.8	0.01	0
84	179	180		0.00090	23.58	0.5	0.00	0
85	1102	1103		0.00090	40.07	1.4	0.01	0
86	766	760		0.00080	-110.57	-9.8	0.17	149
87	760	756		0.00060	-44.83	-1.2	0.01	0
88	756	753		500.00030	-0.25	-31.4	0.00	1
89	753	745		0.00110	63.60	4.5	0.05	39
90	745	738		0.00090	132.63	15.8	0.33	288
91	738	733		0.00070	201.81	28.5	0.91	790
92	733	730		0.00030	253.01	19.2	0.77	667
93	730	722		0.00110	315.67	109.6	5.45	4750
94	722	715		0.00090	368.94	122.5	7.12	6205
95	715	710		0.00070	423.34	125.5	8.37	7295
96	710	703		0.00100	480.20	230.6	17.45	15204
97	703	702		0.00020	540.26	58.4	4.97	4332
98	702	701		0.00170	607.21	626.8	59.97	52256
99	700	701		1000.00060	1.42	2022.6	0.45	394
100	766	767		0.00020	172.94	6.0	0.16	142
101	767	775		0.00110	208.75	47.9	1.58	1373
102	775	780		0.00060	259.60	40.4	1.65	1440
103	780	795		0.00210	301.71	191.2	9.09	7920
104	795	7103		0.00100	361.00	130.3	7.41	6458
105	7103	7105		0.00030	414.41	51.5	3.36	2930
106	7105	7120		0.00210	469.53	463.0	34.26	29848
107	7120	22		0.00400	537.11	1154.0	97.67	85101
108	8	22		1000.00100	1.66	2770.4	0.72	631
109	202	402		0.03480	34.48	41.4	0.22	196
110	203	403		0.01520	27.22	11.3	0.05	42
111	210	410		0.03480	25.34	22.3	0.09	78
112	215	415		0.01650	24.11	9.6	0.04	32
113	222	422		0.03480	22.10	17.0	0.06	52
114	230	430		0.01460	30.48	13.6	0.07	57

VnetPC for Windows v1.0a
H:\REPLADVA.VNW

Branch Results
06/23/99 10:46:14

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	233	433		0.01560	16.67	4.3	0.01	10
116	238	438		0.03760	34.37	44.4	0.24	210
117	245	445		0.01870	34.23	21.9	0.12	103
118	253	453		0.03970	29.35	34.2	0.16	138
119	256	456		0.01720	18.89	6.1	0.02	16
120	260	460		0.01660	38.13	24.1	0.14	126
121	266	466		0.04040	34.33	47.6	0.26	224
122	275	475		0.04090	23.91	23.4	0.09	77
123	280	281		0.00990	-32.31	-10.3	0.05	46
124	292	281		0.02000	15.31	4.7	0.01	10
125	281	467		0.01690	-32.88	-18.3	0.09	83
126	281	480		0.00790	15.88	2.0	0.01	0
127	295	495		0.04100	30.06	37.0	0.18	153
128	2103	4103		0.01710	23.96	9.8	0.04	32
129	2105	4105		0.01610	25.70	10.6	0.04	37
130	2120	4120		0.23560	30.05	212.8	1.01	878
131	102	402		0.53480	32.47	563.8	2.88	2513
132	103	403		0.51520	32.83	555.3	2.87	2503
133	110	410		0.63480	31.53	630.9	3.13	2731
134	115	415		0.71650	30.29	657.4	3.14	2734
135	122	422		0.73480	31.17	713.7	3.51	3054
136	130	430		0.71460	32.18	739.9	3.75	3269
137	133	433		0.61560	34.53	734.2	3.99	3481
138	138	438		0.63760	34.82	773.0	4.24	3696
139	145	445		0.61870	34.80	749.4	4.11	3581
140	153	453		0.63970	34.50	761.2	4.14	3606
141	156	157		0.00980	93.20	85.1	1.25	1089
142	157	456		0.20740	25.68	136.8	0.55	482
143	157	467		0.01600	68.69	75.5	0.82	712
144	160	460		0.31660	27.61	241.4	1.05	915
145	166	466		0.34040	28.05	267.8	1.18	1031
146	175	475		0.34090	26.94	247.4	1.05	915
147	180	480		0.31780	26.23	218.6	0.90	787
148	195	495		0.34100	29.23	291.4	1.34	1169
149	1103	4103		0.31710	29.46	275.2	1.28	1113
150	1105	4105		0.31610	29.42	273.5	1.27	1105
151	1120	4120		0.33560	37.53	472.7	2.80	2436
152	402	502		0.02770	66.95	124.2	1.31	1142
153	403	503		0.07020	60.05	253.2	2.40	2088
154	410	510		0.02770	56.86	89.6	0.80	699
155	415	515		0.02770	54.40	82.0	0.70	612
156	422	522		0.02770	53.27	78.6	0.66	575
157	430	530		0.02770	62.66	108.8	1.07	936
158	433	533		0.07060	51.20	185.1	1.49	1301
159	438	538		0.02800	69.19	134.0	1.46	1273
160	445	545		0.02850	69.03	135.8	1.48	1287
161	453	553		0.02890	63.85	117.8	1.19	1033
162	456	556		0.07140	44.58	141.9	1.00	869
163	460	560		0.02890	65.74	124.9	1.29	1127
164	466	566		0.02890	62.38	112.4	1.10	963
165	467	567		0.07090	35.81	90.9	0.51	447
166	475	575		0.02890	50.85	74.7	0.60	522
167	480	580		0.07140	42.10	126.6	0.84	732
168	495	595		0.02840	59.29	99.8	0.93	812
169	4103	5103		0.07140	53.42	203.7	1.71	1494
170	4105	5105		0.02840	55.12	86.3	0.75	653
171	4120	5120		0.02840	67.58	129.7	1.38	1203

VnetPC for Windows v1.0a
H:\REPLADVA.VNW

Branch Results
06/23/99 10:46:14

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	502	702		0.20000	66.95	896.5	9.46	8241
173	503	703		0.20000	60.05	721.3	6.83	5947
174	510	710		0.18000	56.86	582.0	5.21	4544
175	515	715		0.15000	54.40	443.9	3.81	3316
176	522	722		0.10000	53.27	283.7	2.38	2075
177	530	730		0.03000	62.66	117.8	1.16	1013
178	533	733		0.01000	51.20	26.2	0.21	184
179	538	738		0.00000	69.19	0.0	0.00	0
180	545	745		0.00000	69.03	0.0	0.00	0
181	553	753		0.00000	63.85	0.0	0.00	0
182	556	756		0.00000	44.58	0.0	0.00	0
183	560	760		0.00000	65.74	0.0	0.00	0
184	566	766		0.00000	62.38	0.0	0.00	0
185	567	767		0.10000	35.81	128.2	0.72	630
186	575	775		0.05000	50.85	129.3	1.04	903
187	580	780		0.09000	42.10	159.5	1.06	922
188	595	795		0.10000	59.29	351.5	3.28	2861
189	5103	7103		0.15000	53.42	428.0	3.60	3139
190	5105	7105		0.20000	55.12	607.5	5.28	4598
191	5120	7120		0.20000	67.58	913.5	9.73	8476
192	3	104		0.01780	92.57	152.5	2.22	1938
193	104	103		0.00670	92.57	57.4	0.84	730

VnetPC for Windows v1.0a
H:\REPLADVA.VNW

Fixed Quantities
06/23/99 10:46:14

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.)
35	20	1		608.63		0.00001	0.00000	0.00001

VnetPC for Windows v1.0a
H:\REPLADVA.VNW

Fan Input
06/23/99 10:46:14

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: Fan curve #40
Points: 10

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

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

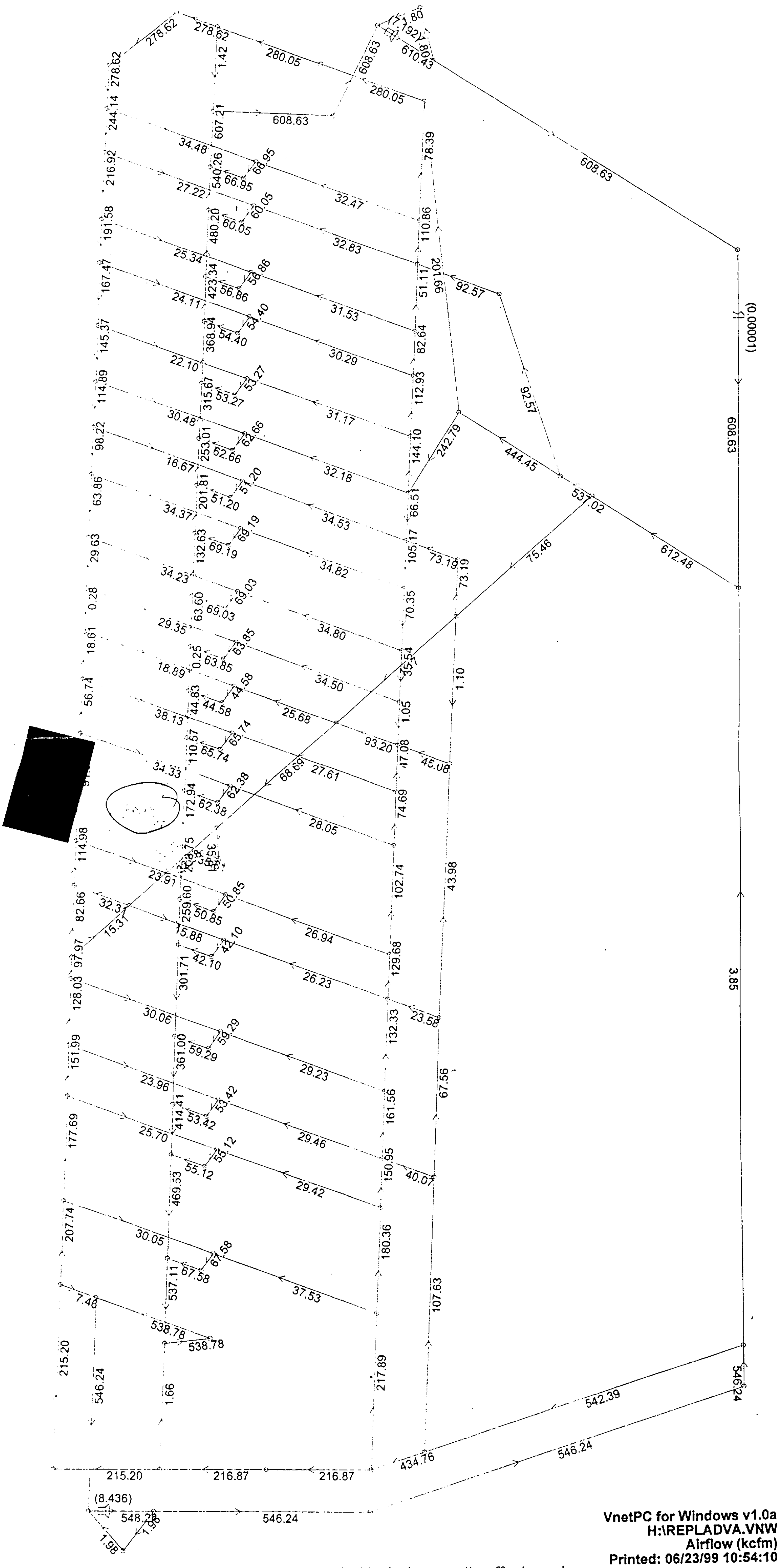
Fan Name: Joy 144-79-590
Fan Setting: 4
Comments: Fan curve #40
Points: 10

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

VnetPC for Windows v1.0a
H:\REPLADVA.VNW

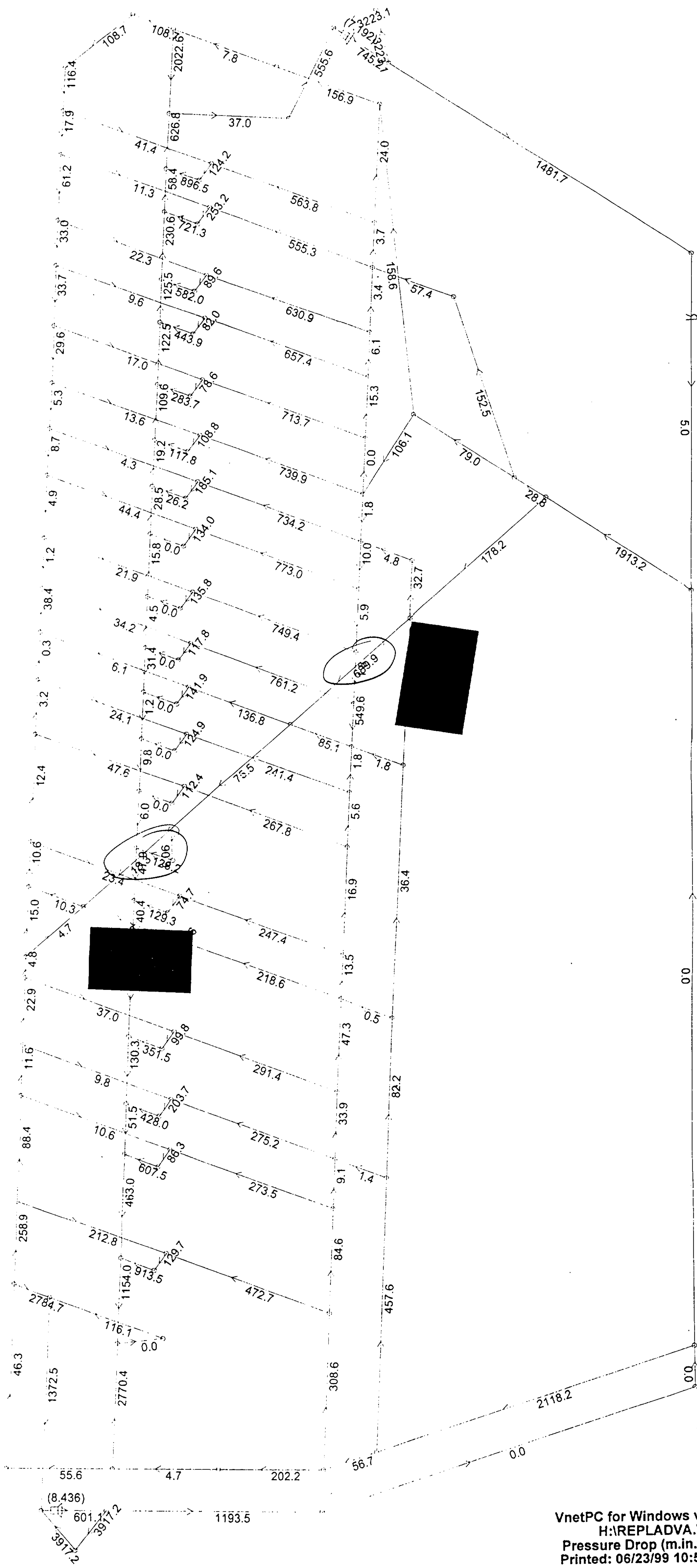
Fan Results
06/23/99 10:46:14

Fan No.	From	To	Fan Pressure (in.wg)	Fan Airflow (kcfm)	Fan Curve	Air Power (hp)	Operating Cost ($/yr)	Fan Description
1	17	18	7.192	610.43	On	691.79	602766	First Empl Shaft Fan
2	14	13	8.436	548.22	On	728.75	634975	Former Dev Shaft Fan



VnetPC for Windows v1.0a
H:\REPLADVA.VNW
Airflow (kcfm)
Printed: 06/23/99 10:54:10

Note: Obliteration of characters in this plot is not quality affecting and can be traced to the original VNETPC tabulated output. This plot of



VnetPC for Windows v1.0a
H:\REPLADVA.VNW
Pressure Drop (m.in.w.g.)
Printed: 06/23/99 10:56:30

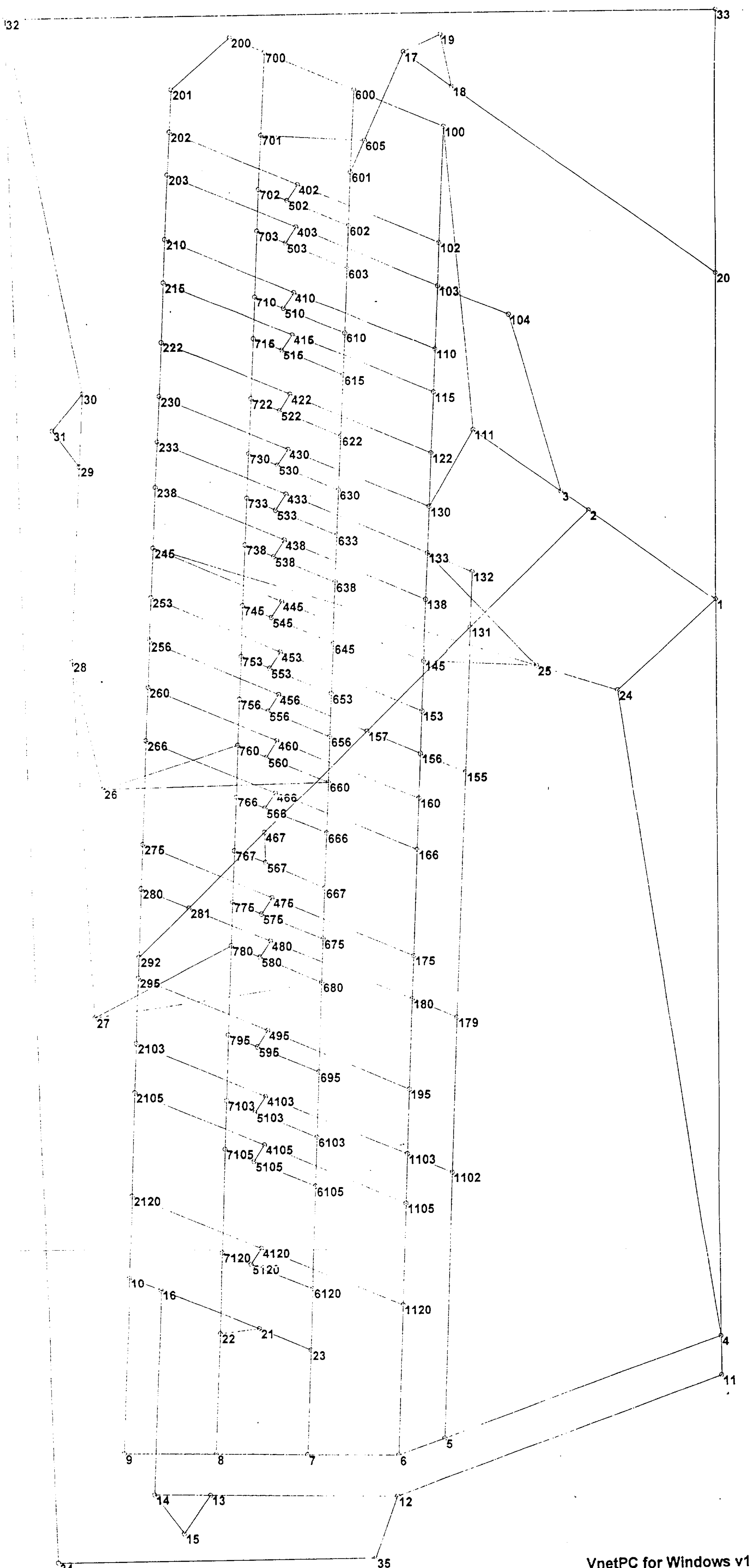
Note: Obliteration of characters in this plot is not quality affecting and

VNETPC Ventilation Model for 1.0 m^3/s per emplacement drift split

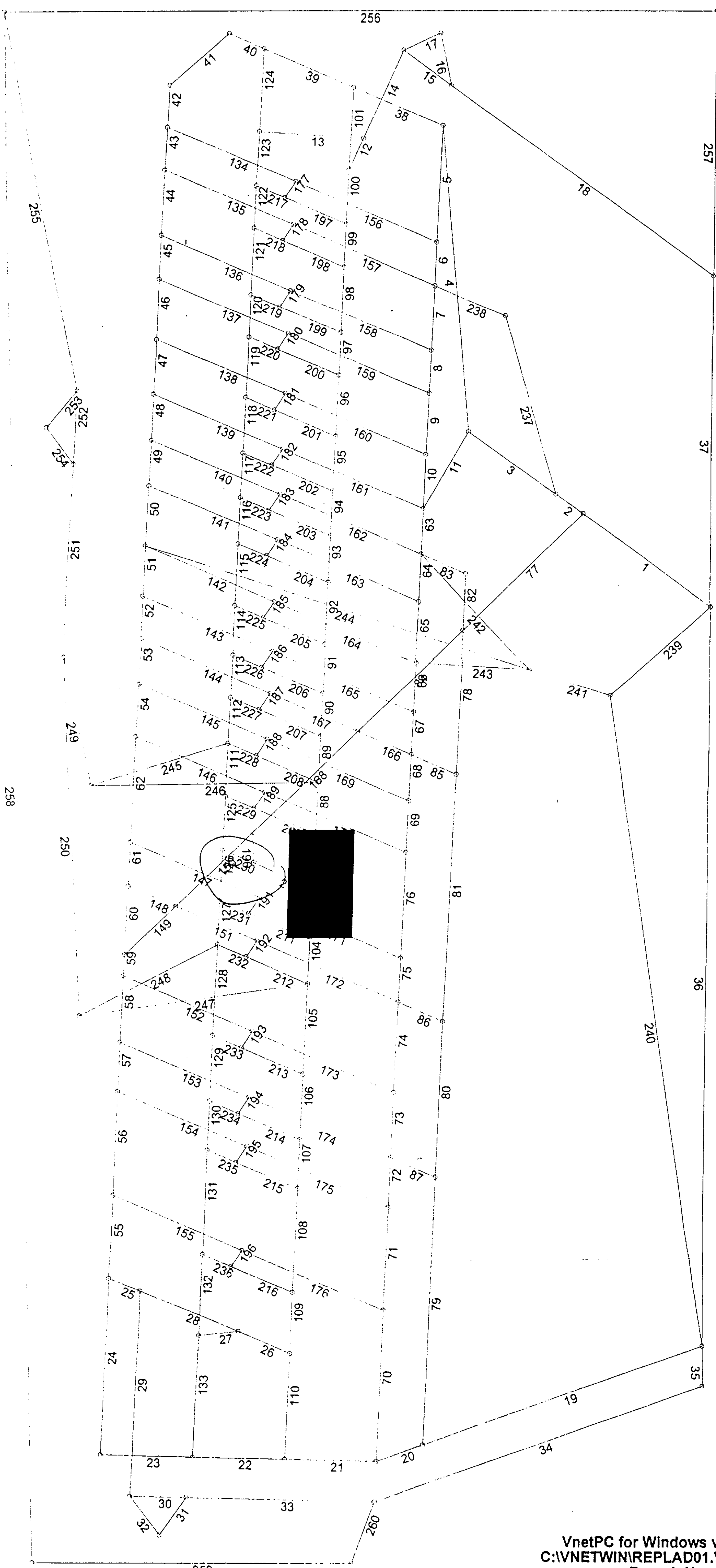
A ventilation model was created in preparation for postclosure natural ventilation mode. At this stage, a projected normal mechanical ventilation balance was established. A diagram of the model was prepared with assigned nodes and branches. Resistance of the branch representing the airways were calculated through Microsoft Excel Spreadsheet and used as input to VNETPC. The ventilation model was simulated with a selected fan curve on the primary system. From the performance shown by the primary fan output of VNETPC, the overall system resistance was calculated. The overall resistance was correlated and applied to natural ventilation pressure of 124 and 248 Pa (0.5 and 1.0 inch Water Gage) postclosure mode. The results are tabulated below:

Calculation for R from VNETPC file: REPLAD01.VNW							
	With Mechanical Power				Predicted Air at NVP Case		
	H	**Q**	**R**		**H**	**Nat Vent Q**	**Air Flow**
	Pressure	Air Quan	Resistance				
	inch WG	cfm/100000	R = H/Q^2		inch WG	Q=(H/R)^.5	q=Qx100000
					(NVP)		cfm
Case NVP = 0.5"							
Fan 1	7.140	5.8318	0.2099389		1	2.18	218250
Fan 2	7.501	5.7497	0.226897		1	2.10	209935
Fan 3	4.390	6.2741	0.1115223		0.5	2.12	211741
					Total		639926
				Average cfm per drift for 240 split			2666

Observation: New design layout with additional exhaust main, intake & exhaust shafts can exceed the 1.0 m^3/s (2119 cfm) average airflow per emplacement drift at projected NVP over 10,000 years.



VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW
Line Plot
Printed: 06/28/99 13:38:08



VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW
Branch Numbers
Printed: 06/28/99 13:41:56

Note: Obliteration of characters in this plot is not quality affecting and can be traced to the original VNETPC tabulated output. This plot of VNETPC output is only used as a general guide to understand the intricacies of the ventilation model.

VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW

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: Set 25 deg
Comments: JOY-M132-79-710 BLADE SET 25 DEG
Points: 10

Quantity	Pressure	
50.00	18.000	Stalling
130.00	15.000	Stalling
200.00	12.600	Stalling
270.00	11.400	Stalling
325.00	12.600	Stalling
380.00	13.400	Max normal operation
440.00	12.400	Normal operation
500.00	10.800	Normal operation
600.00	6.400	Normal operation
660.00	2.000	Normal operation

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

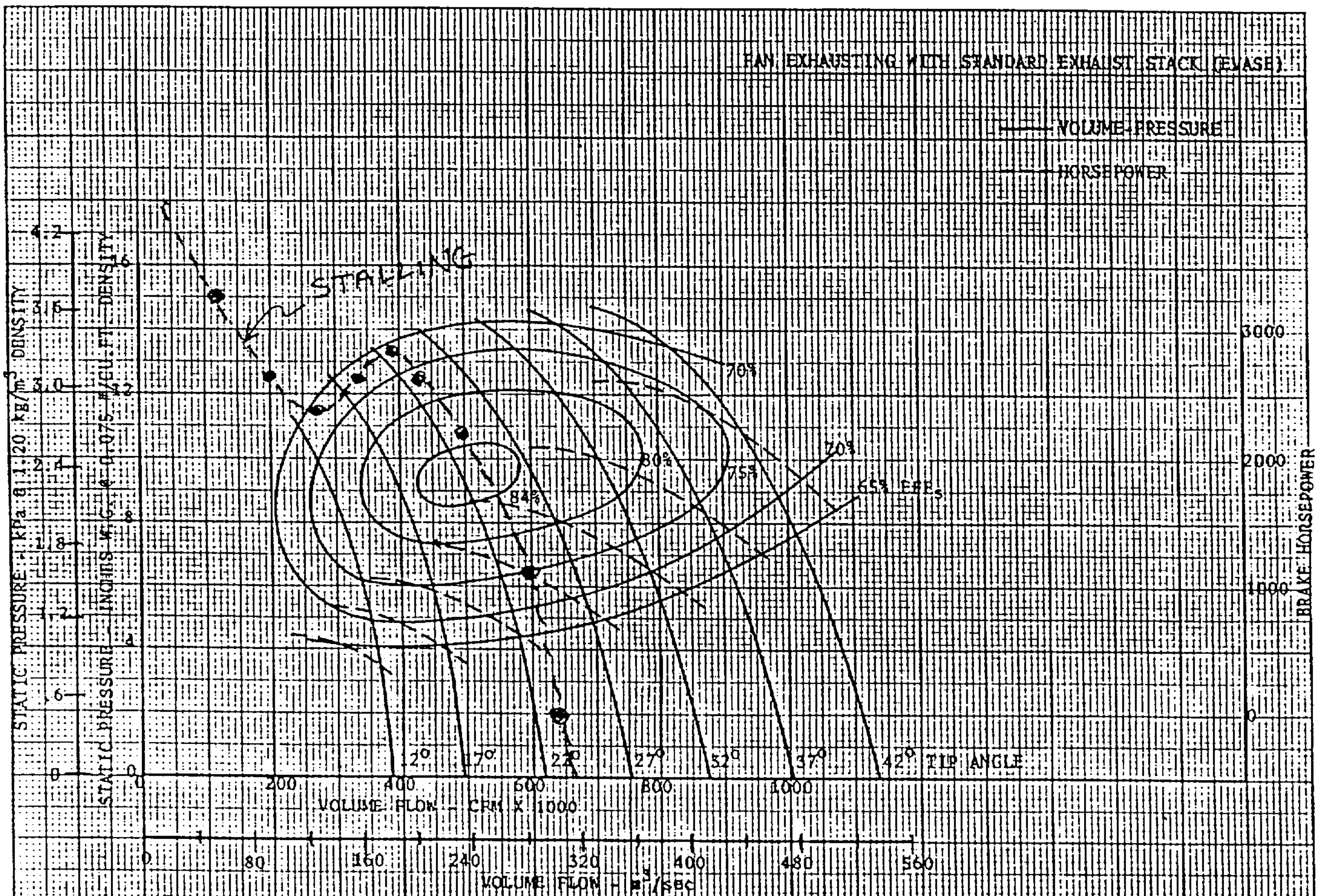
Fan Name: VNETPC 3.1 #19
Fan Setting: Set 25 deg
Comments: JOY-M132-79-710 BLADE SET 25 DEG
Points: 10

Quantity	Pressure	
50.00	18.000	Stalling
130.00	15.000	Stalling
200.00	12.600	Stalling
270.00	11.400	Stalling
325.00	12.600	Stalling
380.00	13.400	Max normal operation
440.00	12.400	Normal operation
500.00	10.800	Normal operation
600.00	6.400	Normal operation
660.00	2.000	Normal operation

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: Set 25 deg
Comments: JOY-M132-79-710 BLADE SET 25 DEG
Points: 10

Quantity	Pressure	
50.00	18.000	Stalling
130.00	15.000	Stalling
200.00	12.600	Stalling
270.00	11.400	Stalling
325.00	12.600	Stalling
380.00	13.400	Max normal operation
440.00	12.400	Normal operation
500.00	10.800	Normal operation
600.00	6.400	Normal operation
660.00	2.000	Normal operation



APRIL 1, 1982
C-8242

JOY AXIVANE MINE FAN
FAN MODEL M132-79-710

Calculation of Airway Resistances During Caretaker Phase Prior to Postclosure (Going to postclosure natural vent at 1 m^3/s per drift split)

FILE # Replad01-05-10-va.xls; Folder - Replad01N: VNETPC INPUT, Design Feature Development, Case 1 m^3/s per emplacement drift. (Data prepared by RSJurani & A Linden)

Line No	BRANCH FROM	TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb (3.5)	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 (3.3)	X-SECT AREA A (Ft^2)	PERIMETER P (Ft) (3.3)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L=L'+10% (Ft) (3.23)	NOTES FOR BRANCH DESCRIPTION
1	1	2	0.0051		0.0051	0.0509	30	389.33	72.36	1992.0	6535	7189	North Ramp
2	2	3	0.0001		0.0001	0.0011	30	389.33	72.36	43.6	143	157	North Ramp
3	3	111	0.0004		0.0004	0.0039	30	389.33	72.36	151.4	497	546	North Ramp
4	111	100	0.0039		0.0039	0.0394	30	389.33	72.36	1543.0	5062	5569	North Ramp Ext
5	100	102	0.0039		0.0039	0.0390	70	389.33	72.36	654.6	2148	2362	East Main Drift Ext.
6	102	103	0.0003		0.0003	0.0028	70	389.33	72.36	43.5	143	157	East Main Drift
7	103	110	0.0013		0.0013	0.0130	70	389.33	72.36	217.4	713	785	East Main Drift
8	110	115	0.0009		0.0009	0.0086	70	389.33	72.36	144.9	475	523	East Main Drift
9	115	122	0.0012		0.0012	0.0121	70	389.33	72.36	202.9	666	732	East Main Drift
10	122	130	0.0014		0.0014	0.0138	70	389.33	72.36	231.9	761	837	East Main Drift
11	111	130	0.0018		0.0018	0.0178	30	389.33	72.36	698.5	2292	2521	North Ramp Curve
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
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
14	605	17	0.0008		0.0008	0.0082	25	402.49	71.12	431.2	1415	1556	Emplacement Shaft (6.9 m dia.)
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
20	5	6	0.0003		0.0003	0.0025	60	389.33	72.36	49.2	161	178	South Ramp
21	6	7	0.0043		0.0043	0.0427	60	389.33	72.36	835.8	2742	3016	South Ramp
22	7	8	0.0001		0.0001	0.0012	60	389.33	72.36	23.1	76	83	South Ramp
23	8	9	0.0012		0.0012	0.0116	60	389.33	72.36	227.2	745	820	South Ramp
24	9	10	0.0010		0.0010	0.0102	60	389.33	72.36	200.0	656	722	South Ramp Ext Curve
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
26	23	21	0.0001		0.0001	0.0010	25	446.53	80.13	66.6	219	240	East Exhaust Main to Connector
27	22	21	0.0000		0.0000	0.0004	25	446.53	80.13	26.1	86	94	West Exhaust Main to Connector
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
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)
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	4	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
39	600	700	0.0001		0.0001	0.0015	70	389.33	72.36	25.1	82	91	North Main
40	700	200	0.0014		0.0014	0.0144	70	389.33	72.36	241.7	793	872	North Main

Calculation of Airway Resistances During Caretaker Phase Prior to Postclosure (Going to postclosure natural vent at 1 m^3/s per drift split)

FILE # Replad01-05-10-va.xls; Folder - Replad01N: VNETPC INPUT, Design Feature Development, Case 1 m^3/s per emplacement drift. (Data prepared by RSJurani & A Linden)

Line No	BRANCH		RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb (3.5)	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 (3.3)	X-SECT AREA A (Ft^2)	PERIMETER P (Ft) (3.3)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L=L'+10% (Ft) (3.23)	NOTES FOR BRANCH DESCRIPTION
	FROM	TO											
41	200	201	0.0014		0.0014	0.0141	70	389.33	72.36	236.1	775	852	West Main
42	201	202	0.0015		0.0015	0.0147	70	389.33	72.36	246.5	809	890	West main
43	202	203	0.0003		0.0003	0.0026	70	389.33	72.36	43.5	143	157	West main
44	203	210	0.0013		0.0013	0.0130	70	389.33	72.36	217.4	713	785	West main
45	210	215	0.0009		0.0009	0.0086	70	389.33	72.36	144.9	475	523	West main
46	215	222	0.0012		0.0012	0.0121	70	389.33	72.36	202.9	666	732	West main
47	222	230	0.0014		0.0014	0.0137	70	389.33	72.36	230.1	755	830	West main
48	230	233	0.0004		0.0004	0.0042	70	389.33	72.36	70.1	230	253	West main
49	233	238	0.0009		0.0009	0.0092	70	389.33	72.36	154.5	507	558	West main
50	238	245	0.0012		0.0012	0.0117	70	389.33	72.36	197.1	647	711	West main
51	245	253	0.0014		0.0014	0.0136	70	389.33	72.36	228.9	751	826	West main
52	253	256	0.0004		0.0004	0.0043	70	389.33	72.36	71.5	235	258	West main
53	256	260	0.0008		0.0008	0.0077	70	389.33	72.36	128.7	422	464	West main
54	260	266	0.0010		0.0010	0.0102	70	389.33	72.36	171.7	563	620	West main
55	10	2120	0.0060		0.0060	0.0595	70	389.33	72.36	999.2	3278	3606	West main
56	2120	2105	0.0028		0.0028	0.0280	70	389.33	72.36	470.3	1543	1697	West main
57	2105	2103	0.0005		0.0005	0.0047	70	389.33	72.36	78.4	257	283	West main
58	2103	295	0.0014		0.0014	0.0140	70	389.33	72.36	235.2	772	849	West main
59	295	292	0.0005		0.0005	0.0045	70	389.33	72.36	75.9	249	274	West main
60	292	280	0.0022		0.0022	0.0224	70	389.33	72.36	376.2	1234	1358	West main
61	280	275	0.0008		0.0008	0.0077	70	389.33	72.36	128.7	422	464	West main
62	275	266	0.0015		0.0015	0.0153	70	389.33	72.36	257.5	845	929	West main
63	130	133	0.0004		0.0004	0.0043	70	389.33	72.36	72.5	238	262	East Main
64	133	138	0.0009		0.0009	0.0095	70	389.33	72.36	159.4	523	575	East Main
65	138	145	0.0012		0.0012	0.0121	70	389.33	72.36	202.9	666	732	East Main
66	145	153	0.0014		0.0014	0.0138	70	389.33	72.36	231.9	761	837	East Main
67	153	156	0.0004		0.0004	0.0043	70	389.33	72.36	72.5	238	262	East Main
68	156	160	0.0008		0.0008	0.0078	70	389.33	72.36	130.4	428	471	East Main
69	160	166	0.0010		0.0010	0.0104	70	389.33	72.36	173.9	571	628	East Main
70	6	1120	0.0065		0.0065	0.0651	70	389.33	72.36	1093.1	3586	3945	East Main
71	1120	1105	0.0026		0.0026	0.0259	70	389.33	72.36	434.8	1427	1569	East Main
72	1105	1103	0.0004		0.0004	0.0043	70	389.33	72.36	72.5	238	262	East Main
73	1103	195	0.0013		0.0013	0.0130	70	389.33	72.36	217.4	713	785	East Main
74	195	180	0.0027		0.0027	0.0268	70	389.33	72.36	449.3	1474	1621	East Main
75	180	175	0.0008		0.0008	0.0078	70	389.33	72.36	130.4	428	471	East Main
76	175	166	0.0016		0.0016	0.0155	70	389.33	72.36	260.9	856	942	East Main
77	2	131	0.0313		0.0313	0.3130	70	177.60	48.44	745.0	2444	2689	ECRB
78	131	155	0.0119		0.0119	0.1193	70	211.30	52.57	440.8	1446	1591	PC Main
79	5	1102	0.0395		0.0395	0.3946	70	211.30	52.57	1457.6	4782	5260	PC Main
80	1102	179	0.0180		0.0180	0.1805	70	211.30	52.57	666.7	2187	2406	PC Main

Calculation of Airway Resistances During Caretaker Phase Prior to Postclosure (Going to postclosure natural vent at 1 m^3/s per drift split)

FILE # Replad01-05-10-va.xls; Folder - Replad01N: VNETPC INPUT, Design Feature Development, Case 1 m^3/s per emplacement drift. (Data prepared by RSJurani & A Linden)

Line No	BRANCH FROM	BRANCH TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb (3.5)	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 (3.3)	X-SECT AREA A (Ft^2)	PERIMETER P (Ft) (3.3)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L=L'+10% (Ft) (3.23)	NOTES FOR BRANCH DESCRIPTION
81	179	155	0.0188		0.0188	0.1883	70	211.30	52.57	695.7	2282	2511	PC Main
82	131	132	0.0061		0.0061	0.0612	70	211.30	52.57	225.9	741	815	PC Main
83	132	133	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 2
84	131	157	0.5201	0.5000	0.0201	0.2014	70	177.60	48.44	479.4	1573	1730	ECRB
85	155	156	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 3
86	179	180	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 4
87	1102	1103	0.0009		0.0009	0.0086	70	211.30	52.57	31.6	104	114	PC 5
88	666	660	0.0008		0.0008	0.0080	60	401.49	72.36	172.7	567	623	East Exhaust Main
89	660	656	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	East Exhaust Main
90	656	653	0.0003		0.0003	0.0034	60	401.49	72.36	72.0	236	260	East Exhaust Main
91	653	645	0.0011		0.0011	0.0107	60	401.49	72.36	230.3	756	831	East Exhaust Main
92	645	638	0.0009		0.0009	0.0092	60	401.49	72.36	198.2	650	715	East Exhaust Main
93	638	633	0.0007		0.0007	0.0072	60	401.49	72.36	154.7	508	558	East Exhaust Main
94	633	630	0.0003		0.0003	0.0033	60	401.49	72.36	70.4	231	254	East Exhaust Main
95	630	622	0.0011		0.0011	0.0108	60	401.49	72.36	231.8	760	837	East Exhaust Main
96	622	615	0.0009		0.0009	0.0094	60	401.49	72.36	202.9	666	732	East Exhaust Main
97	615	610	0.0007		0.0007	0.0067	60	401.49	72.36	144.9	475	523	East Exhaust Main
98	610	603	0.0010		0.0010	0.0101	60	401.49	72.36	217.4	713	785	East Exhaust Main
99	603	602	0.0002		0.0002	0.0020	60	401.49	72.36	43.5	143	157	East Exhaust Main
100	602	601	0.0019		0.0019	0.0187	60	401.49	72.36	400.7	1315	1446	East Exhaust Main
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)
102	666	667	0.0002		0.0002	0.0016	60	401.49	72.36	33.5	110	121	East Exhaust Main
103	667	675	0.0011		0.0011	0.0105	60	401.49	72.36	225.6	740	814	East Exhaust Main
104	675	680	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	East Exhaust Main
105	680	695	0.0021		0.0021	0.0210	60	401.49	72.36	450.0	1476	1624	East Exhaust Main
106	695	6103	0.0010		0.0010	0.0105	60	401.49	72.36	225.1	739	812	East Exhaust Main
107	6103	6105	0.0003		0.0003	0.0035	60	401.49	72.36	75.1	246	271	East Exhaust Main
108	6105	6120	0.0021		0.0021	0.0210	60	401.49	72.36	450.2	1477	1625	East Exhaust Main
109	6120	23	0.0040		0.0040	0.0400	60	401.49	72.36	860.1	2822	3104	East Exhaust Main
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)
111	766	760	0.0008		0.0008	0.0080	60	401.49	72.36	172.7	567	623	West Exhaust Main
112	760	756	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	West Exhaust Main
113	756	753	0.0003		0.0003	0.0034	60	401.49	72.36	72.0	236	260	West Exhaust Main
114	753	745	0.0011		0.0011	0.0107	60	401.49	72.36	230.3	756	831	West Exhaust Main
115	745	738	0.0009		0.0009	0.0092	60	401.49	72.36	198.1	650	715	West Exhaust Main
116	738	733	0.0007		0.0007	0.0072	60	401.49	72.36	154.7	508	558	West Exhaust Main
117	733	730	0.0003		0.0003	0.0033	60	401.49	72.36	70.4	231	254	West Exhaust Main
118	730	722	0.0011		0.0011	0.0107	60	401.49	72.36	230.8	757	833	West Exhaust Main
119	722	715	0.0009		0.0009	0.0094	60	401.49	72.36	202.9	666	732	West Exhaust Main
120	715	710	0.0007		0.0007	0.0067	60	401.49	72.36	144.9	475	523	West Exhaust Main

Calculation of Airway Resistances During Caretaker Phase Prior to Postclosure (Going to postclosure natural vent at 1 m^3/s per drift split)

FILE # Replad01-05-10-va.xls; Folder - Replad01N: VNETPC INPUT, Design Feature Development, Case 1 m^3/s per emplacement drift. (Data prepared by RSJurani & A Linden)

Line No	BRANCH FROM	BRANCH TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb (3.5)	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 (3.3)	X-SECT AREA A (Ft^2)	PERIMETER P (Ft) (3.3)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L=L'+10% (Ft) (3.23)	NOTES FOR BRANCH DESCRIPTION
121	710	703	0.0010		0.0010	0.0101	60	401.49	72.36	217.4	713	785	West Exhaust Main
122	703	702	0.0002		0.0002	0.0020	60	401.49	72.36	43.5	143	157	West Exhaust Main
123	702	701	0.0017		0.0017	0.0173	60	401.49	72.36	371.6	1219	1341	West Exhaust Main
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)
125	766	767	0.0002		0.0002	0.0016	60	401.49	72.36	33.5	110	121	West Exhaust Main
126	767	775	0.0011		0.0011	0.0105	60	401.49	72.36	225.6	740	814	West Exhaust Main
127	775	780	0.0006		0.0006	0.0060	60	401.49	72.36	129.6	425	468	West Exhaust Main
128	780	795	0.0021		0.0021	0.0210	60	401.49	72.36	450.2	1477	1625	West Exhaust Main
129	795	7103	0.0010		0.0010	0.0105	60	401.49	72.36	225.1	739	812	West Exhaust Main
130	7103	7105	0.0003		0.0003	0.0035	60	401.49	72.36	75.1	246	271	West Exhaust Main
131	7105	7120	0.0021		0.0021	0.0210	60	401.49	72.36	450.2	1477	1625	West Exhaust Main
132	7120	22	0.0040		0.0040	0.0403	60	401.49	72.36	865.8	2841	3125	West Exhaust Main
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)
134	202	402	0.0348		0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift West Side
135	203	403	0.0152		0.0152	0.1516	70	211.30	52.57	559.9	1837	2021	PC 1 West Side
136	210	410	0.0348		0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift West Side
137	215	415	0.0165		0.0165	0.1654	70	201.93	52.57	533.3	1750	1925	Emplacement Drift West Side (Empty)
138	222	422	0.0348		0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift West Side
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
140	233	433	0.2156	0.2000	0.0156	0.1560	70	211.30	52.57	576.4	1891	2080	PC 2 West Side
141	238	438	0.0376		0.0376	0.3760	85	168.13	52.57	576.3	1891	2080	Emplacement Drift West Side
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)
143	253	453	0.1197	0.0800	0.0397	0.3970	85	168.13	52.57	608.4	1996	2196	Emplacement Drift West Side
144	256	456	0.1672	0.1500	0.0172	0.1725	70	211.30	52.57	637.1	2090	2299	PC 3 West Side
145	260	460	0.0166		0.0166	0.1662	70	211.30	52.57	614.1	2015	2216	Cross Block 60
146	266	466	0.2404	0.2000	0.0404	0.4039	85	168.13	52.57	619.0	2031	2234	Emplacement Drift West Side
147	275	475	0.2409	0.2000	0.0409	0.4087	85	168.13	52.57	626.4	2055	2261	Emplacement Drift West Side
148	280	281	0.0099		0.0099	0.0992	70	211.30	52.57	366.5	1202	1323	PC 4 West Side 1st leg
149	292	281	0.0200		0.0200	0.2001	70	177.60	48.44	476.3	1563	1719	ECRB West Side
150	281	467	0.0169		0.0169	0.1693	70	177.60	48.44	403.0	1322	1454	ECRB West Side
151	281	480	0.0079		0.0079	0.0785	70	211.30	52.57	290.1	952	1047	PC 4 West Side 2nd leg
152	295	495	0.2410	0.2000	0.0410	0.4104	85	168.13	52.57	629.0	2064	2270	Emplacement Drift West Side
153	2103	4103	0.0171		0.0171	0.1708	70	211.30	52.57	630.8	2070	2277	PC 5 West Side
154	2105	4105	0.2161	0.2000	0.0161	0.1613	70	211.30	52.57	595.9	1955	2151	Cross Block 105
155	2120	4120	0.2356	0.2000	0.0356	0.3565	85	168.13	52.57	546.3	1792	1972	Emplacement Drift West Side
156	102	402	0.2348	0.2000	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift East Side
157	103	403	0.2152	0.2000	0.0152	0.1516	70	211.30	52.57	559.9	1837	2021	PC 1 East Side
158	110	410	0.2348	0.2000	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift East Side
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)
160	122	422	0.2348	0.2000	0.0348	0.3480	85	168.13	52.57	533.3	1750	1925	Emplacement Drift East Side

Calculation of Airway Resistances During Caretaker Phase Prior to Postclosure (Going to postclosure natural vent at 1 m^3/s per drift split)

FILE # Replad01-05-10-va.xls; Folder - Replad01N: VNETPC INPUT, Design Feature Development, Case 1 m^3/s per emplacement drift. (Data prepared by RSJurani & A Linden)

Line No	BRANCH FROM	BRANCH TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb (3.5)	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 (3.3)	X-SECT AREA A (Ft^2)	PERIMETER P (Ft) (3.3)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L=L'+10% (Ft) (3.23)	NOTES FOR BRANCH DESCRIPTION
161	130	430	0.5146	0.5000	0.0146	0.1457	70	211.30	52.57	538.3	1766	1943	Cross Block 30
162	133	433	0.5156	0.5000	0.0156	0.1560	70	211.30	52.57	576.4	1891	2080	PC 2 East
163	138	438	0.2376	0.2000	0.0376	0.3760	85	168.13	52.57	576.3	1891	2080	Emplacement Drift East Side
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)
165	153	453	0.3897	0.3500	0.0397	0.3970	85	168.13	52.57	608.4	1996	2196	Emplacement Drift East Side
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
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
168	157	467	0.0160		0.0160	0.1600	70	177.60	48.44	380.9	1250	1375	ECRB
169	160	460	0.3166	0.3000	0.0166	0.1662	70	211.30	52.57	614.1	2015	2216	Cross Block 60
170	166	466	0.5404	0.5000	0.0404	0.4039	85	168.13	52.57	619.0	2031	2234	Emplacement Drift East Side
171	175	475	0.5409	0.5000	0.0409	0.4087	85	168.13	52.57	626.4	2055	2261	Emplacement Drift East Side
172	180	480	0.2678	0.2500	0.0178	0.1778	70	211.30	52.57	656.6	2154	2370	PC 4 East Side
173	195	495	0.5410	0.5000	0.0410	0.4104	85	168.13	52.57	629.0	2064	2270	Emplacement Drift East Side
174	1103	4103	0.2171	0.2000	0.0171	0.1708	70	211.30	52.57	630.8	2070	2277	PC 5 East Side
175	1105	4105	0.5161	0.5000	0.0161	0.1613	70	211.30	52.57	595.9	1955	2151	Cross Block 105
176	1120	4120	0.5356	0.5000	0.0356	0.3565	85	168.13	52.57	546.3	1792	1972	Emplacement Drift East Side
177	402	502	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Empl Level to Exhaust Main
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
179	410	510	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Empl Level to Exhaust Main
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
181	422	522	0.0277		0.0277	0.2769	20	24.43	17.52	16.6	54	60	Raise Connector, Emp Level to Exhaust Main
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
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
184	438	538	0.0280		0.0280	0.2802	20	24.43	17.52	16.8	55	61	Raise Connector, Emp Level to Exhaust Main
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
186	453	553	0.0289		0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Emp Level to Exhaust Main
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
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
189	466	566	0.0289		0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Emp Level to Exhaust Main
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
191	475	575	0.0289		0.0289	0.2885	20	24.43	17.52	17.3	57	62	Raise Connector, Emp Level to Exhaust Main
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
193	495	595	0.0284		0.0284	0.2835	20	24.43	17.52	17.0	56	61	Raise Connector, Emp Level to Exhaust Main
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
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
196	4120	5120	0.0284		0.0284	0.2835	20	24.43	17.52	17.0	56	61	Raise Connector, Emp Level to Exhaust Main
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 Mains
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 Mains
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 Mains
200	515	615	0.0497	0.0100	0.0397	0.3970	20	24.43	17.52	23.8	78	86	

Calculation of Airway Resistances During Caretaker Phase Prior to Postclosure (Going to postclosure natural vent at 1 m^3/s per drift split)

FILE # Replad01-05-10-va.xls; Folder - Replad01N: VNETPC INPUT, Design Feature Development, Case 1 m^3/s per emplacement drift. (Data prepared by RSJurani & A Linden)

Line No.	BRANCH FROM	BRANCH TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb (3.5)	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 (3.3)	X-SECT AREA A (Ft^2)	PERIMETER P (Ft) (3.3)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L=L'+10% (Ft) (3.23)	NOTES FOR BRANCH DESCRIPTION
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 Mains
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
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 Mains
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 Mains
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
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 Mains
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 Mains
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 Mains
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 Mains
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 Mains
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 Mains
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 Mains
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 Mains
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 Mains
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 Mains
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 Mains
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
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
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

Calculation of Airway Resistances During Caretaker Phase Prior to Postclosure (Going to postclosure natural vent at 1 m^3/s per drift split)

FILE # Replad01-05-10-va.xls; Folder - Replad01N: VNETPC INPUT, Design Feature Development, Case 1 m^3/s per emplacement drift. (Data prepared by RSJurani & A Linden)

Line No	BRANCH FROM	BRANCH TO	RESISTANCE in PU VNETPC Input RPUa+RPUb	REGULATOR RESISTANCE in PU Field Installed RPUb (3.5)	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 (3.3)	X-SECT AREA A (Ft^2)	PERIMETER P (Ft) (3.3)	ACTUAL LENGTH meter (m)	ACTUAL LENGTH L' (Ft)	EQUIV. LENGTH L=L'+10% (Ft) (3.23)	NOTES FOR BRANCH DESCRIPTION
241	24	25	0.0001		0.0001	0.0007	25	828.57	102.04	240.3	788	867	Intake Shaft 9.9 m dia
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
243	25	145	0.1005	0.1000	0.0005	0.0049	25	446.53	80.13	314.5	1032	1135	Connecting Drift
244	25	245	0.0040		0.0040	0.0397	25	389.33	72.36	1864.8	6118	6730	Shaft Connecting Drift 7.62 dia, total distance *
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
246	660	26	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector Drift
247	680	27	0.0001		0.0001	0.0014	25	389.33	72.36	66.6	219	240	East Exhaust Main to Connector Drift
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
249	26	28	0.0005		0.0005	0.0048	25	446.53	80.13	305.6	1003	1103	Connecting Access Drift, I-4 dist + 5m alcove
250	27	28	0.0008		0.0008	0.0079	25	446.53	80.13	506.7	1662	1829	Connecting Access Drift, I-4 dist + 5m alcove
251	28	29	0.0001		0.0001	0.0013	25	828.57	102.04	408.3	1340	1474	Exhaust Shaft 9.9 m dia
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

VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW

Model Information
06/02/99 10:59:20

REPOSITORY 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 ASSUMPTION (3.25)
Units: British

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

Last Airflow Analysis NSK 28 JULY 99
Date: 05/08/99
Time: 12:52 AM
Elapsed Time: 00:00:02

Number of Iterations: 3
Number of Errors: 0
Modified Since: YES

VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW

Branch Input
06/02/99 10:59:20

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)
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				
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				

VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW

Branch Input
06/02/99 10:59:20

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)
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				
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				

VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW

Branch Input
06/02/99 10:59:[illegible]

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)
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				
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				
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				

VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW

Branch Input
06/02/99 10:59:00

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)
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				
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				

VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW

Branch Input
06/02/99 10:59:20

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)
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				
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				

VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW

Branch Results
06/02/99 10:59:20

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)
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

VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW

Branch Resu
06/02/99 10:59

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

VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW

Branch Res
06/02/99 10:5

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

VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW

Branch Resu
06/02/99 10:59

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

VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW

Branch Resu
06/02/99 10:59

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

VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW

Fixed Quanti
06/02/99 10:5

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	

VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW

Fan Inp
06/02/99 10:59:

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: Set 25 deg
Comments: JOY-M132-79-710 BLADE SET 25 DEG
Points: 10

Quantity	Pressure	Description
50.00	18.000	Stalling
130.00	15.000	Stalling
200.00	12.600	Stalling
270.00	11.400	Stalling
325.00	12..600	Stalling
380.00	13.400	Max normal operation
440.00	12.400	Normal operation
500.00	10.800	Normal operation
600.00	6.400	Normal operation
660.00	2.000	Normal operation

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: Set 25 deg
Comments: JOY-M132-79-710 BLADE SET 25 DEG
Points: 10

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

VnetPC for Windows v1.0a Fan In
C:\VNETWIN\REPLAD01.VNW 06/02/99 10:59

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

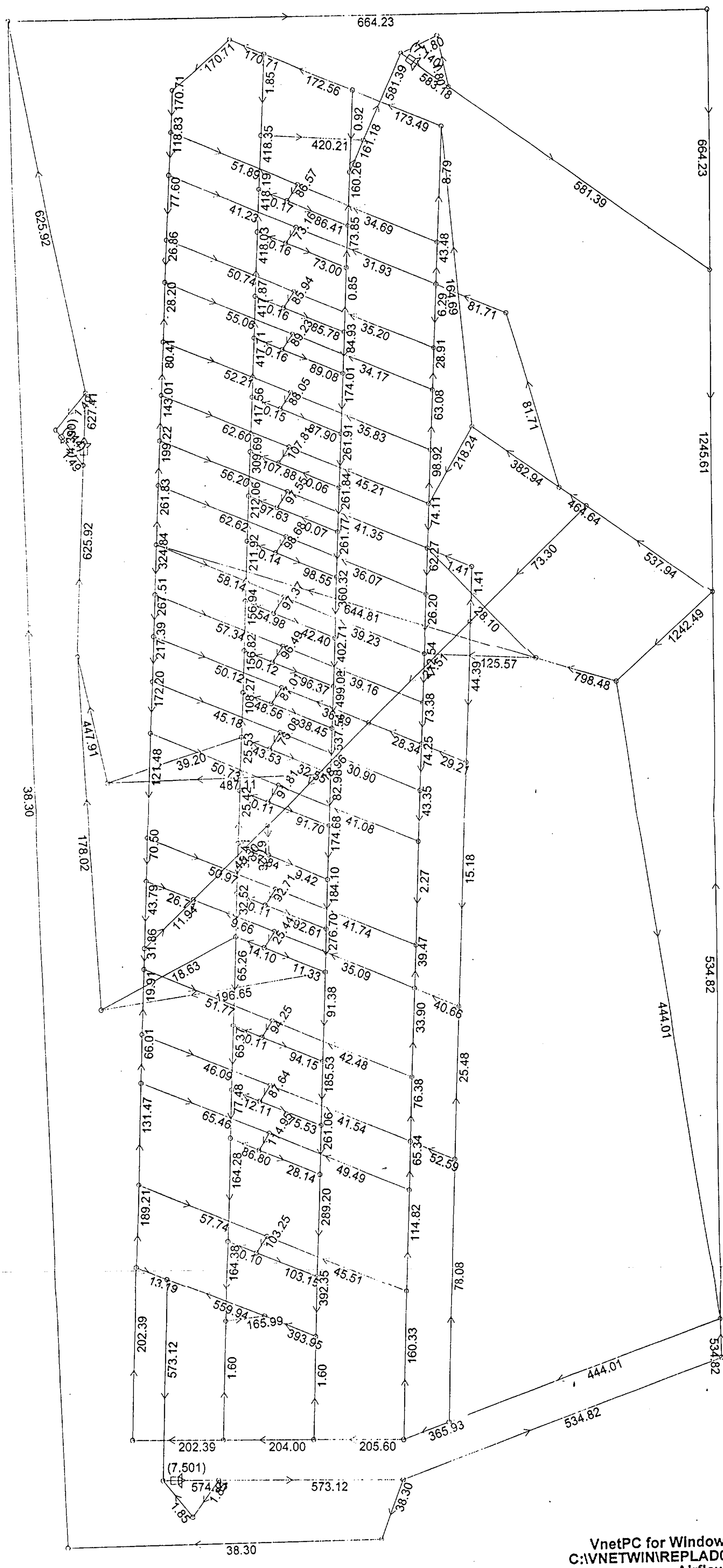
Fan Name: VNETPC 3.1 #19
Fan Setting: Set 25 deg
Comments: JOY-M132-79-710 BLADE SET 25 DEG
Points: 10

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

VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW

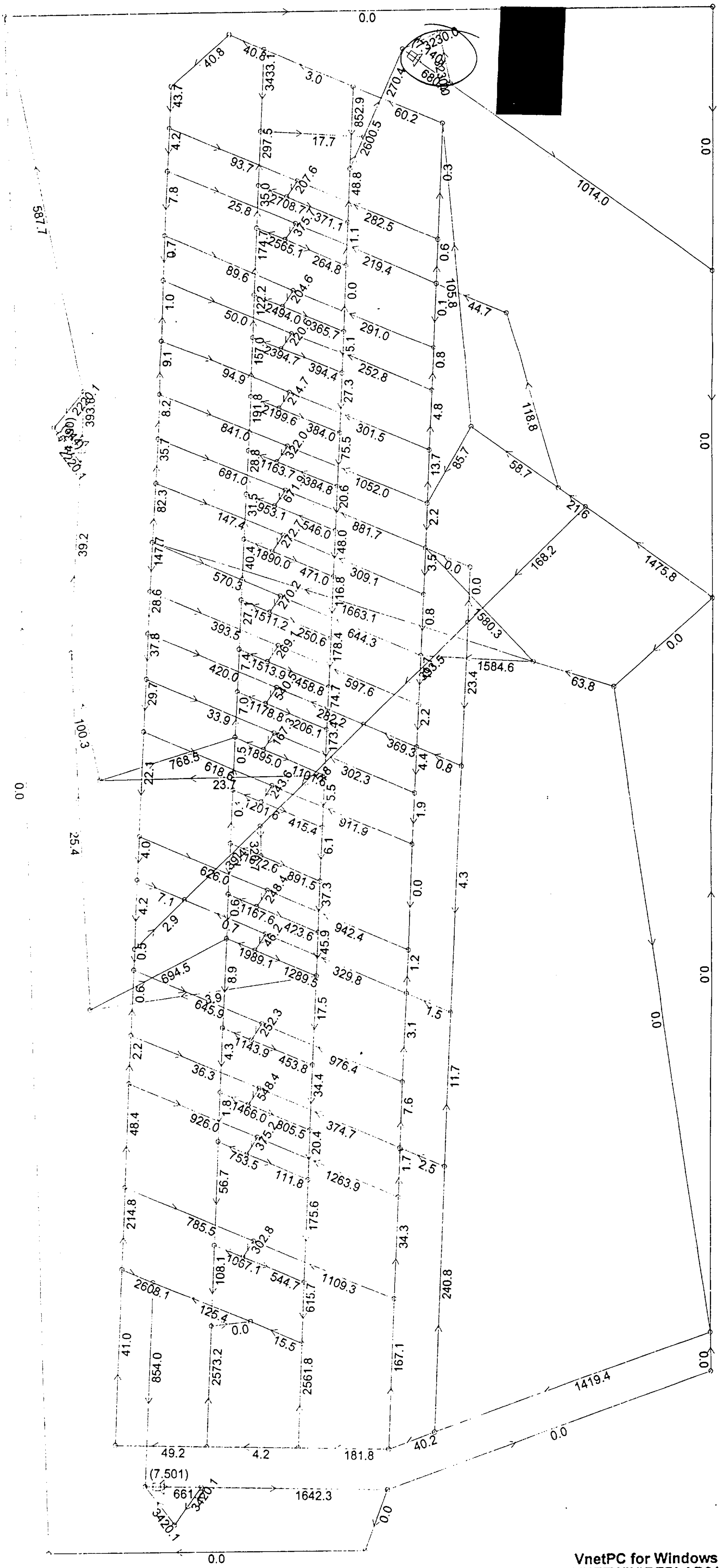
Fan Res
06/02/99 10:5

Fan No.	From	To	Fan Pressure (in.wg)	Fan Airflow (kcfm)	Fan Curve	Air Power (hp)	Operating Cost ($/yr)	Fan Descripticn
1	17	18	7.140	583.18	On	656.13	571699	First Empl Shaft :
2	14	13	7.501	574.97	On	679.60	592149	Former Dev Shaft :
3	29	30	4.390	627.41	On	434.02	378166	Mid Empl Shaft Fa:



VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW
Airflow (kcfm)
Printed: 06/28/99 13:36:31

Note: Obliteration of characters in this plot is not quality affecting and can be traced to the original VNETPC tabulated output. This plot of VNETPC output is only used as a general guide to understand the intricacies of the ventilation model.



Note: Obliteration of characters in this plot is not quality affecting and can be traced to the original VNETPC tabulated output. This plot of VNETPC output is only used as a general guide to understand the intricacies of the ventilation model.

VnetPC for Windows v1.0a
C:\VNETWIN\REPLAD01.VNW
Pressure Drop (m.In.w.g.)
Printed: 06/28/99 13:36:48

Attachment IV- Air and Rock Wall Temperatures Over 10,000 Years

Table IV-1. Tabulation of Estimated Air and Rock Wall Temperatures Over 10,000 Years Output from Figures IV-1 and IV-2 (With Ventilation)

Time after Emplm't (Years) (1)	Air @ 100 m (°C)	Wall @ 100 m (°C)	Air @ 300 m (°C)	Wall @ 300 m (°C)	Air @ 500 m (°C)	Wall @ 500 m (°C)	Air @ 600 m (°C)	Wall @ 600 m (°C)
1	34.53	74.19	44.93	77.92	49.44	79.54	50.62	79.96
5	46.81	88.37	72.85	101.67	86.00	109.52	89.80	111.65
10	50.47	93.10	84.79	114.80	104.64	126.49	110.93	130.11
20	51.46	93.47	90.44	121.08	114.81	136.84	123.03	141.91
30	50.86	89.97	91.31	119.84	118.3	137.74	127.83	143.85
40	49.33	85.57	88.87	115.95	116.71	135.33	126.90	142.15
50	47.6	81.09	85.44	111.25	113.37	131.64	123.91	138.98
60	45.93	76.91	81.87	106.39	109.51	127.56	120.21	135.26
70	44.39	73.15	78.38	101.55	105.56	123.40	116.31	131.35
80	43.01	69.80	75.18	97.52	101.74	119.37	112.46	127.47
90	41.80	66.88	72.33	93.71	98.18	115.59	108.82	123.81
100	40.73	64.30	69.74	90.26	94.81	111.98	105.37	120.32
150	38.58	55.80	64.62	79.48	88.01	99.96	98.47	109.66
200	35.97	50.83	58.06	71.60	78.90	90.16	88.87	99.58
250	34.41	47.71	53.58	66.07	72.14	82.97	81.16	91.26
300	33.37	45.51	50.45	62.07	67.23	77.65	75.35	85.09
400	32	42	47	57	62	72	70	79
500	29	40	44	54	59	68	66	74
1000	28	35	38	47	51	59	57	65
1500	28	32	35	43	47	54	52	59
2000	27	30	33	40	44	51	49	55
3000	27	29	32	39	42	49	48	54
4000	27	28	31	38	42	48	47	53
5000	27	28	31	38	41	47	46	52
6000	26	28	30	37	40	46	45	51
7000	26	27	30	36	40	46	44	50
8000	26	27	30	36	39	46	44	50
10000	26	27	30	36	39	46	44	50

Note 1: Information for years 1 through 300 is input from Assumption 3.20. Information for years 400 through 10,000 is the estimated output from Figures IV-1 and IV-2.

Figure IV-1. Estimated Drift Wall Temp

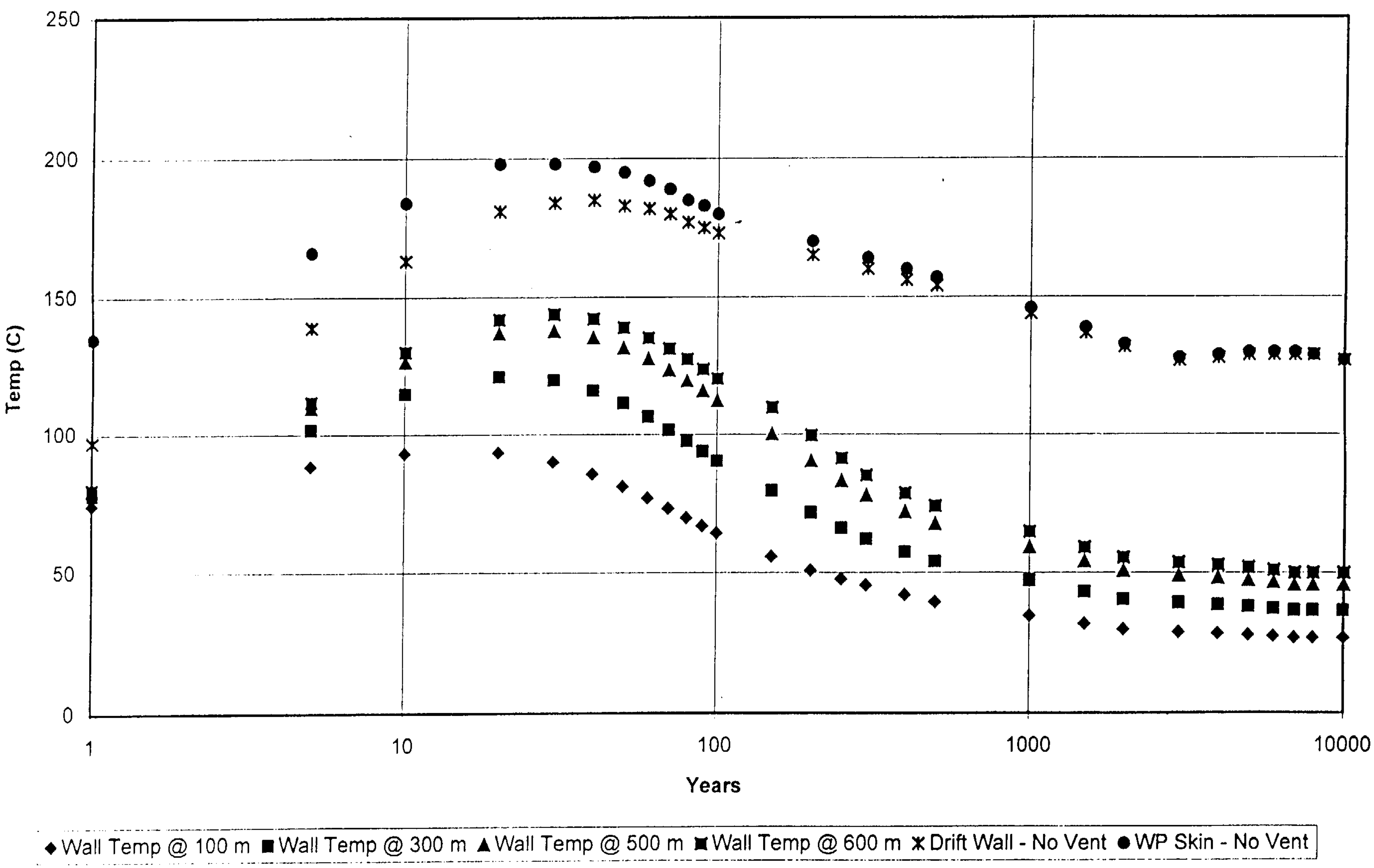
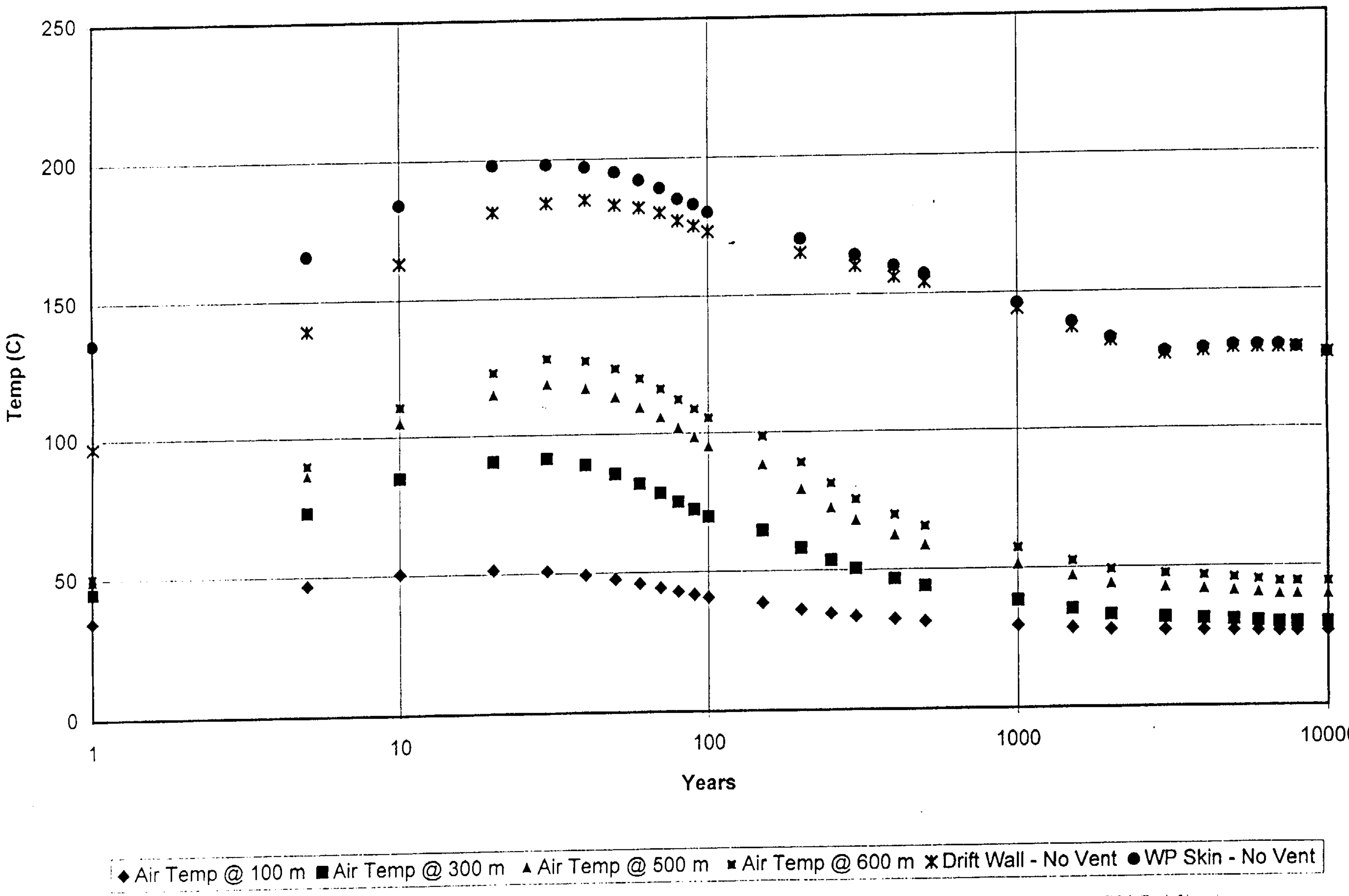


Figure IV-2. Estimated Air Temp



Attachment V- Rock Wall and WP Side Temperatures Over 10,000 Years

Table V-1. Tabulation of Estimated Rock Wall and WP Side Temperatures Over 10,000 Years (With Ventilation)

Time after Emplm't (Years)	Ratio (3.15)	Wall @ 100 m (°C)	Side @ 100 m (°C)	Wall @ 300 m (°C)	Side @ 300 m (°C)	Wall@ 500 m (°C)	Side @ 500 m (°C)
1	1.3918	74.19	103	77.92	108	79.54	111
5	1.1942	88.37	106	101.67	121	109.52	131
10	1.1288	93.10	105	114.80	130	126.49	143
20	1.0939	93.47	102	121.08	132	136.84	150
30	1.0761	89.97	97	119.84	129	137.74	148
40	1.0649	85.57	91	115.95	123	135.33	144
50	1.0656	81.09	86	111.25	119	131.64	140
60	1.0549	76.91	81	106.39	112	127.56	135
70	1.0500	73.15	77	101.55	107	123.40	130
80	1.0452	69.80	73	97.52	102	119.37	125
90	1.0457	66.88	70	93.71	98	115.59	121
100	1.0405	64.30	67	90.26	94	111.98	117
150	1.0357	55.80	58	79.48	82	99.96	104
200	1.0303	50.83	52	71.60	74	90.16	93
250	1.0245	47.71	49	66.07	68	82.97	85
300	1.0250	45.51	47	62.07	64	77.65	80
400	1.0256	42	43	57	58	72	74
500	1.0195	40	41	54	55	68	69
1000	1.0139	35	35	47	48	59	60
1500	1.0146	32	32	43	44	54	55
2000	1.0076	30	30	40	40	51	51
3000	1.0079	29	29	39	39	49	49
4000	1.0078	28	28	38	38	48	48
5000	1.0078	28	28	38	38	47	47
6000	1.0078	28	28	37	37	46	46
7000	1.0078	27	27	36	36	46	46
8000	1	27	27	36	36	46	46
10000	1	27	27	36	36	46	46

Prediction of Moisture Content for Ventilation Air in Emplacement Drift @ Natural Ventilation Airflow = 1.0 m^3/s. Open Loop Postclosure Ventilation at 60 mm/year water influx, assumed 100% being added to the airflow.

Influx Rate of Water				
mm/year	60	60	60	60
inch/year	2.362205	2.3622	2.3622	2.3622
ft/year = wi	0.19685	0.19685	0.19685	0.19685
	after	after	after	after
Length of Drift	600 m	100 m	300 m	500 m
Total Areal Influence (ft^2) (Ma)	36000	6000	18000	30000
of water influx through an				
18' dia x 2000' drift (5.5m dia x 600m drift)				
Ma = 18 x 2000				
Water Mass volume/year (ft^3 water/year),	7086.614	1181.1	3543.31	5905.51
Mvy through an 18' dia x 2000' drift				
Mvy = Ma x wi				
Water Mass flow/year (lb water/year)	442204.7	73700.8	221102	368504
through an 18' dia x 2000' drift				
Mpy = Mvy x 62.4				
Water Mass flow in lb water/minute (Mpm)	0.841333	0.14022	0.42067	0.70111
through an 18' dia x 2000' drift				
Mpm = ((Mpy/365)/24)/60				
Water Mass flow grains/minute	5889.332	981.555	2944.67	4907.78
through an 18' dia x 2000' drift				
Mgm = Mpm x 7000				
Mass of Vent Air, Mva (lb/min), through	134.9682	134.968	134.968	134.968
Emplacement Drift at 1.0 cms (2119 cfm)				
@ density 15.7 ft^3/lb air, (2119/15.7)				
Additional Water to Vent Air from Influx	43.63498	7.2725	21.8175	36.3625
Mwa = Mgm/Mva, grains/lb air				
Original Mass Water Content of "C" air				
grains/lb air @ 30% ave. relative humidity	52.263	52.263	52.263	52.263
Total Mass Water Content of "C" air				
grains/lb air = original + influx water	95.89798	59.5355	74.0805	88.6255

Attachment VII

Predicted Psychrometric Properties of Ventilation Air in Repository Emplacement Side

Tabulated data for standard calculations of predicted psychrometric properties of ventilation air in emplacement drift. See Section 5.5.2 for additional explanation on development of psychrometric chart.

These are data estimated for locations 100, 300, 500 and 600 meters from the emplacement inlet air.

1 m^3/s Airflow Postclosure Natural Ventilation System - Open Loop

Predicted Psychrometric Properties of Ventilation Air in Repository Emplacement Side

Temperature dry bulb and wet bulb at moisture of 96 grains per pound air from Attachment VI in emplacement outlet after 600 m.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Year After Empl.	Emplacement Air Temp. from Attachment IV (after 600m)	Dry Bulb Temp. Td	Dry Bulb Temp. Td	Wet Bulb Temp Tw	Wet Bulb Temp Tw	Bar. Pres. Ave. Pb	Sat. Vapor Pressure at Td Ps	Sat. Vapor Pres at Tw P's	Partial Vapor Pressure Pv	Relative Humidity R	Specific Humidity Moisture W (H2O)	Specific Humidity Moisture W*7000	Specific Volume v	Air Density Moist Air w	Enthalpy Heat Cont. h
		Equiv. of Col B	Converted fr Col. C	Estimated to fit Col. M	Converted fr Col. E	Assumption 3.4	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated
	^o C	^o F	^o C	^o F	^o C	Inch Hg	inch Hg	Inch Hg	Inch Hg	% Rel. Hum.	lb/lb dry air	Grains/lb air	ft^3/lb dry air	lb/ft^3	Btu/lb air
1	50 62	123	50.6	78.430	25.8	26.2	3.76545	0.98292	0.56527	15.01	0.01372	**96.009**	**17.164**	0.05869	44.846
5	89 80	194	89 8	91.730	33.2	26.2	20.71337	1.50425	0.56543	2.73	0.01372	**96.037**	**19.240**	0.05196	62.212
10	110 93	232	110.9	97.410	36.3	26.2	44.30094	1.79143	0.56556	1.28	0.01372	**96.061**	**20.360**	0.04889	71.579
20	123 03	253	123.0	100.320	38.0	26.2	65.77228	1.95615	0.56546	0.86	0.01372	**96.043**	**21.001**	0.04728	76.937
30	127 83	262	127.8	101.420	38.6	26.2	76 37940	2.02174	0.56575	0.74	0.01373	**96.092**	**21.255**	0.04667	79.073
40	126 90	260	126.9	101.210	38.5	26.2	74.22139	2.00907	0.56574	0.76	0.01373	**96.091**	**21.206**	0.04679	78.660
50	123 91	255	123.9	100.520	38.1	26.2	67.62021	1.96793	0.56522	0.84	0.01371	**96.002**	**21.047**	0.04717	77.320
60	120 21	248	120 2	99.660	37.6	26.2	60.12865	1.91768	0.56539	0.94	0.01372	**96.031**	**20.851**	0.04765	75.686
70	116 31	241	116.3	98.730	37.1	26.2	52.98765	1.86459	0.56543	1.07	0.01372	**96.038**	**20.644**	0.04817	73.959
80	112 46	234	112 5	97.790	36.6	26.2	46 64131	1.81223	0.56552	1.21	0.01372	**96.054**	**20.441**	0.04868	72.256
90	108 82	228	108 8	96.880	36.0	26 2	41.23399	1.76276	0.56564	1.37	0.01372	**96.073**	**20.248**	0.04918	70.646
100	105 37	222	105 4	95.990	35 6	26 2	36.60023	1.71551	0.56528	1.54	0.01372	**96.012**	**20.065**	0.04967	69.107
150	98 47	209	98 5	94.160	34.5	26.2	28.62524	1.62180	0.56540	1.98	0.01372	**96.033**	**19.699**	0.05066	66.053
200	88 87	192	88 9	91.460	33 0	26 2	19.98649	1.49165	0.56542	2.83	0.01372	**96.035**	**19.191**	0.05210	61.799
250	81 16	178	81 2	89.150	31 8	26.2	14.74444	1.38760	0.56544	3.83	0.01372	**96.039**	**18.782**	0.05332	58.384
300	75 35	168	75 4	87.320	30.7	26.2	11 60836	1.30970	0.56563	4.87	0.01372	**96.072**	**18.474**	0.05427	55.815
400	70 00	158	70 0	85 550	29 8	26 2	9 23982	1 23800	0.56540	6.12	0.01372	**96.032**	**18.191**	0.05517	53.437
500	66 00	151	66 0	84.180	29.0	26.2	7.74961	1.18488	0 56549	7.30	0.01372	**96.047**	**17.979**	0.05586	51.667
1000	57 00	135	57 0	80.910	27 2	26 2	5 12655	1.06601	0.56526	11.03	0.01372	**96.007**	**17.502**	0.05749	47.673
1500	52 00	126	52 0	78 980	26.1	26.2	4 02999	1.00085	0.56531	14.03	0.01372	**96.017**	**17.237**	0.05843	45.459
2000	49 00	120	49.0	77.780	25.4	26.2	3.47407	0 96210	0.56542	16.28	0.01372	**96.036**	**17.078**	0.05900	44.133
3000	48 00	118	48 0	77.370	25 2	26 2	3.30407	0 94917	0.56537	17.11	0.01372	**96.027**	**17.025**	0.05920	43.688
4000	47 00	117	47 0	76.960	25.0	26 2	3.14127	0 93639	0.56547	18.00	0.01372	**96.045**	**16.972**	0.05939	43.248
5000	46 00	115	46 0	76.540	24.7	26 2	2 98544	0.92345	0.56534	18.94	0.01372	**96.021**	**16.919**	0.05959	42.801
6000	45 00	113	45 0	76 120	24 5	26 2	2 83631	0.91067	0 56537	19 93	0.01372	**96.027**	**16.866**	0.05979	42.359
7000	44 00	111	44 0	75.700	24 3	26 2	2 69365	0 89804	0.56556	21 00	0 01372	**96.060**	**16.813**	0.05999	41.921
8000	44 00	111	44 0	75.700	24 3	26 2	2 69365	0.89804	0.56556	21.00	0.01372	**96.060**	**16.813**	0.05999	41.921
10000	44 00	111	44 0	75 700	24 3	26.2	2.69365	0.89804	0.56556	21.00	0.01372	**96.060**	**16.813**	0.05999	41.921

Formulas used to determine psychrometric properties of air (Hartman et al. 1997, page 15-16):

Sat Vapor Pressure (at Td), Ps = 0 18079* e^(((17 27*Td)-552 64)/(Td+395 14)), inches Hg
Sat Vapor Pressure (at Tw), P's = 0 18079* e^(((17.27*Tw)-552 64)/(Tw+395 14)), inches Hg
Vapor Pressure, Pv = P's-((Pb-P's)*(Td-Tw))/(2800-1 3*Tw), inches Hg
Relative Humidity, R = (Pv/Ps)*100%

Specific Humidity, W = 0.622*(Pv/(Pb-Pv)), lb/lb dry air
or Grains Specific Humidity, W*7000 = 0 622*(Pv/(Pb-Pv))*7000, grains water vapor/lb dry air
Specific Volume, v = 53.35*(460+Td)/((Pb-Pv)*0.491*144), ft^3/lb
Specific Weight, w = (1.325/(460+Td))*(Pb-.378*Pv), lb/ft^3 (not tabulated)
Enthalpy, h = 0.24*Td+W*(1060+0.45*Td), Btu/lb dry air

1 m^3/s Airflow Postclosure Natural Ventilation System - Open Loop

0

Predicted Psychrometric Properties of Ventilation Air in Repository Emplacement Side

Temperature dry bulb and wet bulb at moisture of 60 grains per pound air from Attachment VI in emplacement outlet after 100 m.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
		Dry Bulb	Dry Bulb	Wet Bulb	Wet Bulb	Bar.	Sat. Vapor	Sat. Vapor	Partial	Relative	Specific Humidity		Specific	Air Density	Enthalpy
	Emplacement	Temp.	Temp.	Temp	Temp	Pres. Ave.	Pressure at Td	Pres at Tw	Vapor Pressure	Humidity	Moisture	Moisture	Volume	Moist Air	Heat Cont.
	Air Temp. from	Td	Td	Tw	Tw	Pb	Ps	P's	Pv	R	W (H2O)	W*7000	v	w	h
Year	Attachment IV	Equiv. of	Converted	Estimated	Converted	Assumption 3.4	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated
After		Col B	fr Col. C	to fit	fr Col. E										
	(after 100m)			Col. M											
Empl.	^o C	^o F	^o C	^o F	^o C	inch Hg	inch Hg	inch Hg	inch Hg	% Rel. Hum.	lb/lb dry air	Grains/lb air	ft^3/lb dry air	lb/ft^3	Btu/lb air
1	34 53	94.2	34.5	65.230	18.5	26.2	1.62150	0.62886	0.35646	21.98	0.00858	**60.054**	**16.180**	0.06208	32.054
5	46 81	116 3	46 8	71.410	21.9	26 2	3.11114	0.77755	0.35640	11.46	0.00858	**60.044**	**16.825**	0.05957	37.443
10	50.47	122.8	50.5	73.100	22 8	26.2	3.73761	0.82322	0.35652	9.54	0.00858	**60.065**	**17.017**	0.05885	39.053
20	51.46	124.6	51 5	73.550	23.1	26.2	3.92463	0.83576	0.35671	9.09	0.00859	**60.097**	**17.070**	0.05866	39.493
30	50 86	123.5	50.9	73.280	22.9	26.2	3 81035	0.82822	0.35668	9.36	0.00858	**60.092**	**17.038**	0.05878	39.228
40	49 33	120 8	49 3	72.580	22.5	26 2	3.53180	0.80892	0.35646	10.09	0.00858	**60.055**	**16.957**	0.05907	38.551
50	47 60	117.7	47 6	71.780	22.1	26.2	3.23810	0.78736	0.35641	11.01	0.00858	**60.046**	**16.866**	0.05941	37.790
60	45 93	114.7	45 9	71.000	21.7	26.2	2.97478	0.76681	0.35659	11.99	0.00858	**60.077**	**16.779**	0.05974	37.062
70	44 39	111.9	44 4	70.260	21 3	26 2	2.74853	0 74776	0.35647	12.97	0.00858	**60.056**	**16.698**	0.06005	36.383
80	43 01	109 4	43 0	69 590	20.9	26.2	2 55855	0.73087	0.35649	13.93	0.00858	**60.060**	**16.625**	0.06032	35.778
90	41 80	107.2	41.8	69.000	20.6	26 2	2.40142	0.71627	0.35671	14.85	0.00859	**60.098**	**16.562**	0.06057	35.253
100	40 73	105.3	40 7	68.450	20.3	26.2	2.26948	0.70289	0.35618	15.69	0.00857	**60.007**	**16.505**	0.06079	34.768
150	3° 58	101.4	38 6	67.370	19.7	26 2	2 02319	0.67725	0.35663	17.63	0.00858	**60.084**	**16.393**	0.06123	33.837
200	35 97	96 7	36 0	66.000	18 9	26 2	1.75558	0.64591	0.35644	20.30	0.00858	**60.051**	**16.255**	0.06177	32.686
250	34 41	93 9	34 4	65.170	18.4	26 2	1 61074	0.62754	0.35661	22.14	0.00858	**60.080**	**16.173**	0.06210	32.006
300	33 37	92 1	33 4	64.600	18.1	26 2	1.52005	0.61520	0.35647	23.45	0.00858	**60.056**	**16.119**	0.06232	31.546
400	32 00	89 6	32 0	63.950	17.8	26 2	1.40736	0.60138	0.35970	25.56	0.00866	**60.609**	**16.049**	0.06262	31.031
500	29 00	84 2	29 0	62.150	16 8	26.2	1.18564	0.56452	0.35664	30.08	0.00858	**60.086**	**15.889**	0.06327	29.632
1000	28 00	82 4	28 0	61.560	16.4	26 2	1.11882	0.55288	0.35638	31.85	0.00858	**60.040**	**15.836**	0.06349	29.186
1500	28 00	82 4	28 0	61.560	16 4	26 2	1.11882	0.55288	0.35638	31.85	0.00858	**60.040**	**15.836**	0.06349	29.186
2000	27 00	80.6	27 0	60.980	16.1	26 2	1.05530	0.54164	0 35661	33.79	0.00858	**60.080**	**15.784**	0.06371	28.753
3000	27 00	80 6	27 0	60.980	16 1	26 2	1.05530	0.54164	0.35661	33.79	0.00858	**60.080**	**15.784**	0.06371	28.753
4000	27 00	80 6	27 0	60 980	16.1	26 2	1.05530	0.54164	0.35661	33.79	0 00858	**60.080**	**15.784**	0.06371	28.753
5000	27 00	80 6	27 0	60.980	16.1	26.2	1.05530	0 54164	0.35661	33.79	0.00858	**60.080**	**15.784**	0.06371	28.753
6000	26 00	78 8	26 0	60.370	15.8	26.2	0 99495	0.53004	0.35620	35.80	0.00857	**60.010**	**15.731**	0.06394	28.303
7000	26 00	78 8	26 0	60 370	15 8	26.2	0 99495	0 53004	0.35620	35 80	0.00857	**60.010**	**15.731**	0.06394	28.303
8000	26 00	78 8	26 0	60.370	15 8	26 2	0 99495	0 53004	0.35620	35.80	0.00857	**60.010**	**15.731**	0.06394	28.303
10000	26 00	78.8	26 0	60.370	15 8	26 2	0 99495	0 53004	0.35620	35 80	0.00857	**60.010**	**15.731**	0.06394	28.303

Formulas used to determine psychrometric properties of air (Hartman et al. 1997, page 15-16):

Sat Vapor Pressure (at Td), Ps = 0 18079* e^(((17.27*Td)-552.64)/(Td+395.14)), inches Hg
Sat Vapor Pressure (at Tw), P's = 0 18079* e^(((17 27*Tw)-552 64)/(Tw+395 14)), inches Hg
Vapor Pressure, Pv = P's-((Pb-P's)*(Td-Tw))/(2800-1 3*Tw), inches Hg
Relative Humidity, R = (Pv/Ps)*100%

Specific Humidity, W = 0.622*(Pv/(Pb-Pv)), lb/lb dry air
or Grains Specific Humidity, W*7000 = 0.622*(Pv/(Pb-Pv))*7000, grains water vapor/lb dry air
Specific Volume, v = 53.35*(460+Td)/((Pb-Pv)*0.491*144), ft^3/lb
Specific Weight, w = (1.325/(460+Td))*(Pb-.378*Pv), lb/ft^3 (not tabulated)
Enthalpy, h = 0 24*Td+W*(1060+0.45*Td), Btu/lb dry air

1 m^3/s Airflow Postclosure Natural Ventilation System - Open Loop

0

Predicted Psychrometric Properties of Ventilation Air in Repository Emplacement Side

Temperature dry bulb and wet bulb at moisture of 74 grains per pound air from Attachment VI in emplacement outlet, after 300 m.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
		Dry Bulb	Dry Bulb	Wet Bulb	Wet Bulb	Bar.	Sat. Vapor	Sat. Vapor	Partial	Relative	Specific Humidity		Specific	Air Density	Enthalpy
	Emplacement	Temp.	Temp.	Temp	Temp	Pres. Ave.	Pressure at Td	Pres at Tw	Vapor Pressure	Humidity	Moisture	Moisture	Volume	Moist Air	Heat Cont.
	Air Temp. from	Td	Td	Tw	Tw	Pb	Ps	P's	Pv	R	W (H2O)	W*7000	v	w	h
Year	Attachment IV	Equiv. of	Converted	Estimated	Converted	Assumption 3.4	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated
After		Col B	fr Col. C	to fit	fr Col. E										
	(after 300m)			Col. M											
Empl.	^o C	^o F	^o C	^o F	^o C	inch Hg	inch Hg	inch Hg	inch Hg	% Rel. Hum.	lb/lb dry air	Grains/lb air	ft^3/lb dry air	lb/ft^3	Btu/lb air
1	44 93	112.9	44.9	72.780	22.7	26.2	2.82611	0.81439	0.43818	15.50	0.01058	**74.056**	**16.779**	0.05989	38.841
5	72 85	163 1	72 9	83.920	28.8	26 2	10.44442	1.17502	0.43838	4.20	0.01058	**74.091**	**18.251**	0.05477	51.148
10	84 79	184 6	84 8	87.890	31 1	26 2	17.04571	1.33355	0.43794	2.57	0.01057	**74.015**	**18.881**	0.05282	56.396
20	90 44	194 8	90.4	89.650	32.0	26 2	21.22639	1.40957	0.43824	2.06	0.01058	**74.068**	**19.179**	0.05194	58.894
30	91 31	196 4	91.3	89.910	32.2	26,2	21.94086	1.42112	0.43806	2.00	0.01058	**74.035**	**19.224**	0.05181	59.272
40	88 87	192 0	88.9	89.170	31 8	26 2	19.98649	1.38847	0.43823	2.19	0.01058	**74.065**	**19.096**	0.05218	58.201
50	85 44	185 8	85 4	88.100	31.2	26.2	17.48816	1.34243	0.43816	2.51	0.01058	**74.053**	**18.915**	0.05271	56.688
60	8?.87	179.4	81.9	86.960	30.5	26.2	15.17262	1.29483	0.43833	2.89	0.01058	**74.082**	**18.727**	0.05328	55.120
70	78 38	173 1	78.4	85.810	29 9	26 2	13.16470	1.24832	0.43832	3.33	0.01058	**74.081**	**18.543**	0.05385	53.582
80	75 18	167 3	75 2	84.717	29.3	26 2	11.52588	1.20546	0.43787	3.80	0.01057	**74.003**	**18.374**	0.05438	52.160
90	72 33	162 2	72 3	83.730	28.7	26 2	10.21520	1.16786	0.43802	4.29	0.01058	**74.029**	**18.224**	0.05485	50.909
100	69 74	157.5	69.7	82.810	28 2	26.2	9.13606	1.13374	0.43807	4.79	0.01058	**74.037**	**18.087**	0.05530	49.769
150	64 62	148 3	64 6	80.930	27.2	26 2	7 28548	1.06670	0.43822	6.01	0.01058	**74.064**	**17.817**	0.05619	47.517
200	58 06	136 5	58 1	78.380	25 8	26 2	5.38926	0.98131	0.43800	8.13	0.01058	**74.025**	**17.471**	0.05737	44.621
250	53 58	128 4	53 6	76 550	24.8	26 2	4.35232	0.92375	0.43803	10.06	0.01058	**74.031**	**17.235**	0.05821	42.648
300	50 45	122 8	50 5	75.220	24.0	26.2	3.73392	0.88380	0.43794	11.73	0.01057	**74.015**	**17.070**	0.05881	41.267
400	47	116 6	47 0	73.710	23.2	26.2	3.14127	0.84026	0.43804	13.94	0.01058	**74.033**	**16.888**	0.05948	39.750
500	44	111 2	44 0	72.350	22.4	26.2	2.69365	0 80267	0.43803	16.26	0.01058	**74.032**	**16.730**	0.06007	38.428
1000	38	100 4	38 0	69.500	20 8	26 2	1.96085	0.72862	0.43816	22.35	0.01058	**74.053**	**16.414**	0.06130	35.788
1500	35	95 0	35 0	68.000	20 0	26.2	1.66425	0 69211	0.43812	26.33	0.01058	**74.046**	**16.256**	0.06192	34.465
2000	33	91.4	33 0	66.970	19.4	26.2	1.48887	0 66797	0.43805	29.42	0.01058	**74.034**	**16.160**	0.06235	33.582
3000	32	89 6	32 0	66.450	19.1	26.2	1.40736	0.65606	0.43814	31.13	0.01058	**74.051**	**16.098**	0.06257	33.144
4000	31	87.8	31 0	65.920	18.8	26.2	1.32976	0.64412	0.43811	32.95	0.01058	**74.045**	**16.045**	0.06278	32.702
5000	31	87 8	31 0	65.920	18 8	26.2	1.32976	0 64412	0.43811	32.95	0.01058	**74.045**	**16.045**	0.06278	32.702
6000	30	86 0	30 0	65.380	18.5	26.2	1.25590	0.63215	0.43796	34.87	0.01057	**74.020**	**15.992**	0.06300	32.258
7000	30	86 0	30 0	65 380	18 5	26 2	1.25590	0 63215	0.43796	34.87	0.01057	**74.020**	**15.992**	0.06300	32.258
8000	30	86 0	30 0	65.380	18.5	26 2	1 25590	0 63215	0.43796	34.87	0.01057	**74.020**	**15.992**	0.06300	32.258
10000	30	86 0	30 0	65 380	18 5	26.2	1.25590	0 63215	0 43796	34.87	0 01057	**74.020**	**15.992**	0.06300	32.258

Formulas used to determine psychrometric properties of air (Hartman et al. 1997, page 15-16):

Sat Vapor Pressure (at Td), Ps = 0 18079* e^(((17.27*Td)-552 64)/(Td+395 14)), inches Hg
Sat Vapor Pressure (at Tw). P's = 0 18079* e^(((17 27*Tw)-552 64)/(Tw+395 14)), inches Hg
Vapor Pressure. Pv = P's-((Pb-P's)*(Td-Tw))/(2800-1.3*Tw), inches Hg
Relative Humidity, R = (Pv/Ps)*100%

Specific Humidity, W = 0.622*(Pv/(Pb-Pv)), lb/lb dry air
or Grains Specific Humidity, W*7000 = 0.622*(Pv/(Pb-Pv))*7000, grains water vapor/lb dry air
Specific Volume, v = 53.35*(460+Td)/((Pb-Pv)*0.491*144), ft^3/lb
Specific Weight, w = (1.325/(460+Td))*(Pb-.378*Pv), lb/ft^3 (not tabulated)
Enthalpy, h = 0.24*Td+W*(1060+0.45*Td), Btu/lb dry air

1 m^3/s Airflow Postclosure Natural Ventilation System - Open Loop
0

Predicted Psychrometric Properties of Ventilation Air in Repository Emplacement Side

Temperature dry bulb and wet bulb at moisture of 89 grains per pound air from Attachment VI in emplacement outlet, after 500 m.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
		Dry Bulb	Dry Bulb	Wet Bulb	Wet Bulb	Bar.	Sat. Vapor	Sat. Vapor	Partial	Relative	Specific Humidity		Specific	Air Density	Enthalpy
	Emplacement	Temp.	Temp.	Temp	Temp	Pres. Ave.	Pressure at Td	Pres at Tw	Vapor Pressure	Humidity	Moisture	Moisture	Volume	Moist Air	Heat Cont.
	Air Temp. from	Td	Td	Tw	Tw	Pb	Ps	P's	Pv	R	W (H2O)	W*7000	v	w	h
Year	Attachment IV	Equiv. of	Converted	Estimated	Converted	Assumption 3.4	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated
After		Col B	fr Col. C	to fit	fr Col. E										
	(after 500m)			Col. M		inch Hg	inch Hg	inch Hg	inch Hg	% Rel. Hum.	lb/lb dry air	Grains/lb air	ft^3/lb dry air	lb/ft^3	Btu/lb air
Empl.	^o C	^o F	^o C	^o F	^o C										
1	49.44	121.0	49.4	76.980	25.0	26.2	3.55122	0.93701	0.52519	14.79	0.01272	**89.063**	**17.075**	0.05894	43.218
5	86.00	186.8	86.0	89.885	32.2	26.2	17.87707	1.42000	0.52495	2.94	0.01272	**89.022**	**19.009**	0.05257	59.381
10	104.64	220.4	104.6	95.160	35.1	26.2	35.67758	1.67245	0.52509	1.47	0.01272	**89.046**	**19.995**	0.04979	67.630
20	114.81	238.7	114.8	97.760	36.5	26.2	50.43509	1.81058	0.52494	1.04	0.01272	**89.019**	**20.533**	0.04839	72.124
30	118.30	244.9	118.3	98.620	37.0	26.2	56.53816	1.85840	0.52534	0.93	0.01273	**89.089**	**20.718**	0.04792	73.679
40	116.71	242.1	116.7	98.230	36.8	26.2	53.68609	1.83658	0.52512	0.98	0.01272	**89.050**	**20.633**	0.04814	72.969
50	113.37	236.1	113.4	97.405	36.3	26.2	48.08128	1.79116	0.52513	1.09	0.01272	**89.053**	**20.457**	0.04858	71.493
60	109.51	229.1	109.5	96.430	35.8	26.2	42.21687	1.73873	0.52522	1.24	0.01272	**89.068**	**20.252**	0.04911	69.788
70	105.56	222.0	105.6	95.400	35.2	26.2	36.84360	1.68480	0.52492	1.42	0.01272	**89.016**	**20.043**	0.04966	68.032
80	101.74	215.1	101.7	94.385	34.7	26.2	32.20132	1.63308	0.52510	1.63	0.01272	**89.048**	**19.841**	0.05021	66.348
90	98.18	208.7	98.2	93.410	34.1	26.2	28.32481	1.58470	0.52499	1.85	0.01272	**89.029**	**19.653**	0.05073	64.770
100	94.81	202.7	94.8	92.470	33.6	26.2	25.02264	1.53924	0.52523	2.10	0.01272	**89.070**	**19.475**	0.05122	63.286
150	88.01	190.4	88.0	90.490	32.5	26.2	19.33352	1.44716	0.52503	2.72	0.01272	**89.035**	**19.115**	0.05226	60.273
200	78.90	174.0	78.9	87.680	30.9	26.2	13.44878	1.32472	0.52512	3.90	0.01272	**89.051**	**18.633**	0.05371	56.246
250	72.14	161.9	72.1	85.460	29.7	26.2	10.13252	1.23445	0.52518	5.18	0.01272	**89.061**	**18.276**	0.05483	53.257
300	67.23	153.0	67.2	83.770	28.8	26.2	8.18430	1.16937	0.52531	6.42	0.01273	**89.084**	**18.016**	0.05567	51.089
400	62.00	143.6	62.0	81.880	27.7	28.2	6.46926	1.10014	0.52500	8.12	0.01272	**89.030**	**17.739**	0.05660	48.768
500	59.00	138.2	59.0	80.760	27.1	26.2	5.63179	1.06082	0.52501	9.32	0.01272	**89.033**	**17.580**	0.05714	47.441
1000	51.00	123.8	51.0	77.620	25.3	26.2	3.83676	0.95704	0.52514	13.69	0.01272	**89.055**	**17.157**	0.05864	43.906
1500	47.00	116.6	47.0	75.950	24.4	26.2	3.14127	0.90554	0.52489	16.71	0.01272	**89.012**	**16.945**	0.05942	42.130
2000	44.00	111.2	44.0	74.660	23.7	26.2	2.69365	0.86743	0.52497	19.49	0.01272	**89.024**	**16.787**	0.06001	40.805
3000	42.00	107.6	42.0	73.780	23.2	26.2	2.42680	0.84224	0.52509	21.64	0.01272	**89.046**	**16.681**	0.06042	39.924
4000	42.00	107.6	42.0	73.780	23.2	26.2	2.42680	0.84224	0.52509	21.64	0.01272	**89.046**	**16.681**	0.06042	39.924
5000	41.00	105.8	41.0	73.330	23.0	26.2	2.30216	0.82961	0.52503	22.81	0.01272	**89.036**	**16.628**	0.06062	39.480
6000	40.00	104.0	40.0	72.880	22.7	26.2	2.18310	0.81714	0.52515	24.06	0.01272	**89.056**	**16.575**	0.06083	39.041
7000	40.00	104.0	40.0	72.880	22.7	26.2	2.18310	0.81714	0.52515	24.06	0.01272	**89.056**	**16.575**	0.06083	39.041
8000	39.00	102.2	39.0	72.420	22.5	26.2	2.06940	0.80457	0.52507	25.37	0.01272	**89.043**	**16.522**	0.06103	38.597
10000	39.00	102.2	39.0	72.420	22.5	26.2	2.06940	0.80457	0.52507	25.37	0.01272	**89.043**	**16.522**	0.06103	38.597

Formulas used to determine psychrometric properties of air (Hartman et al. 1997, page 15-16):

Sat Vapor Pressure (at Td), Ps = 0.18079* e^(((17.27*Td)-552.64)/(Td+395.14)), inches Hg

Sat Vapor Pressure (at Tw), P's = 0.18079* e^(((17.27*Tw)-552.64)/(Tw+395.14)), inches Hg

Vapor Pressure, Pv = P's-((Pb-P's)*(Td-Tw))/(2800-1.3*Tw), inches Hg

Relative Humidity, R = (Pv/Ps)*100%

Specific Humidity, W = 0.622*(Pv/(Pb-Pv)), lb/lb dry air

or Grains Specific Humidity, W*7000 = 0.622*(Pv/(Pb-Pv))*7000, grains water vapor/lb dry air

Specific Volume, v = 53.35*(460+Td)/((Pb-Pv)*0.491*144), ft^3/lb

Specific Weight, w = (1.325/(460+Td))*(Pb-.378*Pv), lb/ft^3 (not tabulated)

Enthalpy, h = 0.24*Td+W*(1060+0.45*Td), Btu/lb dry air

Air and Rock Wall Temperatures, Relative Humidity (RH), and WP Side Temp Output

Calculation is based on VA subsurface layout with the following averages: Airflow @ 1.0 m^3/s (2119 cfm) per emplacement drift; Water Influx @ 60 mm/year (Assumption 3.12); thermal loads @ 85 MTU/acre; and barometric pressure in repository horizon @ 88.72 kPa (26.2 inches Hg) (Assumption 3.4).

A	C	D	E	F	H	I	J	K	M	N	O	P	R	S	T	U	W	X	Y	Z
	100 m inside Emplacement Drift				300 m inside Emplacement Drift				500 m inside Emplacement Drift				600 m inside Emplacement Drift				Air	Nat. Vent. Pressure	Nat. Vent. Pressure	Nat. Vent. Pressure
Year after Empl	Air Temp	Rock Wall Temp	Air Relative Humidity (RH) from Att. VII, p. 3	WP Side Temp	Air Temp	Rock Wall Temp	Air Relative Humidity (RH) from Att. VII, p. 4	WP Side Temp	Air Temp	Rock Wall Temp	Air Relative Humidity (RH) from Att. VII, p. 5	WP Side Temp	Air Temp	Rock Wall Temp	Air Relative Humidity (RH) from Att. VII, p. 2	WP Side Temp	Temp. Delta between Intake & Exhaust dT (Col R-25)1.8	Head Equiv 1st Set H=.0327dT	Head Equiv 2nd Set H=.0287dT	Head Equiv 3rd Set H=.0153dT
	Note 1	Note 2	Col. K	Note 6	Note 1	Note 2	Col. K	Note 6	Note 1	Note 2	Col. K	Note 6	Note 1	Note 2	Col. K	Note 6		Note 3	Note 4	Note 5
	^oC	^oC	RH -%	^oC	^oC	^oC	RH -%	^oC	^oC	^oC	RH -%	^oC	^oC	^oC	RH -%	^oC	^oF	Inch WG	Inch WG	Inch WG
1	34.53	74.19	21.98	103	44.93	77.92	15.50	108	49.44	79.54	14.79	111	50.62	79.96	15.01	111	46.12	1.5	1.3	0.7
5	46.81	88.37	11.46	106	72.85	101.67	4.20	121	86.00	109.52	2.94	131	89.80	111.65	2.73	133	116.64	3.8	3.3	1.8
10	50.47	93.10	9.54	105	84.79	114.80	2.57	130	104.64	126.49	1.47	143	110.93	130.11	1.28	147	154.67	5.1	4.4	2.4
20	51.46	93.47	9.09	102	90.44	121.08	2.06	132	114.81	136.84	1.04	150	123.03	141.91	0.86	155	178.45	5.8	5.1	2.7
30	50.86	89.97	9.36	97	91.31	119.84	2.00	129	118.30	137.74	0.93	148	127.83	143.85	0.74	155	185.09	6.1	5.3	2.8
40	49.33	85.57	10.09	91	88.87	115.95	2.19	123	116.71	135.33	0.98	144	126.90	142.15	0.76	151	183.42	6.0	5.3	2.8
50	47.60	81.09	11.01	86	85.44	111.25	2.51	119	113.37	131.64	1.09	140	123.91	138.98	0.84	148	178.04	5.8	5.1	2.7
60	45.93	76.91	11.99	81	81.87	106.39	2.89	112	109.51	127.56	1.24	135	120.21	135.26	0.94	143	171.38	5.6	4.9	2.6
70	44.39	73.15	12.97	77	78.38	101.55	3.33	107	105.56	123.40	1.42	130	116.31	131.35	1.07	138	164.36	5.4	4.7	2.5
80	43.01	69.80	13.93	73	75.18	97.52	3.80	102	101.74	119.37	1.63	125	112.46	127.47	1.21	133	157.43	5.1	4.5	2.4
90	41.80	66.88	14.85	70	72.33	93.71	4.29	98	98.18	115.59	1.85	121	108.82	123.81	1.37	129	150.88	4.9	4.3	2.3
100	40.73	64.30	15.69	67	69.74	90.28	4.79	94	94.81	111.98	2.10	117	105.37	120.32	1.54	125	144.67	4.7	4.2	2.2
150	38.58	55.80	17.63	58	64.62	79.48	6.01	82	88.01	99.96	2.72	104	98.47	109.66	1.98	114	132.25	4.3	3.8	2.0
200	35.97	50.83	20.30	52	58.06	71.60	8.13	74	78.90	90.16	3.90	93	88.87	99.58	2.83	103	114.97	3.8	3.3	1.8
250	34.41	47.71	22.14	49	53.58	66.07	10.06	67	72.14	82.97	5.18	85	81.16	91.26	3.83	93	101.09	3.3	2.9	1.5
300	33.37	45.51	23.45	47	50.45	62.07	11.73	64	67.23	77.65	6.42	80	75.35	85.09	4.87	87	90.63	3.0	2.6	1.4
400	32	42	25.56	43	47	57	13.94	58	62	72	8.12	74	70	79	6.12	81	81.00	2.6	2.3	1.2
500	29	40	30.08	41	44	54	16.26	55	59	68	9.32	69	66	74	7.30	75	73.80	2.4	2.1	1.1
1000	28	35	31.85	35	38	47	22.35	48	51	59	13.69	60	57	65	11.03	66	57.60	1.9	1.7	0.9
1500	28	32	31.85	32	35	43	26.33	44	47	54	16.71	55	52	59	14.03	60	48.60	1.6	1.4	0.7
2000	27	30	33.79	30	33	40	29.42	40	44	51	19.49	51	49	55	16.28	55	43.20	1.4	1.2	0.7
3000	27	29	33.79	29	32	39	31.13	39	42	49	21.64	49	48	54	17.11	54	41.40	1.4	1.2	0.6
4000	27	28	33.79	28	31	38	32.95	38	42	48	21.64	48	47	53	18.00	53	39.60	1.3	1.1	0.6
5000	27	28	33.79	28	31	38	32.95	38	41	47	22.81	47	46	52	18.94	52	37.80	1.2	1.1	0.6
6000	26	28	35.80	28	30	37	34.87	37	40	46	24.06	46	45	51	19.93	51	36.00	1.2	1.0	0.6
7000	26	27	35.80	27	30	36	34.87	36	40	46	24.06	46	44	50	21.00	50	34.20	1.1	1.0	0.5
8000	26	27	35.80	27	30	36	34.87	36	39	46	25.37	46	44	50	21.00	50	34.20	1.1	1.0	0.5
10000	26	27	35 80	27	30	36	34.87	36	39	46	25.37	46	44	50	21.00	50	34.20	1.1	1.0	0.5

Note 1 - Air temp data from Attachment IV.
Note 2 - Rock wall temp data from Attachment IV.
Note 3 - NVP equation derived from differential elevation 1089 feet, in equation H= (dT/10)*0.03*(1089'/100'), H = 0.0327dT; (From North Ramp portal elev. 1123 m to Emplacement Shaft collar elev 1455 m) (3.8)
Note 4 - NVP equation derived from differential elevation of 958 feet, in equation H= (dT/10)*0.03*(958'/100'), H = 0.0287dT (From South Ramp portal elev 1160 m to Dev. Shaft collar elev 1452 m) (3.8)
Note 5 - NVP equation derived from shaft differential elevation 508.5 feet, in equation H= (dT/10)*0.03*(508.5'/100'), H = 0.0153dT (From new intake shaft collar elev 1300 m to new exhaust shaft collar elev 1455 m) (3.8)
Note 6 - WP Side temperature from Attachment V and Table 5.

Attachment IX- Permission Letter to use Curves

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

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.

[signature] 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

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