Appendix A14

Dynatec Corporation, Ventilation Study (2004).

Appendix A15 Preliminary Ventilation System Feasibility Study

NB: This report was provided as input to the original Dynatec plan. Pertinent sections of the full ventilation report are provided here. Some of the sequencing of construction activities has been modified, but the discussion on ventilation requirements and approach to initiating and maintaining ventilation are still appropriate for understanding the approach, the scale of the required ventilation and additional requirements.

A15.1 Feasibility Analysis for Ventilation at Initial DUSEL Construction Phase

The initial construction phase is divided into four sub-sections, which involve a combination of activities including:

- Refurbishment of existing infrastructure,
- De-watering,
- Excavation of the DUSEL facilities, and
- Re-establish existing and/or new infrastructure as DUSEL progresses through its various operational phases.

Therefore this first phase will commence with the refurbishment of the shaft systems and conclude with the completion of the laboratories and related infrastructure for the Science and Engineering Laboratory on the 7400 Level (DUSEL).

As described in the December 2003 Dynatec report, access to the Science and Engineering Laboratories was to be via the Yates Shaft to the 4850 Level Laboratory, whilst the Ross Shaft/ No. 6 Winze would be utilized to access the 7400 Level Laboratory. Refurbishment of both the Yates and Ross Shafts is required, and the ventilation scheme for this phase of construction remains unchanged (i.e., sealing shaft stations as shaft refurbishment proceeds towards the 4850 Level and placing the Homestake Mine under negative pressure by operating one of the permanent exhaust-fans on top the No. 5 Shaft.) In doing so it is expected that between 60,000 to 75,000 cubic feet per minute (cfm) will downcast each shaft. Ventilating the shafts in this manner will ensure cool fresh air will be drawn past the shaft rehabilitation crews as they approach the warmer levels (e.g., 4850 Level) of Homestake Mine.

To ensure that the respective headframes are kept above freezing, commercially available space heaters would supplement existing headframe heating systems as required.

Once these shafts are refurbished to State and Federal standards, and safe access to the 4850 Level is established across to the #6 Winze from the both the Yates and Ross Shafts, work can commence on the refurbishment of the No. 6 Winze. At this juncture of the project, with safe access is established between the two shafts, an alternate means of egress is established now established at the DUSEL project site to the 4850 Level.

The winze will permit the transport of personnel and materials to the 7400 Level, in addition to the hoisting of excavated material from the 7400 Level Laboratory. The No. 6 Winze hoist room is located on the 4550 Level. An airflow of 10,000 cfm is required to ventilate the winze hoist room.

However, when Homestake was in operation, the No. 6 Winze utilized two friction hoists, one for personnel and material, and the other for ore and waste hoisting. Normally these units can not be used until the winze is fully de-watered (the friction hoists' tail ropes cannot be under water). However Dynatec has developed a method of converting the hoists to operate temporarily as conventional hoists, thereby allowing the winze refurbishing and de-watering phase to proceed in a timely manner.

Running concurrently to the winze refurbishment program is the de-watering of mined workings below the 5300 Level. In this regard it is Dynatec's intention to implement de-watering operations from the No. 6 Winze.

An internal ramp system, running from the 4850 Level to the 8000 Level parallels the No. 6 Winze. Consequently, for reasons stated in the initial December 2003 report, 50,000 cfm is still required for the de-watering phase when the water in the winze is lowered below the 5600 Level. At this juncture of the project an alternate means of material supply and egress from the winze during its rehabilitation phase.

The construction of the temporary hoisting facilities prior to commencing the No. 6 Winze refurbishment allows the de-watering crews an opportunity to lower the water levels in the shaft below the 5600 Level, thereby establishing flow-past ventilation for the winze refurbishing crew. As in the Yates and Ross Shaft refurbishment, isolation of the No. 6 Winze from previously mined-out areas will establish a fresh air ventilation corridor from surface to the required laboratory excavation horizon.

As presented in the December 2003 report, the primary ventilation system will comprise of two separate downcast fans located below the collar of the Yates and Ross shaft. It is proposed to utilize the existing Ross Tramway to facilitate the installation. These fans would be operated in conjunction with a surface exhaust fan installed atop of the No. 5 Shaft. The downcast fans will have heating penthouses associated with them, and be sized in such a manner that their combined air volumes downcasting these shafts will exceed the exhausted mass air volume by 50,000 cfm. The difference, 50,000 cfm, will allow each shaft to upcast approximately 25,000 cfm of conditioned air each, thereby minimizing the effect of freezing the shaft's sheave wheels, ropes and guides during winter.

Once the Homestake Mine is de-watered below the 8000 Level and the refurbishment of the No. 6 Winze is completed, excavation for the 7400 Level Laboratory will take place across two of the mining horizons simultaneously (the 7100 and 7400 Levels) to expedite construction. Approximately 60,000 cfm is required for the 7100 exhaust level, while approximately 95,000 cfm is required for the 7400 Level.

In addition to fresh air required for Laboratory excavation, additional air (~60,000 cfm) is required to maintain de-watering facilities on the 6950 and 8000 Levels, again providing "single pass" ventilation to each area

This report provides an air requirement breakdown and Tables 15A.1a through to 15A.1c, provide a summary of the above ventilation description. The complete analysis is provided in the Dynatec Study and its appendices

Table A15.1a

Summary of Air Volume Requirements during the Mine De-Watering

Constructing a Temporary Hoist/Hoist Room for No. 6 Winze

Job Task	Primary Ventilation System Air Volume Requirements	
	Yates Shaft	**Ross Shaft**
Downcast Yates for Personnel and Material Transport	60,000 cfm	-
Excavate and Equip a Temporary Hoist Room		60,000 cfm
De-Water Below 5300 Level	-	50,000 cfm
Upcast Headframes	25,000 cfm	25,000 cfm
Intake Air Requirement	**85,000 cfm**	**135,000 cfm**
No. 5 Shaft Exhaust Quantity	**170,000 cfm**	

Table A15.1b

Summary of Air Volume Requirements while No. 6 Winze Refurbishment is in Progress and De-watering Continues

Job Task	Primary Ventilation System Air Volume Requirements	
	Yates Shaft	**Ross /No. 6**
Downcast Yates for Personnel and Material Transport	60,000 cfm	-
Ventilate Temporary No. 6 Winze Hoist Room	-	10,000 cfm
Refurbish Permanent No. 6 Winze Hoist Room	-	20,000 cfm
Refurbish No. 6 Winze	-	20,000 cfm
De-Water Below 5300 Level	-	50,000 cfm
Upcast Headframes	25,000 cfm	25,000 cfm
Intake Air Requirement	**85,000 cfm**	**125,000 cfm**
No. 5 Shaft Exhaust Quantity	**160,000 cfm**	

Table A15.1c

Summary of Air Volume Requirements during the 7400 Lab Construction Phase

Job Task	**Primary Ventilation System Air Volume Requirements**	
	Yates Shaft	**Ross/No. 6**
Downcast Yates for Personnel and Material Transport	60,000 cfm	-
Ventilate No. 6 Winze Hoist Room	-	10,000 cfm
Ventilate the 6950 Level Pump Station	-	20,000 cfm
Excavate 7100/7700 Level Exhaust Drift	-	60,000 cfm
Excavate the 7400 Lab	-	95,000 cfm
Ventilate the 8000 Level Pump Station	-	40,000 cfm
Upcast Headframes	25,000 cfm	25,000 cfm
Intake Air Requirement	**85,000 cfm**	**250,000 cfm**
No. 5 Shaft Exhaust Quantity	**285,000 cfm**	

Taking these estimated requirements under consideration, for the Yates Shaft air handling facility, it appears that a fan and heating penthouse capable of operating in a fairly constant range of between 80,000 and 100,000 cfm is required.

15.2 Feasibility Analysis for Ventilation during the DUSEL Operations Phase

During the DUSEL operational phase, in which only science experiments and observations are taking place, the main air intakes, located in the Ross Tramway below the Yates and Ross collars will supply a total of 250,000 cfm of conditioned air to DUSEL facility. That is 25,000 cfm for each headframe and 200,000 cfm for the underground laboratories, which will eventually be exhausted via the No. 5 Shaft exhaust. Table A15.2, provides a summary of the ventilation requirements for DUSEL. The full analysis upon which this summary is based is in the Dynatec Report of December 2003. This report will be updated in the next stage of DUSEL design work, to accommodate the revised DUSEL Initial Suite of Experiments. However, the requirements presented are representative of the needs for DUSEL and provide adequate conceptual information.

Table A15.2. Summary of Air Volume Requirements during the Initial DUSEL Operations Phase (Only General Experimental Hall in Operation)

Job Task	Primary Ventilation System Air Volume Requirements	
	Yates Shaft	**Ross/No. 6**
Downcast Yates for Personnel and Material Transport	60,000 cfm	-
Ventilate No. 6 Winze Hoist Room	-	10,000 cfm
Operate 7400 Laboratory	-	65,000 cfm
Maintain 6950 L Pump Station	-	20,000 cfm
Maintain 8000 L Pump Station	-	40,000 cfm
Upcast Headframes	25,000 cfm	25,000 cfm
Intake Air Requirement	**85,000 cfm**	**160,000 cfm**
No. 5 Shaft Exhaust Quantity	**195,000 cfm**	

During the facilities operational phase, fresh air to the laboratory will be via the Ross/Yates Shaft system then via the No. 6 Winze to the 7400 Level. The 7400 laboratory may be pressurized with clean (HEPA filtration) and conditioned air (See Section 3.0 of the Dynatec Report). Exhaust from this facility will be approximately 10% less than input, resulting in facility pressurization, thereby preventing the inadvertent entry of contaminants to the facility.

Exhaust fans are located on two separate horizons (7100 and 7700 Level) from the 7400 Level Laboratory to capture experimental exhausts that are heavier or lighter than air, respectively. This exhaust will travel to the No. 5 Shaft via the internal ramps and raises outside the fresh air corridor (decommissioned mine workings).

With the introduction of clean conditioned air introduced to the laboratory, a single pass ventilation system will be utilized, thereby eliminating the possibility of internal contamination due to recirculating air.

A15.3 Feasibility Analysis for Ventilation at DUSEL Expansion Concurrent with Laboratory Operations

In expanding the DUSEL whilst experiments and observations are in progress can in many ways can be considered a worst case scenario with respect to demands placed on DUSEL's primary and secondary ventilation systems. Examples of excessive system demands are:

- Separation of exhaust streams from activities of the scientific community and the excavation contractor.
- Increased heat load with the operation of diesel powered equipment.
- Increased primary ventilation rates.
- Increased risk of emergency evacuations due to mine fires caused by the excavation

contractors.

With respect to separation of exhaust streams, this has been considered in the initial laboratory design and ventilation concept and has been taken a step further. In the 7400 Level Science and Engineering Laboratory, the exhaust from this facility will either be vented up to the 7100 Level, or down to the 7700 Level. If expansion of this facility were to occur, the excavation exhaust would be directed to the No. 5 Shaft exhaust facility via the 7400 Level. Therefore, the exhaust from the Laboratory and the exhaust from the excavation and expansion activities will evacuate the area on different horizons or elevations.

Within the laboratories themselves, flow of air through the facilities will be such that no re-circulation of air will occur in the science halls and observatories.

This concept is also applied to the air intake as well. Although fresh air intakes are common for the 7400 Level Science and Engineering Laboratory, the intakes for these scientific facilities are "upstream" from where future expansion excavation would commence.

Increased heat load is considered in Section 3.0 of Dynatec Report. however, diesel powered mining equipment produces slightly more than 2,500 BTU/hr/BHP operating (A.W.T. Barenburg). Although this would normally tax existing air cooling plants, since all of the excavation work for the laboratory expansion will be downstream from the science facility "heat pollution" should be minimized.

With respect to increased primary ventilation rates, it is assumed the same air volumes utilized in the Initial Construction Program will be applied. Tables A15.3a through A15.3d provide a summary of the additional air requirements derived from the Dynatec Report.

Table A15.3a

Air Volume Requirements during the First Expansion of the 7400 Laboratory

Excavation of Future Laboratories A and B

Job Task	**Primary Ventilation System Air Volume Requirements**	
	Yates Shaft	**Ross/No. 6**
Downcast Yates for Personnel and Material Transport	60,000 cfm	-
Ventilate No. 6 Winze Hoist Room	-	10,000 cfm
Operate 7400 Laboratory	-	65,000 cfm
Expand the 7400 Lab	-	95,000 cfm
Maintain 6950 L Pump Station	-	20,000 cfm
Maintain 8000 L Pump Station	-	40,000 cfm
Upcast Headframes	25,000 cfm	25,000 cfm
Intake Air Requirement	**85,000 cfm**	**255,000 cfm**
No. 5 Shaft Exhaust Quantity	**290,000 cfm**	

Table A15.3b

Air Volume Requirements during the Second Expansion of the 7400 Laboratory

Excavation of Future Laboratories C and D

Job Task	Primary Ventilation System Air Volume Requirements	
	Yates Shaft	Ross/No. 6
Downcast Yates for Personnel and Material Transport	60,000 cfm	-
Ventilate No. 6 Winze Hoist Room	-	10,000 cfm
Operate 7400 Laboratory	-	77,000 cfm
Expand the 7400 Lab	-	95,000 cfm
Maintain 6950 L Pump Station	-	20,000 cfm
Maintain 8000 L Pump Station	-	40,000 cfm
Upcast Headframes	25,000 cfm	25,000 cfm
Intake Air Requirement	**85,000 cfm**	**267,000 cfm**
No. 5 Shaft Exhaust Quantity	**302,000 cfm**	

Table A15.3c

Air Volume Requirements during the Third Expansion of the 7400 Laboratory

Excavation of Future Laboratory E

Job Task	Primary Ventilation System Air Volume Requirements	
	Yates Shaft	Ross/No. 6
Downcast Yates for Personnel and Material Transport	60,000 cfm	-
Ventilate No. 6 Winze Hoist Room	-	10,000 cfm
Operate 7400 Laboratory	-	84,000 cfm
Expand the 7400 Lab	-	95,000 cfm
Maintain 6950 L Pump Station	-	20,000 cfm
Maintain 8000 L Pump Station	-	40,000 cfm
Upcast Headframes	25,000 cfm	25,000 cfm
Intake Air Requirement	**85,000 cfm**	**274,000 cfm**
No. 5 Shaft Exhaust Quantity	**309,000 cfm**	

Table A15.3d

Air Volume Requirements during the Fourth Expansion of the 7400 Laboratory

Laboratories A through E in Place, one additional Expansion

Job Task	**Primary Ventilation System Air Volume Requirements**	
	Yates Shaft	**Ross/No. 6**
Downcast Yates for Personnel and Material Transport	60,000 cfm	-
Ventilate No. 6 Winze Hoist Room	-	10,000 cfm
Operate 7400 Laboratory	-	130,000 cfm
Expand the 7400 Lab	-	95,000 cfm
Maintain 6950 L Pump Station	-	20,000 cfm
Maintain 8000 L Pump Station	-	40,000 cfm
Upcast Headframes	25,000 cfm	25,000 cfm
Intake Air Requirement	**85,000 cfm**	**320,000 cfm**
No. 5 Shaft Exhaust Quantity	**355,000 cfm**	

A15.4 Feasibility Analysis Summary of Ventilation Requirements

Table A15.4 is a summary of air volume requirements of the DUSEL primary ventilation circuit from initial shaft rehabilitation work through the fourth expansion of the 7400 Level Science and Engineering Laboratory.

Table A15.4 Summary of Primary Fan Requirements

Phase	**Reference**	**Yates Shaft (cfm)**	**Ross Shaft (cfm)**	**No. 5 Shaft (cfm)**
Yates and Ross Refurbishment	-	-	-	150,000
No. 6 Winze/De-Watering	Table A15.1a	85,000	135,000	170,000
No. 6 Winze/De-Watering	Table A15.1b	85,000	125,000	160,000
7400 Level Construction	Table A15.1c	85,000	250,000	285,000
Initial DUSEL Operation	Table A15.2	85,000	160,000	195,000
First DUSEL Expansion	Table A15.3a	85,000	255,000	290,000
Second DUSEL Expansion	Table A15.3b	85,000	267,000	302,000
Third DUSEL Expansion	Table A15.3c	85,000	274,000	309,000
Fourth DUSEL Expansion	Table A15.3d	85,000	320,000	355,000

In Section A15.8 of this report, utilizing the Homestake supplied data and ventilation-modeling program (VnetPC) will be used to determine surface primary and underground booster fan operating duty points, however it appears that:

- For the Yates Shaft, a variable pitch axial flow fan capable of providing between 80,000 and 100,000 cfm would suffice.
- For the Ross Shaft, two variable pitch axial flow fans with variable frequency and variable speed motors, each capable of providing between 125,000 and 170,000 cfm would meet all air volume requirements.
- For the No. 5 Shaft, two variable pitch axial flow fans with variable frequency and variable speed motors, each capable of providing between 150,000 and 200,000 cfm would meet all air volume requirements.

A15.5 Underground Facility Air Heating, Cooling, and Conditioning

At the lower levels of the Homestake Mine (below the 4700 Level), a dry bulb temperature gradient of 21º F was observed by Homestake's Ventilation Department. The dry bulb temperatures range from 75º F range on the 4700 Level to 96º F on the 7700 Level of the mine. The 7400 Level Science and Engineering Laboratory will be located in this high temperature region (+90º F) of Homestake Mine.

Theoretically, auto-compression raises the dry bulb temperature of the air about 1ºC per every 100 m traveled down a ventilation shaft. Therefore, in general terms, the temperature rise noted by the Homestake ventilation staff is not unexpected, as auto-compression accounts for approximately 10º C (18º F) of the temperature rise. Variances between theoretical and actual temperatures can be attributed to air velocity and surface temperature of the drift/shaft rock surface.

In documentation from Homestake, it was reported that the average rock temperature gradient is 1º F per 83 feet. Virgin rock temperatures of 133º F were measured on the 8000 Level but have cooled significantly decades ago to the ambient air temperatures (~95º F).

Therefore, for this report to recommend mine air heating may seem an extravagance, as it would provide an additional heat load on the DUSEL operating horizons; however it is required to ensure safe transport of men and materials in the Ross and Yates Shaft conveyances during the winter. The build-up of ice on the respective shaft's timber and guides, ropes and sheave wheels must be prevented. If ice should come loose from the shaft timber, the damage incurred to the shaft timber may be costly. Certainly the shaft conveyance would be taken out of service, whilst inspections take place. However, if the falling ice should hit a cage while transporting DUSEL personnel, injuries could occur.

In addition to cooling the air, it must be conditioned as well. Conditioning, in the context of this report not only deals with humidity control, but dust and radon gas control as well. In this regard, by the nature of the operations and their juxtaposition and proximity to the planned facility expansions (TablesA15.3a – A15.3d), cross contamination can be mitigated.

15.6 Mine Air Heating

The mine-air heating plants would have the capacity to heat air from –40º F to +34º F, producing a maximum of 6.9 million BTU/hr at the Yates Shaft, and 26.0 million BTU/hr at the Ross Shaft. These heating capacities are for volumes expected during facility expansion experiencing extremely cold external air temperatures, while science experiments are in progress. During normal operating conditions, the consumption of heating fuel would be much lower. In Homestake supplied ventilation department reference material, the average minimum temperature during the winter months is –20º F. Therefore, heating 85,000 cfm, the Yates facility will consume an average of 4.0 million BTU/hr of heating fuel, whilst the Ross facility, heating 160,000 cfm, will consume an average of 7.6 million BTU/hr of heating fuel during the initial operation of the 7400 Level Science and Engineering Laboratory.

Table A15.6 demonstrates the average heating fuel consumption during the various operational phases of DUSEL. Detailed calculations are presented in Dynatec Report.

Table A15.6 Summary of Heating Fuel Consumption

Phase	Reference	Yates Shaft (BTU/hr)	Ross Shaft (BTU/hr)
Yates and Ross Refurbishment	-	-	-
No. 6 Winze/De-Watering	Table A15.1a	4.1 million	6.4 million
No. 6 Winze/De-Watering	Table A15.1b	4.1 million	5.9 million
7400 Level Construction	Table A15.1c	4.1 million	11.9 million
Initial DUSEL Operation	Table A15.2	4.1 million	7.6 million
First DUSEL Expansion	Table A15.3a	4.1 million	12.1 million
Second DUSEL Expansion	Table A15.3b	4.1 million	12.7 million
Third DUSEL Expansion	Table A15.3c	4.1 million	13.0 million
Fourth DUSEL Expansion	Table A15.3d	4.1 million	15.2 million

Using the theoretical auto-compression of air heating rate of 1ºC/100 m vertical displacement, the expected temperature rise from Ross Tramway elevation to the 4850 Level is approximately 26º F. Offsetting this temperature rise is air velocity, rock temperature, and evaporation of water from the respective shaft's timber sprinkler systems, which tends to cool the air mass. This would partially explain the Homestake supplied data, in which the 4850 Level averaged 48º F WB/50º F DB producing an 87% RH in winter.

Therefore, the expected dry bulb temperature on 4850 Level will be within the values measured by Homestake when in winter operation (~50º to 60º F).

A15.7 Mine Air Cooling and Conditioning

DUSEL specifies that a temperature of 70º F at 60% Relative Humidity (RH) must be maintained within the confines of the "clean" laboratory. Clean is specified by DUSEL as a "Class 10,000 clean room, with the provision for achieving higher levels of cleanliness in selected rooms."

Homestake reports that the No. 6 Winze area of the 8000 Level experiences an average 73º F WB/77º F DB in winter producing an 82% RH, and an average 78º F WB/81º F DB producing an 87% RH in summer. For the purpose of this report, and to provide a margin of safety, the air chilling load for the 7400 Level Science and Engineering Laboratory will be determined using a maximum dry bulb temperature of 90º F.

In DynatecReport cooling determinations demonstrate that the air chilling plant must operate across a range of 146-ton to 219-ton to meet summer cooling loads experienced during the initial operations phase to the fourth facility expansion. The term ton is not a weight, but a measure of cooling capacity. 1-ton is equivalent to 12,000 BTU/hr, a measure of heat, which the chiller dissipates.

In a memo from J. Marks, Ventilation Engineer at Homestake prior to its closing, it was noted that Homestake had, at its closing a 350-ton district chiller was located on the 8000 Level, and a 290-ton district chiller was located on the 7400 Level. There were also a number of 30-ton spot chillers available as well. Presently, the mine is flooded to the 5600 Level. A new unit will have to be purchased for the 7400 Laboratory, plus portable spot chillers for the development headings driven in this area of the mine.

The use of the portable air-chillers is a function of the conditions actually experienced once the 7100 through to the 7700 Level excavation horizon is reached. Assuming that 30,000 cfm would be provided for each development heading possibly two 30-ton air chillers may be required for each heading mined in this region. Therefore:

- For the 7100 Level exhaust fan drift 2 x 30-ton air chillers may be required.
- For the 7700 Level laboratory 2 x 30-ton air chillers may be required for each heading being developed. Therefore if 4 headings are being developed then eight air chillers would be present, however only 6 would be operating at any one time.
- For the 7700 Level exhaust fan drift the air chillers utilized on the 7100 Level can be used.

A15.8 COMPUTERIZED VENTILATION ASSESSMENT

A15.8.1 Introduction

In an effort to determine project requirements, a computerized ventilation model of the de-commissioned Homestake Mine was conducted for Dynatec. Prior to mine closure the Homestake ventilation department utilized a commercially available modeling system, VnetPC, developed and sold by Mine Ventilation Services (MVS) of Fresno California.

To expedite matters, the Consultant utilized these data input files and modeling system to determine the DUSEL primary ventilation system's main and booster fan requirements. Specifically, the Consultant utilized the Homestake developed branch resistance data for the Yates, Ross and No. 5 Shaft, plus key airways connecting these primary air intake and exhaust systems. Therefore, for analysis purposes data input files were reduced from 469 branches utilizing 299 junctions to 88 branches utilizing 65 junctions.

A15.8.2 Model Accuracy

A mine's ventilation circuit can be likened to an electrical circuit, with a fan acting as a battery or some other electrical source. In this type of system, it is generally accepted that approximately 90% of a mine's resistance to airflow can be attributed to the mine's main intake and exhaust shafts and raises which run from surface to underground. The internal airways (drifts, raises, and ramp systems) connected to these main air intake and exhaust routes airways, act in parallel to each other minimizing their individual influence on the system. However, where the majority of airflow passes through a main conduit, like the Yates Shaft, RossShaft/No.6 Winze and No. 5 Shaft, these facilities will have the greatest influence on the system's power requirements.

The primary means of evaluating a mine's primary ventilation network when utilizing a computer modeling program, is by applying Kirchoff's Laws for loop analysis. This method is used since many of the concepts associated with electrical circuit analysis can be readily applied to ventilation circuit analysis. On such concept is how circuits are analyzed in either parallel or series. Therefore, the contracted data input file will tend to develop higher system resistances across specific sections of the mine (e.g., from No. 6 Winze to No. 5 Shaft) than those experienced in the much larger Homestake model, as there will be fewer branches in parallel. Consequently, in the Consultant's modeling of the DUSEL facility, the computer-determined fan duty points will be conservative, since those points, and hence power requirements, will be higher than actual fan duty points measured when placed in operation.

However, the air volumes determined in Section A15.2 are only estimates, based on preliminary laboratory layouts, the diesel equipment requirements for the initial excavation. Therefore, the level of confidence in the results of computer modeling approaches 25%.

A15.8.3 Modeling Results

The advantage of computer modelling a mine's ventilation system is that it allows the engineer to determine what the ventilation requirements are across various ventilation regimes. The models presented in this report consider:

- Ventilating DUSEL whilst Refurbishing/De-Watering No. 6 Winze (NH1a.VNW).
- Ventilating DUSEL whilst Refurbishing/De-watering No. 6 Winze below the 5600

Level (NH2a.VNW).

- Ventilating DUSEL whilst excavating the 7100 Level Exhaust Drift and the 7400 Level Lab (NH3a1.VNW).
- Ventilating DUSEL whilst excavating the 7700 Level Exhaust Drift and the 7400 Level Lab (NH3a1.VNW).
- Ventilating DUSEL during the initial operation of the 7400 Lab (NH4a.VNW).
- Ventilating DUSEL while the 7400 Lab is undergoing its first expansion (NH5a1.VNW).
- Ventilating DUSEL while the 7400 Lab is undergoing its second expansion (NH5a2.VNW).
- Ventilating DUSEL while the 7400 Lab is undergoing its third expansion (NH5a3.VNW).
- Ventilating DUSEL while the 7400 Lab is undergoing its fourth expansion (NH5a4.VNW).

The input and output results of these ventilation simulation models, complete with ventilation schematics, are located in Appendix C of the Dynatec Report. The table overleaf provides a summary of the computer modeling.

In reviewing Table A15.8a , one sees that in some instances two fans are recommended to meet the required ventilation facility duty point, followed by a contraction to only one fan (i.e., fan duty transition from construction of the 7400 lab to its operation mode). In those instances, the extra fan could be placed on emergency standby, or used instead of other fans that are undergoing maintenance.