

**THE INSTALLATION
OF UNDERGROUND
BOOSTER FANS AT
NORTH GOONYELLA COAL MINE**

INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

VENTILATION SYSTEM PRIOR TO BOOSTER FANS

System requirements are;-

Maintain intake Methane GB concentration below 0.5%;

Virgin gas content increasing with depth;

Expected development advance rates increasing to 180 m/wk;

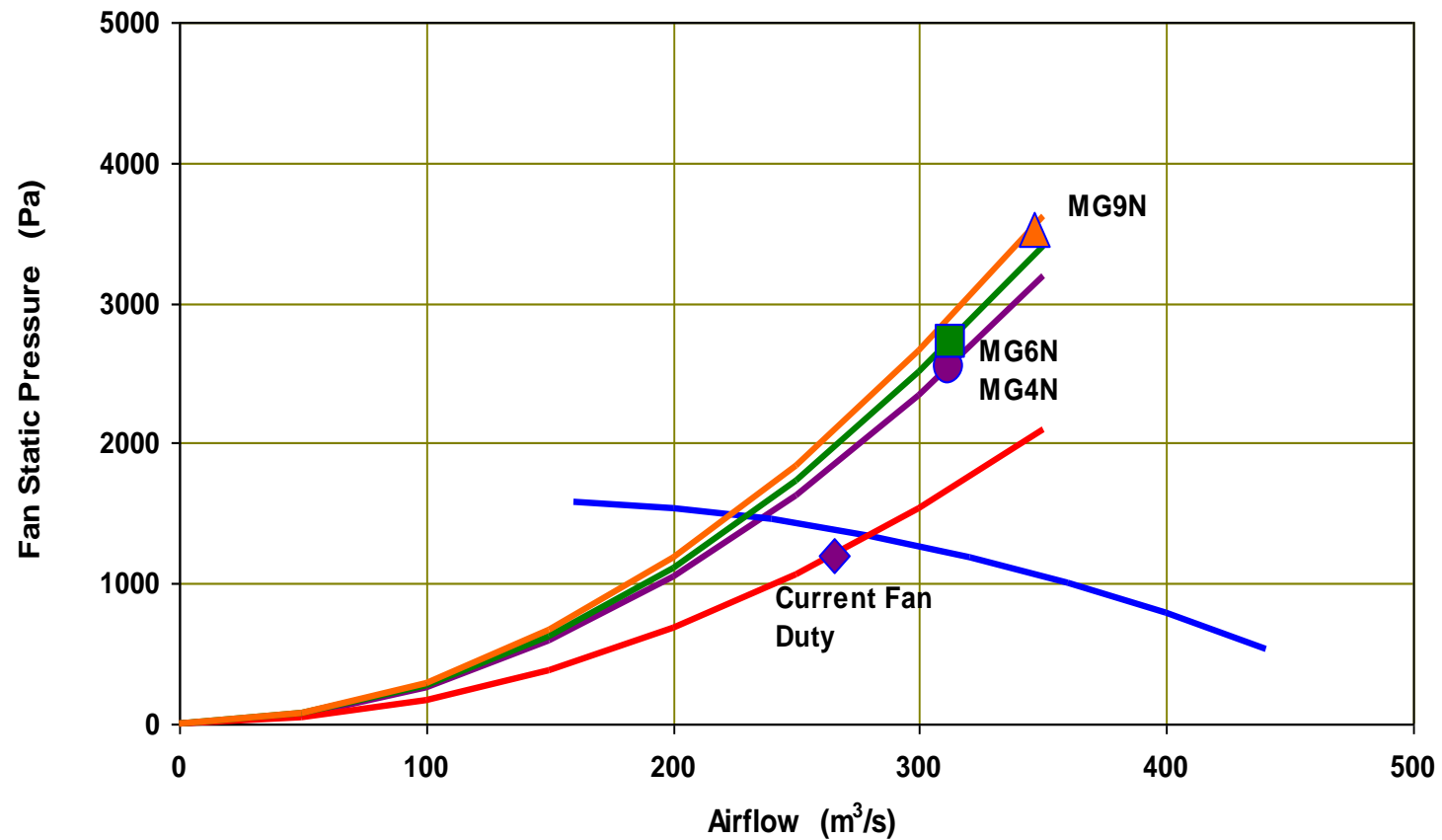
Require 70 m³/s at last open c/t in MG development.

Ventilation Planning indicated that the current system would be unable to meet system requirements beyond 2400 chainage in MG4N.

Main fans operating near design capacity.

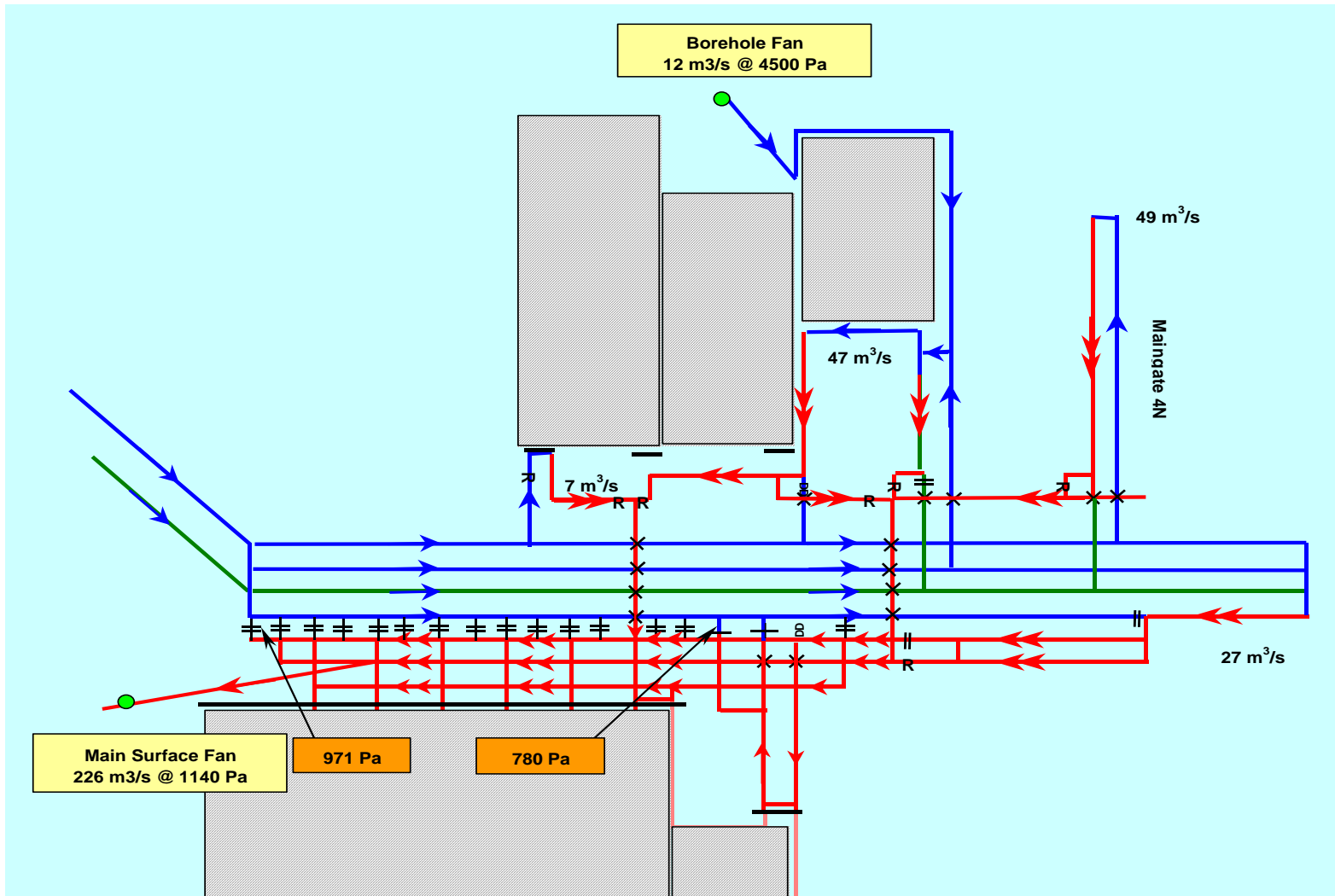
INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

MAIN FAN PERFORMANCE PRIOR TO BOOSTER FANS



INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

VENTILATION PRIOR TO BOOSTER FANS



BOOSTER FAN INSTALLATION

- **Twin fan installation located in the main return airways at G & I headings 25 c/t.**
- **Each fan is powered by a single 600 kW motor located in a purpose designed intake air chamber**
- **Centrifugal fan**
- **Variable speed control**
- **Designed to service the mine to LW9N**
- **Central bypass airway to maintain mine ventilation when the booster fan is non operational.**

BOOSTER FAN INSTALLATION

Preferred option because;-

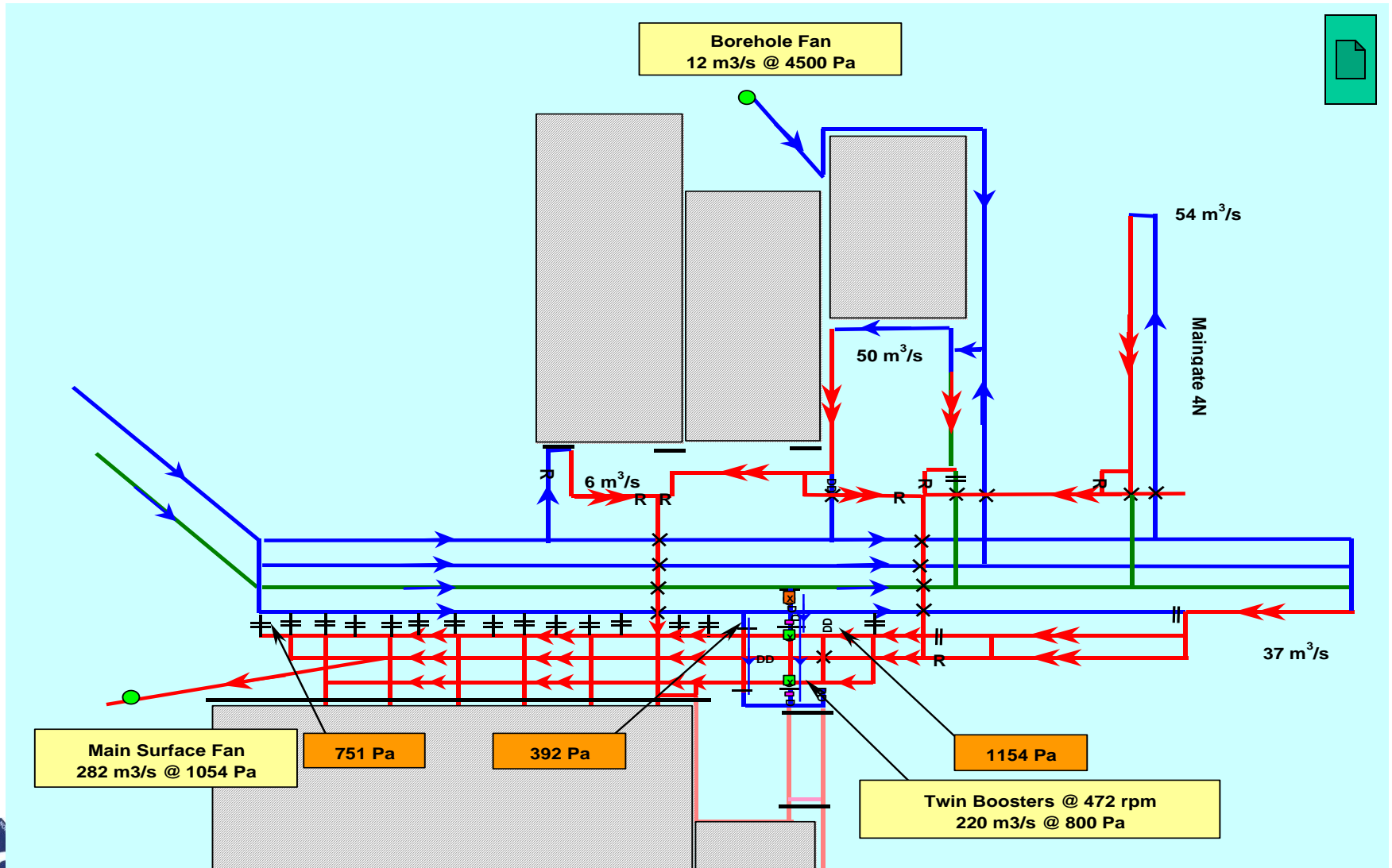
Underground pressure differentials

Cost

Timing

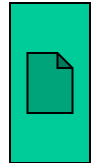
INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

Ventilation After Booster Fan Installation



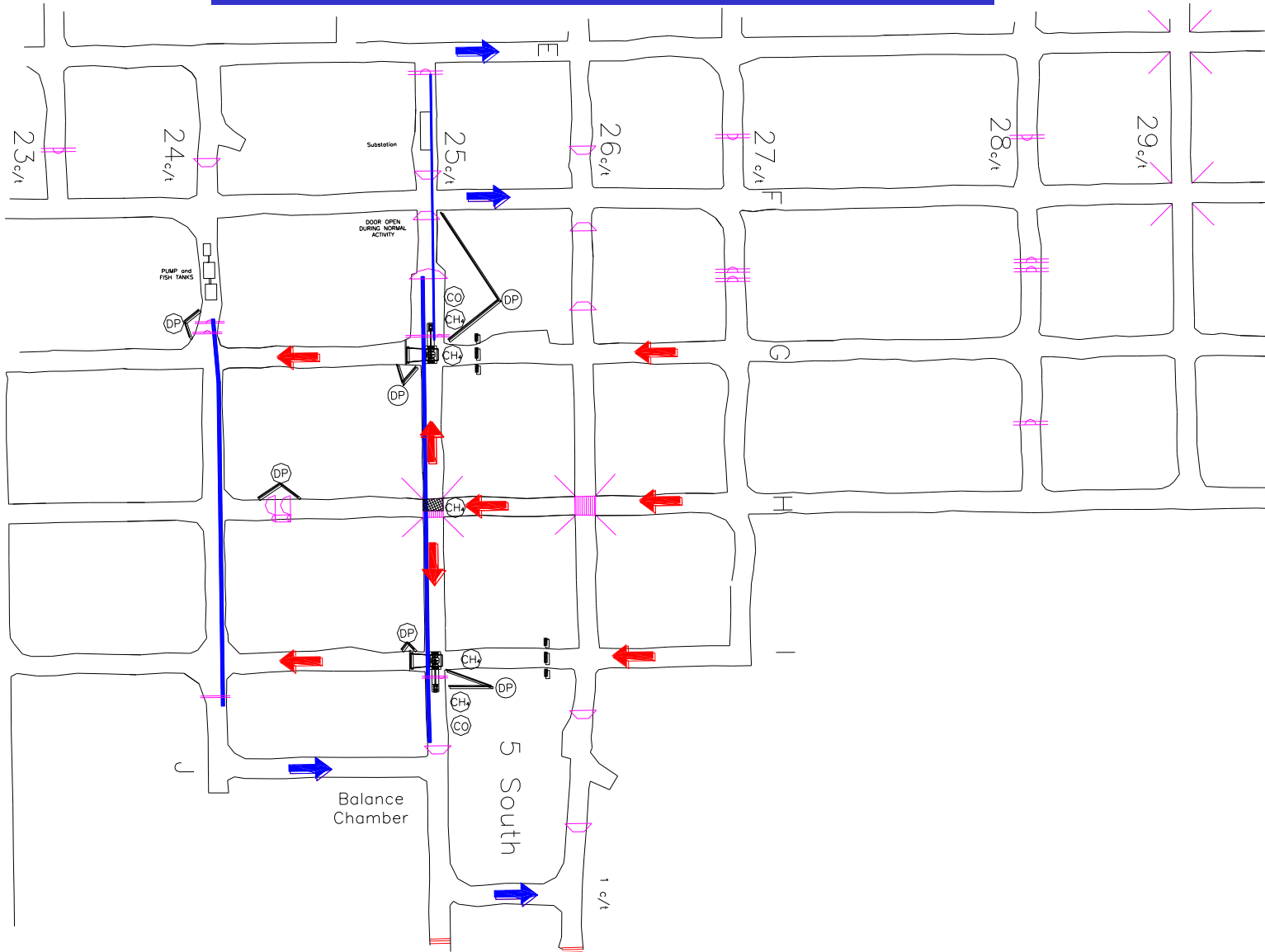
BOOSTER FAN INSTALLATION

- **Place fan in series with existing main fans**
- **Apply additional air power to inbye workings**
- **Reduced ventilation pressures outbye of the booster**
- **Increased ventilation pressures inbye of the booster**
- **Reduction of main fan requirements for a given inbye performance**



INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

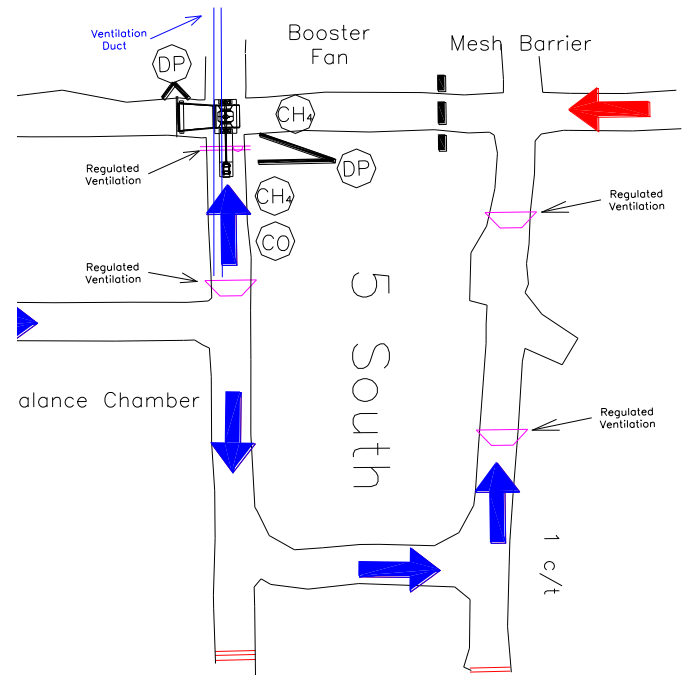
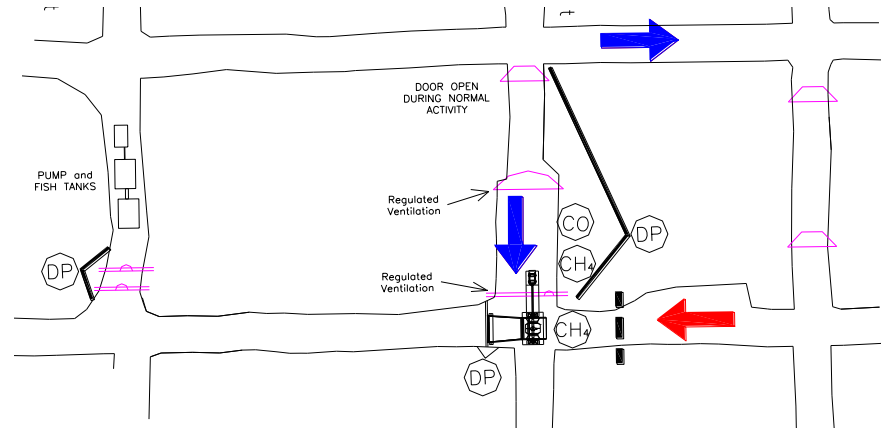
BOOSTER FAN INSTALLATION



INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

MONITORING

- Ventilation Pressure
 - Booster fans
 - Motor bulkheads
 - Bypass doors
- Methane
 - Motor chambers
 - Booster fan inlet
- Carbon Monoxide
 - Motor chambers
- Fan Speed
- Motor bearing – vibration & temperature
- Fan shaft bearing – vibration & temperature



INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

INSPECTIONS

Frequency	Responsibility	Inspection
Twice / shift	ERZ Controller	Motors & Substation
Shiftly	ERZ Controller	Booster Fans
Monthly	Ventilation Officer	Ventilation Adequacy VCD Integrity Accelerated Oxidation

INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

NORMAL OPERATING CONDITIONS

- **Under normal operating conditions the mine is ventilated by:**
 - **Twins surface fans.**
 - **Both booster fans running.**
 - **Maingate borehole forcing fan.**

- **The central bypass doors are closed when the booster fans are running.**

INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

NORMAL OPERATING CONDITIONS

- **To alter the duty of either the main surface fans, the booster fans or the borehole fan is classified as a Major Ventilation Change and as such requires authorisation from the Ventilation Officer & countersigned by the Mine Manager.**

INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

CHANGING SETTINGS

- **Ventilation Change Scope of Work prepared and authorised by the Ventilation Officer, countersigned by the Mine Manger. Based on ventilation modeling of the change defining:**
 - **Target face ventilation quantities.**
 - **Main fan duty**
 - **Intermediate and final booster fan speed / duty settings**
 - **Goaf pressure balance arrangements**
 - **Ventilation pressures at strategic locations**
- **Notice of alteration to fan settings**
- **Notification of persons affected**
- **Alteration of booster fan, main fan and gas monitoring alarm settings**
- **Change validation**
- **Ventilation model update**

BOOSTER FAN STARTING

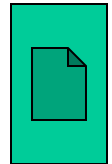
- **Single main fan operating (must be in place before booster fans can be started)**
- **Status check – main fan collar pressure, gas, pressure & condition monitoring at booster fan.**
- **Start booster fans and increase speed to intermediate level (speed increases automatically)**
- **By-pass door closes with increasing pressure (relies solely on ventilation pressure for operation)**

BOOSTER FAN STARTING

- **Start second main fan (manual, will not start unless booster fans are running at set intermediate speed)**
- **Increase booster fan to authorised operating duty (Happens automatically)**
- **Status check – main fan collar pressure, gas, pressure & condition monitoring at booster fan**
- **Adjust mine regulators as required**
- **Confirm gas and ventilation monitoring**

BOOSTER FAN STOPPING

- Normal fan operation – twin main fans, twin booster fans, maingate borehole fan
- When one booster fan trips the second booster fan is shutdown
- By-pass door opens
- One of the main surface fans trips (No2.)
- The development feeder power is isolated
- Status check – main fan collar pressure, gas, booster fan installation gas, pressure & condition monitoring
- Confirm reason for booster fan stoppage
- Underground controller to notify Shift Supervisor and ERZ controllers
- Review regulator settings where booster fan outage to be extended



PLANNED SHUTDOWN

- **Booster fans to be shutdown periodically in a controlled and planned manner for maintenance purposes.**
- **Represents a Major Ventilation Change – written authorisation of Ventilation Officer, countersigned by Mine Manager.**
- **Except in the case of emergencies, requires:**
 - **24 hours notice**
 - **Formal request with scope of work to be performed during shutdown, prepared by department seeking the shutdown.**

FAILURE MODES

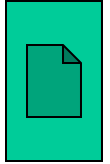
- **Loss of power to mine site**
- **Loss of underground power**
- **Loss of underground power, other than the booster fan feed**
- **Failure of both main fans**
- **Failure of a single main fan**
- **Failure of both boosters fans**

FAILURE MODES

- **Failure of a single booster fan**
- **Failure of maingate borehole fan**
- **ERZ trip at inbye interface**
- **By-pass door fails to open when booster fans shutdown**
- **By-pass door fails to close when booster fans powered up**
- **Failure of Communications**

INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

BYPASS DOORS



- **Door held closed during normal operation**
- **Door partially open – nil pressure condition**
- **Door open upon booster fan failure**
- **Door restrained from opening fully to enable closure
on booster fan restart.**

INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

INSTALLATION

Fans delivered to mine site in June/July 2002

Work began in September 2002 with secondary support work and site clean up.

Began Excavating booster fan sites October 2002

Completed Excavating sites December 26th 2002

Laying concrete January

Erecting fans February/March

Electrical installation occurred in parallel with other tasks

EXCAVATION

Removal of 3.0m coal caunch at I hdg went well

Thickness of concrete work underestimated

G heading fan site concrete excavated approx. 1.0m thick

Concrete had mesh and roof bolts embedded inside

Excavated using combination of the following;-

- **Trencher Machine to cut 700mm deep “slots” to make excavations easier;**
- **Machine mounted jack picks hired (mixed success)**
- **Manual jack picking (brute strength).**

INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

CONCRETE WORKS

Concrete works responsibility of fan supplier (Flackt-Woods)

Concrete 40 MPa spec with reinforcing to Australian Standards

60 m³ per fan site, 120 m³ total

Subcontractor experienced difficulties in that the Reo bar supplied from supplier in Townsville was incorrectly manufactured

Subcontractor utilised steel purpose designed formwork – resulted in and excellent finished product

Utilised specialist concreter to supervise the concrete works

INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

FAN INSTALLATION

Fan installation and build up went smoothly

Flackt-Woods supervised subcontractor installing fans

Fan impellers delivered on purpose designed skids for ease of transport

Fan supplied in parts to specified sizes for transport underground.

Utilised existing skid for transportation of fan parts where reqd

Motors heaviest item (5.5 tonnes)

Surveyed transport route prior to order to identify load restrictions

INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

ELECTRICAL INSTALLATION

Used contractors where possible to minimise drain on mine resources

Changed schedule to allow electrical installation to occur in parallel with other operations

Termination of heavy power cables from fan substation to fan motors more difficult than expected

Fan supplier clearly did not understand requirements of Qld legislation for electrical equipment such as monitors

INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

ELECTRICAL INSTALLATION

On site support from substation and motor suppliers was good

Off site testing of substation with actual fan motor saved time during commissioning

Very few problems encountered during the commissioning that were related to the booster fan electrical installation

VVVF drives proven very effective in operation

Some problems encountered with the fibre optic line installation

COMMISSIONING

Commissioning period extended due to factors not related to the booster fan installation;-

Delayed commissioning due to poor roof on Longwall

Major repairs to Trunk belt (splicing)

Requirement to weld on the Longwall face

Waiting for window for development panel extension

Major fault #2 surface fan only 1 fan available for 2 days

Major unplanned power outage to site during commissioning

COMMISSIONING

Actual commissioning period on booster fans was 5 days

Some problems encountered;-

I hdg motor coupling moved slightly (bedding in)

One vibration sensor on I hdg fan reading normal but plc interpreted as trip (calibration problem)

One pressure sensor had blockage in stainless steel tubing run for pressure readings (not sensor problem)

Need to dismantle and rebuild 24 I-J stopping to allow 2 surface fan operation (due to welding on LW)

COMMISSIONING

**There were many positives to the commissioning stage;-
The electrical systems worked very well**

Electrical interlocks were all physically tested – all worked

**Both fans ran smoothly – temperatures & vibrations
were all well within limits and stable**

**Ventilation pressures and quantities were all very
close to those modelled – verifying and adding confidence
to accuracy of the ventilation model**

**Due to the outside problems, the commissioning was very
flexible – this was able to be done and still achieve all objectives**

INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

COMMISSIONING

Support from OEMs was good, especially with the stop/start nature of the commissioning

Able to test single fan operation of each booster fan (important information for future)

Able to run each booster fan up to full RPM

Proved the system including the designed interlocks and operation

Fans running and commissioning over on Friday 2nd May 3:15 pm

INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

POST COMMISSIONING

Air quantities in mine are greatly improved;-

Longwall 52 m³/s (52 m³/s prior to booster fans);

MG4N 98 m³/s at Dogleg regulator (68 m³/s prior to booster fans)

Mains H heading 45 m³/s (27 m³/s prior to booster fans);

Mains B heading inbye 35 c/t 35 m³/s (8 m³/s prior to booster fans).

Pressures inbye booster fan increased from 700 Pa to 1300 Pa

Main fan collar pressure 1060 Pa (1140 prior to booster fans)

INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

POST COMMISSIONING

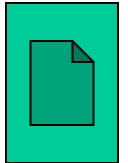
One point of note is that a very good fan curve has been developed for the booster fans.

Could be used for all fans.

Allows for accurate prediction of fan operation.

Excellent tool for future ventilation planning.

Developed by Geogas.



INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

SUBSTATION



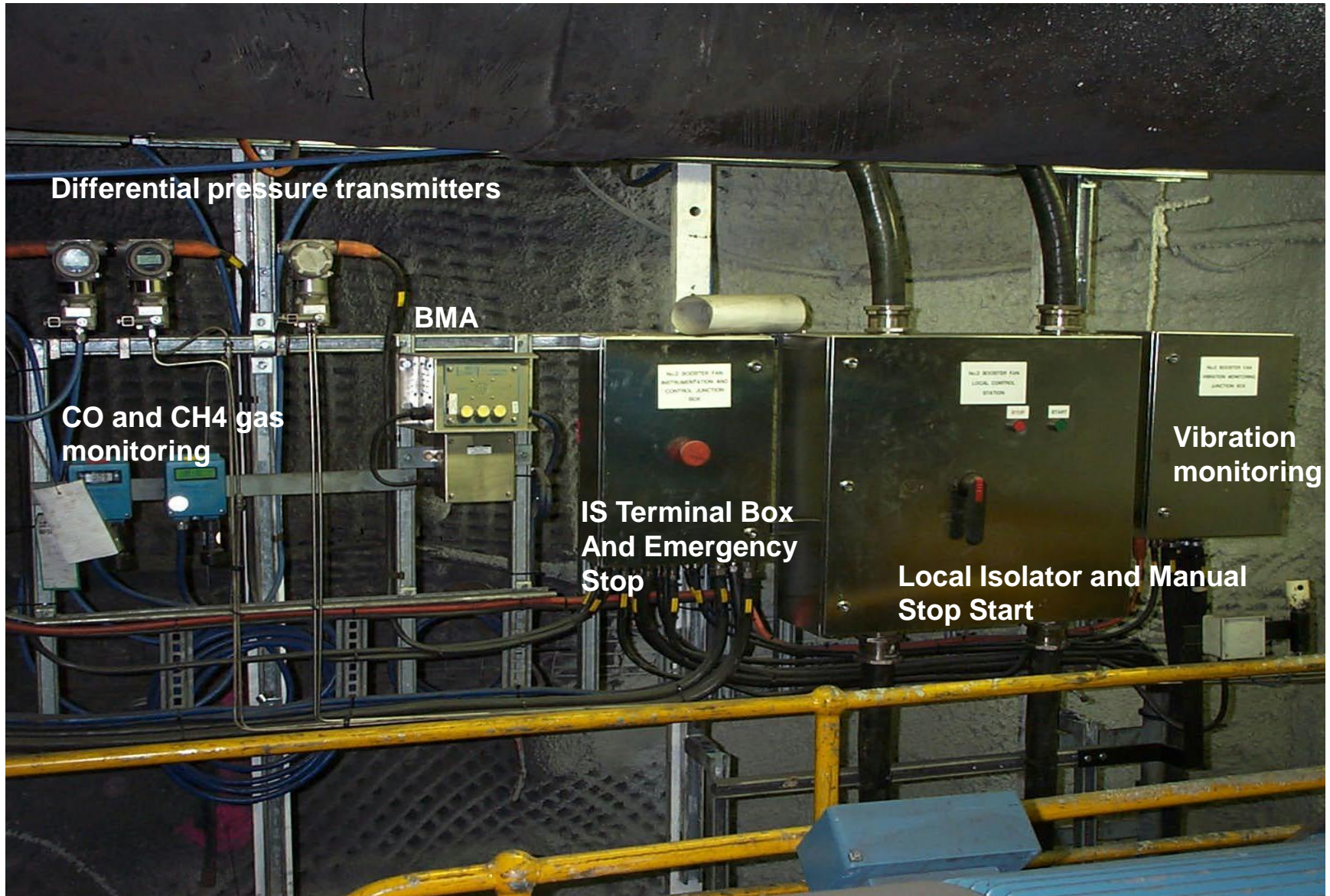
INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

G HEADING MOTOR CHAMBER

630 kW 690v
MOTOR

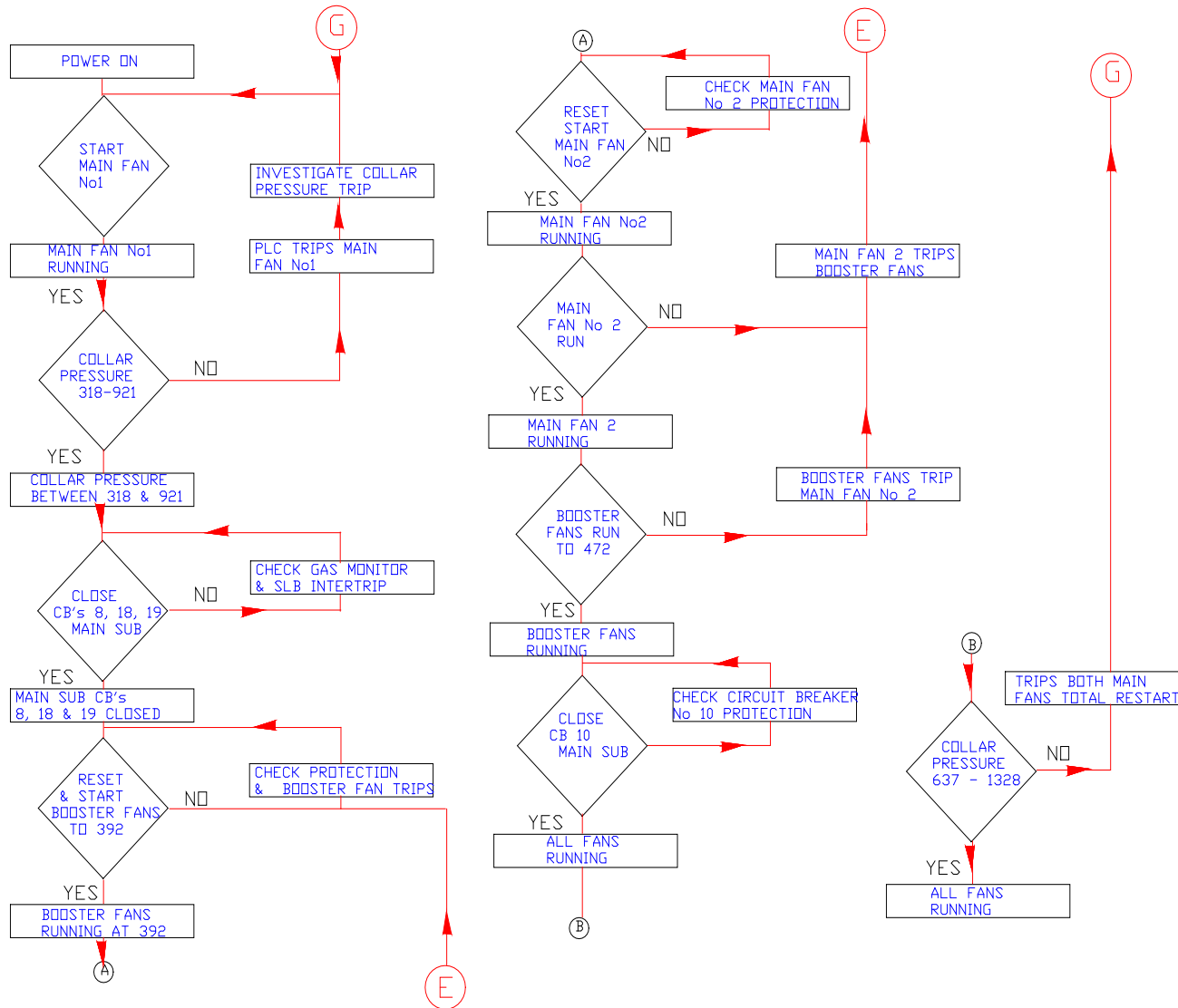
This is an NERZ zone

INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS



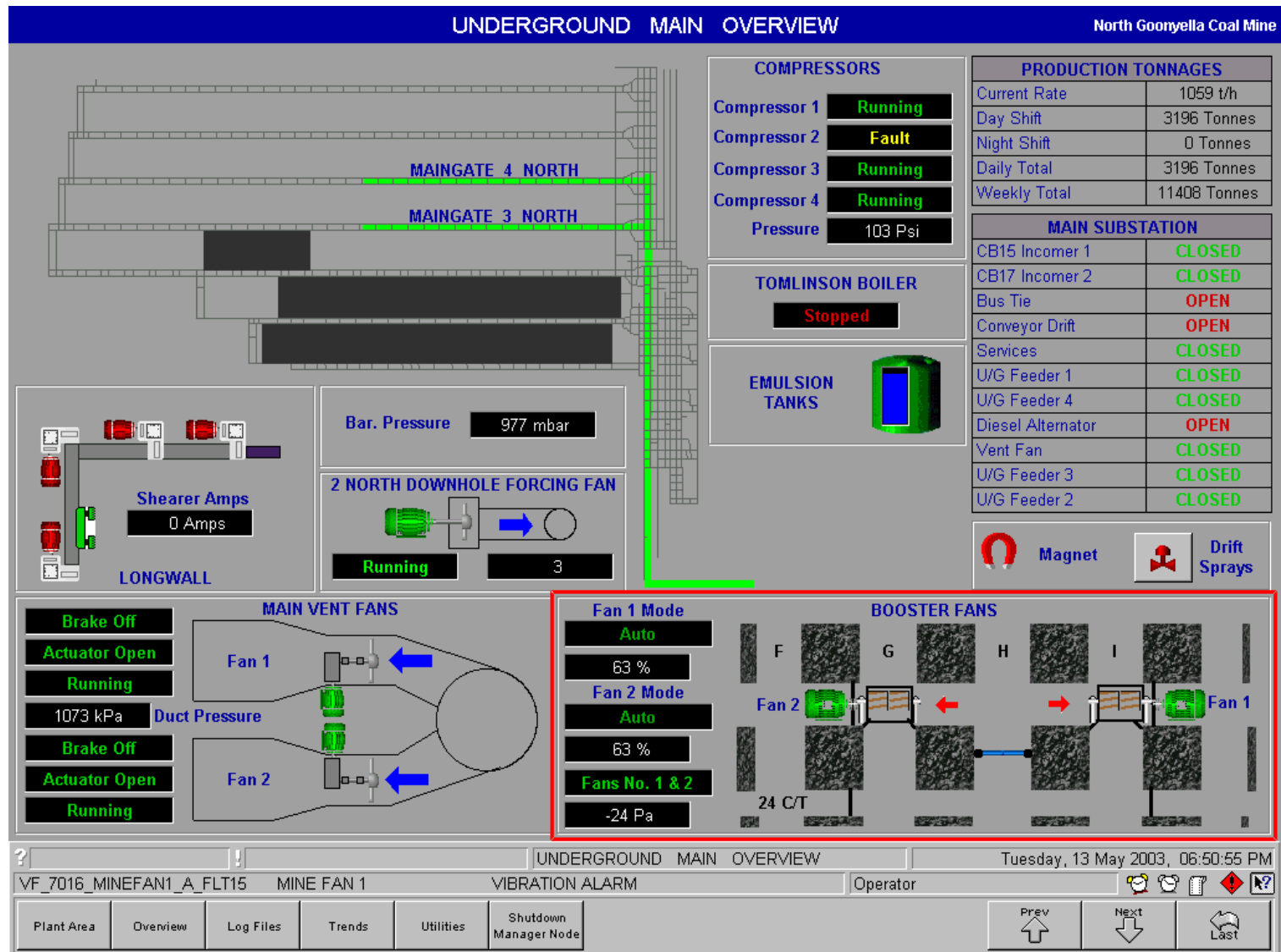
INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

STARTUP FLOWCHART



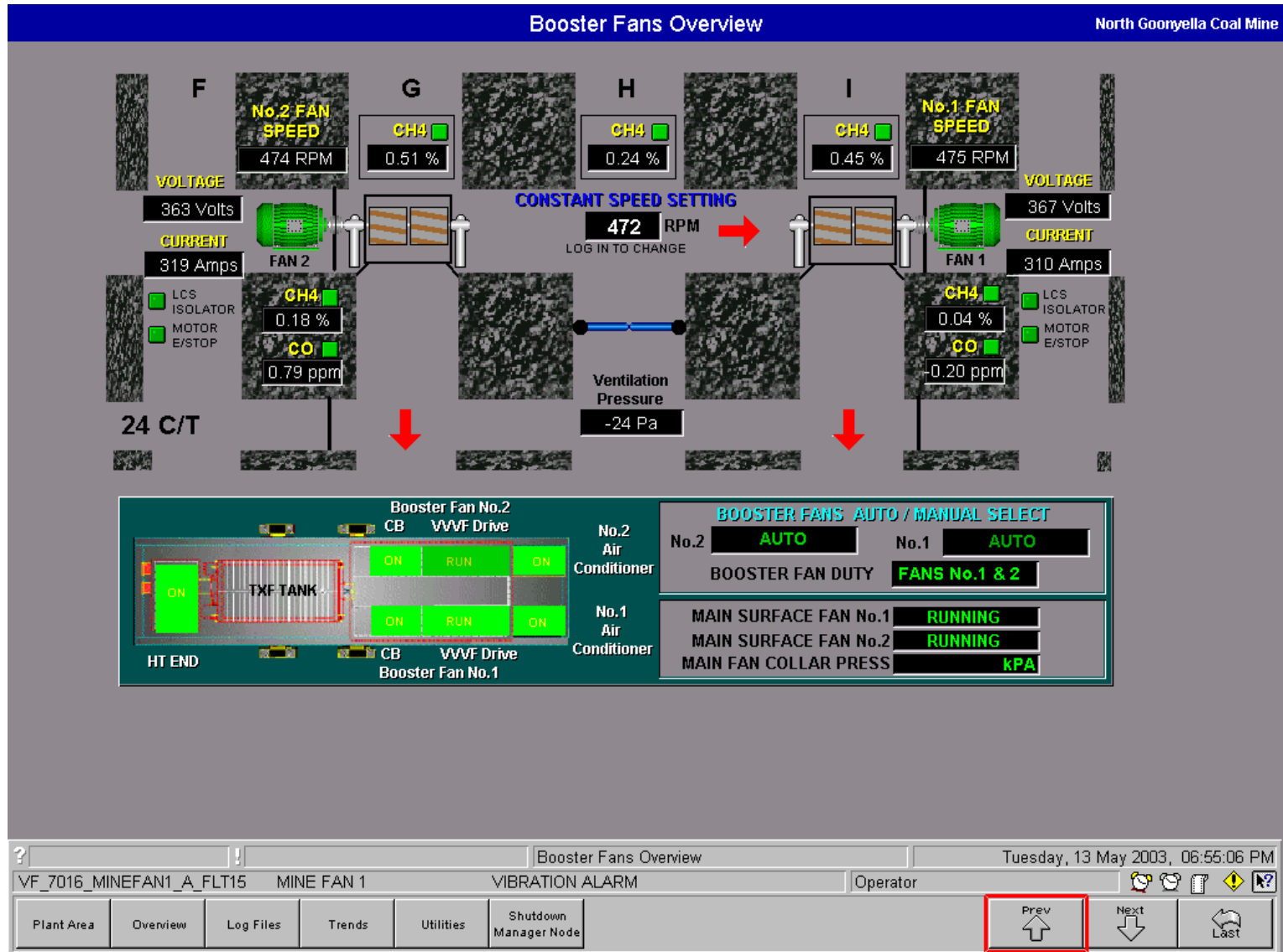
INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

MAIN CITECT SCREEN (SURFACE CONTROL ROOM)



INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

BOOSTER FAN OVERVIEW SCREEN



INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

BOOSTER FAN DETAIL SCREEN

BOOSTER FAN No.2

North Goonyella Coal Mine

Motor Chamber

- Pressure: 1410 Pa
- CH4: 0.18
- CO: 0.79
- Amps: 318.3
- Volts: 363

Drive End

- Temperature: 31
- Vibration: 0.1

Non Drive End

- Temperature: 26
- Vibration: 0.1

Stator Temperature

- No.1: 83
- No.2: 81
- No.3: 82

Fan Airflow: 1178 Pa

Fan Pressure: 881 Pa

Fan Non Drive End

- Temperature: 14
- Vibration: 0.2

Fan Drive End

- Temperature: 17
- Vibration: 0.6

Brake Solenoids: Pressure, Bypass

Brake Temperature: 25 deg. C

ALARMS

- Earth Leakage
- Methane OK
- Carbon Monoxide OK
- DE Bearing Temp OK
- NDE Bearing Temp OK
- Motor Winding Temp OK
- Motor Chamber Pressure OK
- Fan D.P. Pressure OK
- Emergency Stop OK
- Shaft NDE Bearing Temp OK
- Shaft DE Bearing Temp OK
- Motor Vibration Monitor NDE OK
- Motor Vibration Monitor DE OK
- Shaft Vibration Monitor NDE OK
- Shaft Vibration Monitor DE OK

BOOSTER FAN DUTY

- FANS No.1 & 2: RUNNING
- MAIN SURFACE FAN No.1: RUNNING
- MAIN SURFACE FAN No.2: RUNNING
- MAIN FAN COLLAR PRESS: kPa
- BYPASS DOORS: CLOSED
- FAN LOCKING PIN: PIN FREE

AUTO OPERATION SELECTED

1-FAN SPEED: 74 RPM

VOLTAGE: 365 Volts

CURRENT: 308 Amps

CH4: 1.04 %

CO: 20 ppm

STATUS

- LCS ISOLATOR
- MOTOR E/STOP

MANUAL SELECT

- AUTO
- No.1 & 2
- STOPPING
- STARTING
- STOPPING kPa

CV_7063_MG3N_A_ISOL4 MAINGATE 3 NORTH ACB2 CONVEYOR ISOLATOR Operator

Tuesday, 13 May 2003, 06:59:26 PM

Plant Area Overview Log Files Trends Utilities Shutdown Manager Node

Prev Next Last



INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

VVVF DRIVE DETAIL SCREEN

Booster Fan No.2 VVVF Drive Data North Goonyella Coal Mine

Process Speed: 63% (0-100)

Motor Speed: 63% (0-100)

Frequency: 31.58 Hz (0-100)

Output Current: 318.0 AMPS (0-1000)

Output Torque: 33% (0-100)

Output Power: 2.10% (0-100)

DC Bus Voltage: 927 Volts (0-1000)

Mains Voltage: 668 Volts (0-1000)

Output Voltage: 365 Volts (0-1000)

Stack Temperature: 54 Deg C (0-200)

DRIVE STATUS

Drive Ready To Start

Enabled

Drive Running w. Selected Reference

Drive In Remote Mode

Drive At Reference

No Active Faults

No Active Warnings

Drive At Limit

VVVF Alarms Start Permissives

1-FAN SPEED: 74 RPM

VOLTAGE: 364 Volts

CURRENT: 310 Amps

CH4: 0.04 %

CO: 39 ppm

LCS ISOLATOR

MOTOR E/STOP

MODE SELECT

AUTO

No.1 & 2

STOPPING

STARTING

kPA

CV_7063_MG3N_A_ISOL4 MAINGATE 3 NORTH ACB2 CONVEYOR ISOLATOR Operator

Plant Area Overview Log Files Trends Utilities Shutdown Manager Node

Prev Next Last



INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

ENVIRONMENTAL MONITORING DETAIL SCREEN

North Goonyella Coal Mine

ENVIRONMENTAL MONITORING AND SETTINGS

No.1 MOTOR CHAMBER

METHANE	0.04	% CH4	<input type="checkbox"/>	ALARM	0.25	TRIP	0.50
CARBON MONOXIDE	0.39	ppm CO	<input type="checkbox"/>	ALARM	27.00	TRIP	33.00
PRESSURE	955	kPa	<input type="checkbox"/>				
FAN PRESSURE	880	kPa	<input type="checkbox"/>				

No.2 MOTOR CHAMBER

METHANE	0.18	% CH4	<input type="checkbox"/>	ALARM	0.25	TRIP	0.50
CARBON MONOXIDE	0.98	ppm CO	<input type="checkbox"/>	ALARM	27.00	TRIP	33.00
PRESSURE	1408	kPa	<input type="checkbox"/>				
FAN PRESSURE	878	kPa	<input type="checkbox"/>				

HEADINGS

METHANE	G	0.51	% CH4	<input type="checkbox"/>	ALARM	1.25	TRIP	2.00
	H	0.24	% CH4	<input type="checkbox"/>	ALARM	1.25	TRIP	2.00
	I	0.45	% CH4	<input type="checkbox"/>	ALARM	1.25	TRIP	80.00

BYPASS DOORS

		CLOSED					
PRESSURE		-24	kPa	<input type="checkbox"/>			

HT END

TXF TANK

ON RUN ON

CB VVVF Drive

Booster Fan No.1

No.1 Air Conditioner

MAIN SURFACE FAN No.1 **RUNNING**

MAIN SURFACE FAN No.2 **RUNNING**

MAIN FAN COLLAR PRESS **kPa**

SELECT

AUTO

0.1 & 2

Cannot free Parent window | Booster Fans Overview | Tuesday, 13 May 2003, 07:03:51 PM

CV_7063_MG3N_A_ISOL4 | MAINGATE 3 NORTH | ACB2 CONVEYOR ISOLATOR | Operator

Plant Area | Overview | Log Files | Trends | Utilities | Shutdown Manager Node

Prev | Next | Last



INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

FAN 2 START PERMISSIVES

North Goonyella Coal Mine

1-FAN PEED

74 RPM

VOLTAGE

365 Volts

CURRENT

FAN 1 313 Amps

CH4

0.04 %

CO

39 ppm

LCS ISOLATOR

MOTOR E/STOP

MODAL SELECT

AUTO

No.1 & 2

INNING

INNING

kPA

? Cannot free Parent window Booster Fans Overview Tuesday, 13 May 2003, 07:05:42 PM

CV_7063_MG3N_A_ISOL4 MAINGATE 3 NORTH ACB2 CONVEYOR ISOLATOR Operator

Plant Area Overview Log Files Trends Utilities Shutdown Manager Node

Prev Next Last




INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

VVVF STARTER HIGH TENSION END

HT MCB
CLOSED

- EMERGENCY STOP
- MCB GAS
- TANK HI PRESSURE
- TANK LOW PRESSURE



TROLEX 9042 CONTROLLER HEALTHY

North Goonyella Coal Mine

NO.1 FAN SPEED
75 RPM

VOLTAGE
364 Volts

CURRENT
FAN 1 310 Amps

CH4 0.04 %
CO 39 ppm

LCS ISOLATOR
 MOTOR E/STOP

HIGH TENSION PM2000 PROTECTION RELAY STATUS

OPERATING STATE	SETTINGS
PM2000 STATUS: COMMS FAULT - OSI BAORD	FLC: <input type="text" value="0"/> Amps (0 to 500)
HT CURRENT: <input type="text" value="0"/> Amps (0 to 1000)	O/L CURVE: INVERSE
HT E/L CURRENT: <input type="text" value="0"/> mA (0 to 1000)	O/L MULTIPLIER: <input type="text" value="0"/> (0 to 20)
PILOT RESISTANCE: <input type="text" value="0.00"/> Ohms (0 to 150)	E/L SETTING: <input type="text" value="0.00"/> mA (0 to 1000)
	E/L DELAY: <input type="text" value="0.00"/> mS (0 to 1000)

DUAL SELECT

AUTO

No.1 & 2

UNNING

UNNING

kPA

CV_7063_MG3N_A_ISOL4 MAINGATE 3 NORTH ACB2 CONVEYOR ISOLATOR Operator

Tuesday, 13 May 2003, 07:06:16 PM

Plant Area Overview Log Files Trends Utilities Shutdown Manager Node

Prev Next Last



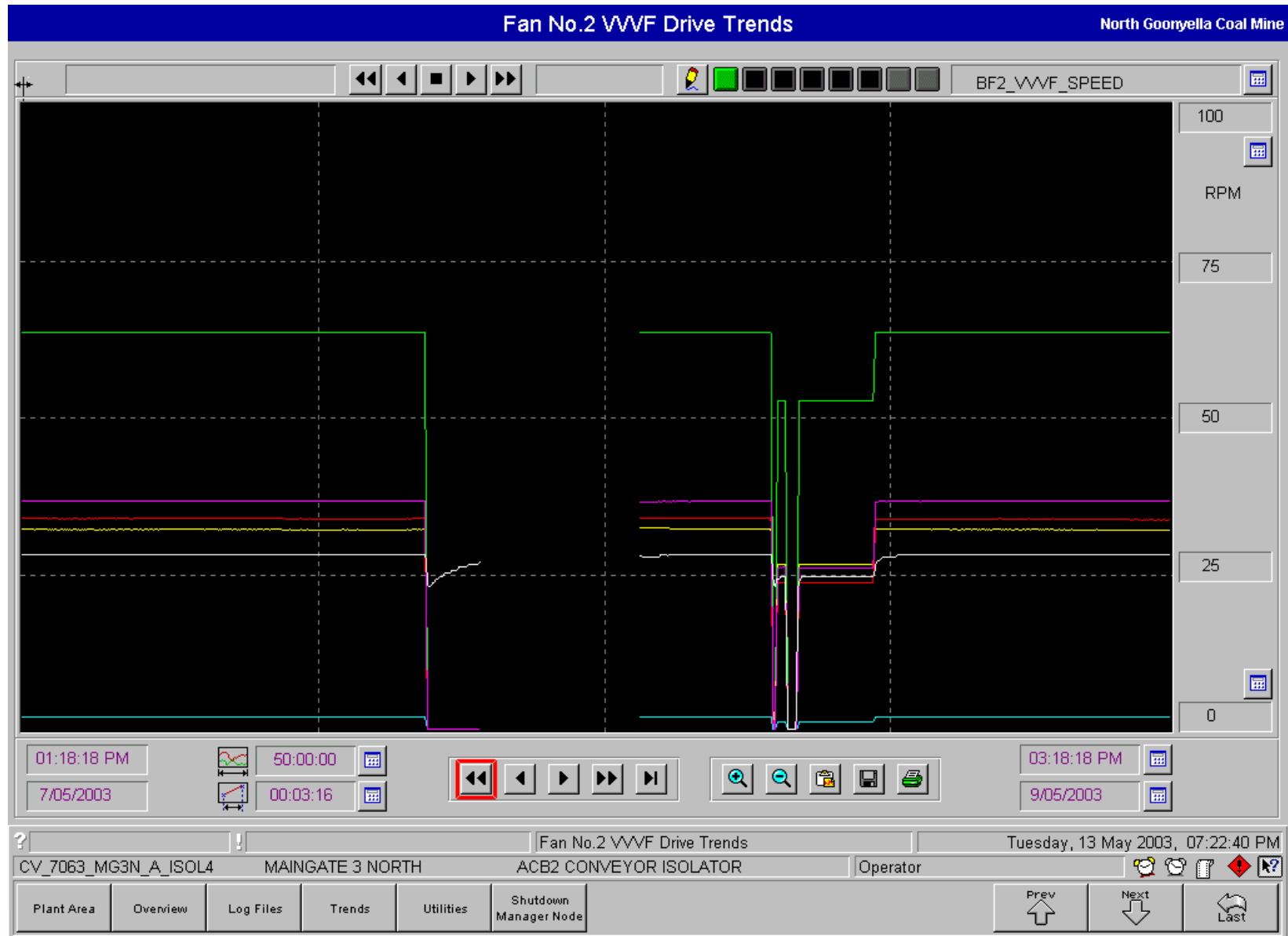
INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS



INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS



INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS



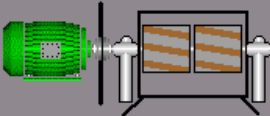
INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

Air Pressure and Temperature Parameters

North Goonyella Coal Mine

VENTILATION, VIBRATION & TEMPERATURES SETTINGS

BOOSTER FAN No.1



ACTUAL VALUE
-23.62 Pa

% DIFFERENCE
102.81 %

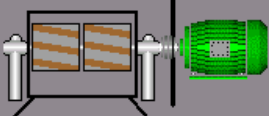
PRE-SET VALUE
840.00 Pa

BYPASS DOORS

SET POS NEG
WARNING % 15.00 -20.00

SET TRIP % 25.00 -65.00

BOOSTER FAN No.2



VENTILATION

CHAMBER	
ACTUAL VALUE	954.000 Pa
% DIFFERENCE	-2.36 %
PRE-SET VALUE	932.000 Pa
SET WARNING % POS NEG	15.00 -20.00
SET TRIP % POS NEG	25.00 -25.00

FAN	
ACTUAL VALUE	884.000 Pa
% DIFFERENCE	0.56 %
PRE-SET VALUE	890.000 Pa
SET WARNING % POS NEG	15.00 -15.00
SET TRIP % POS NEG	25.00 -40.00

MOTOR DE	
ALARM	85.00
TRIP	90.00
MOTOR NDE	
ALARM	85.00
TRIP	90.00

FAN SHAFT DE	
ALARM	85.00
TRIP	90.00
FAN SHAFT NDE	
ALARM	60.00
TRIP	80.00

TEMPERATURE °C

VENTILATION

CHAMBER	
ACTUAL VALUE	1409.000 Pa
% DIFFERENCE	-0.64 %
PRE-SET VALUE	1400.000 Pa
SET WARNING % POS NEG	40.00 -40.00
SET TRIP % POS NEG	65.00 -65.00

FAN	
ACTUAL VALUE	878.000 Pa
% DIFFERENCE	1.46 %
PRE-SET VALUE	890.000 Pa
SET WARNING % POS NEG	15.00 -15.00
SET TRIP % POS NEG	25.00 -25.00

MOTOR DE	
ALARM	85.00
TRIP	90.00
MOTOR NDE	
ALARM	85.00
TRIP	90.00

FAN SHAFT DE	
ALARM	85.00
TRIP	90.00
FAN SHAFT NDE	
ALARM	60.00
TRIP	80.00

TEMPERATURE °C

VIBRATION - mm/s

MOTOR	
ALARM	7.0
TRIP	10.0
FAN	
ALARM	4.5
TRIP	8.0

MOTOR WINDING

ALARM	120
TRIP	150

VIBRATION - mm/s

MOTOR	
ALARM	7.0
TRIP	10.0
FAN	
ALARM	4.5
TRIP	8.0

MOTOR WINDING

ALARM	120
TRIP	150

More Parameters

CV_7063_MG3N_A_ISOL4 MAINGATE 3 NORTH ACB2 CONVEYOR ISOLATOR Operator

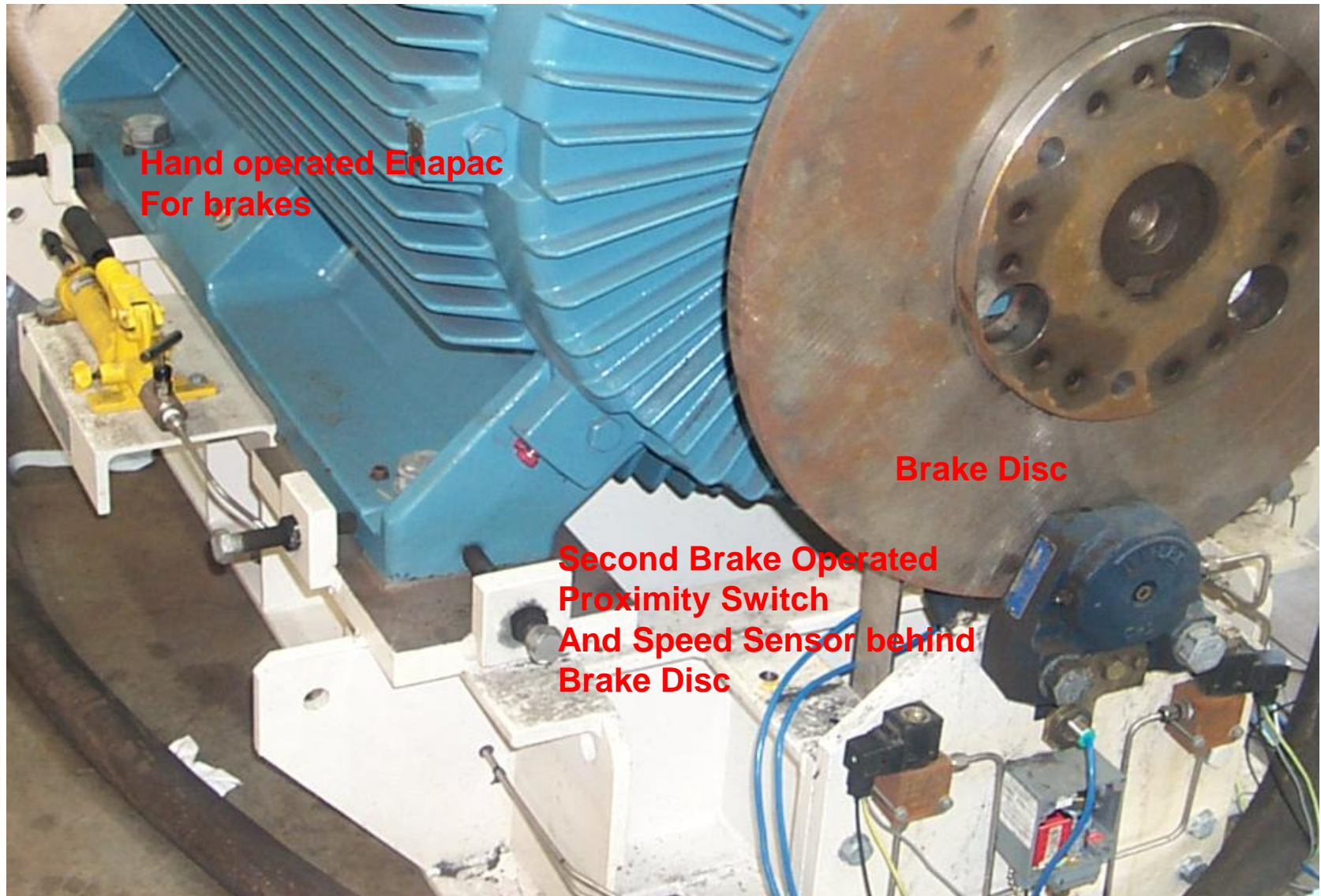
Tuesday, 13 May 2003, 07:25:54 PM

Plant Area Overview Log Files Trends Utilities **Shutdown Manager Node** Prev Next Last



INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

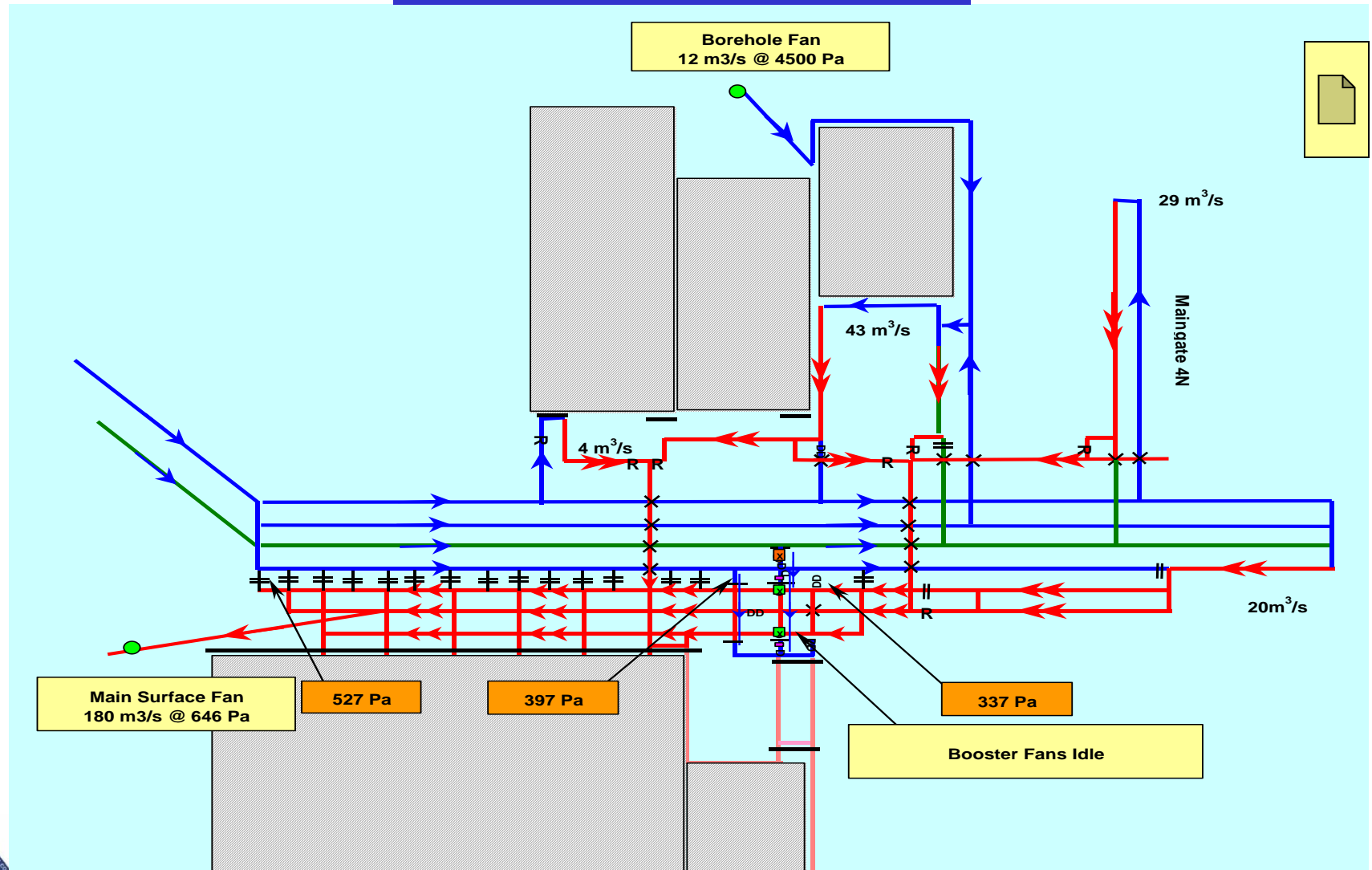
MOTOR SHOWING SHAFT HOLDING BRAKE ASSEMBLY



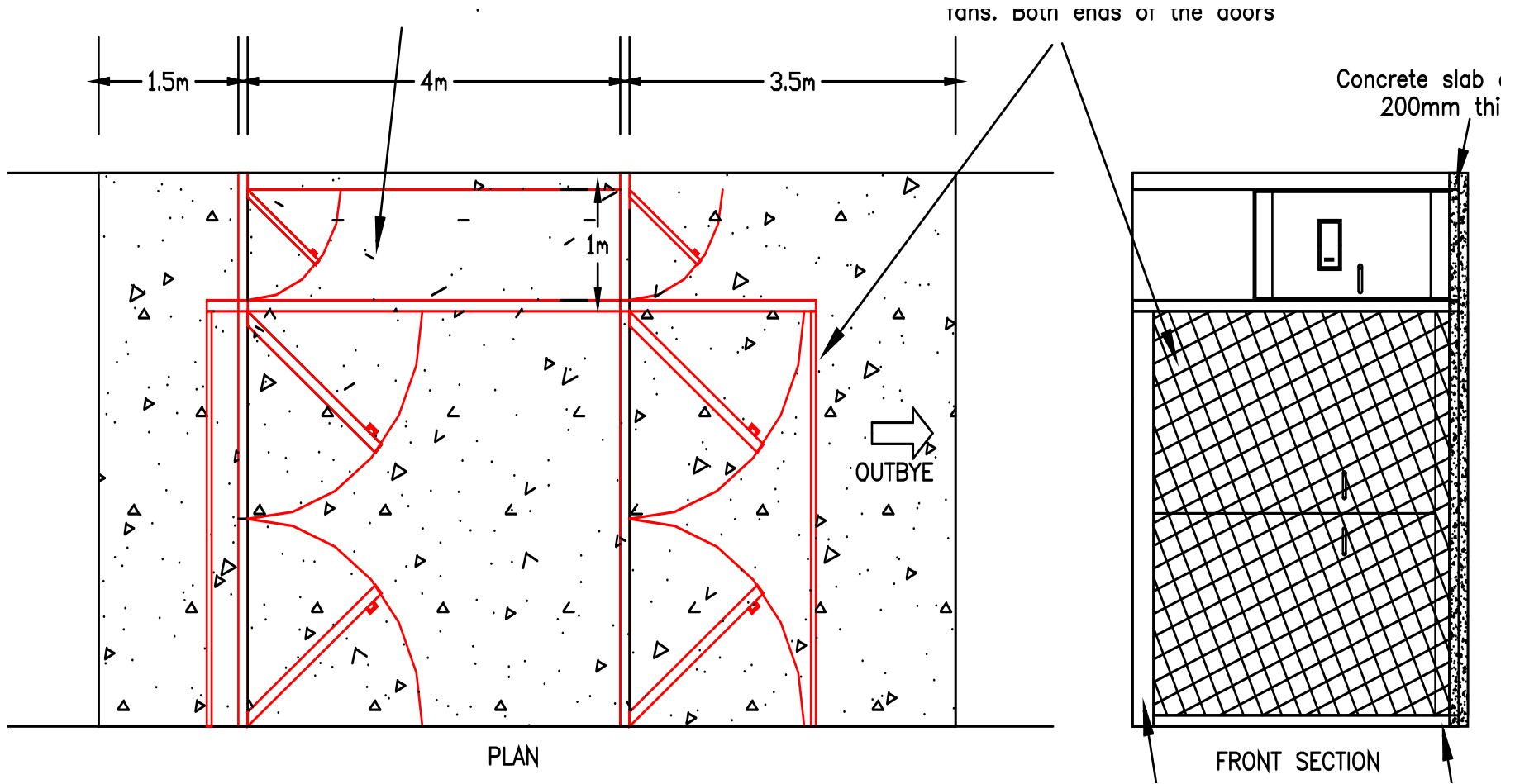
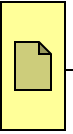
**THE INSTALLATION
OF UNDERGROUND
BOOSTER FANS AT
NORTH GOONYELLA COAL MINE**

INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

BOOSTER FANS STOPPED - Effect on Mine Ventilation



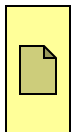
Bypass Door Schematic



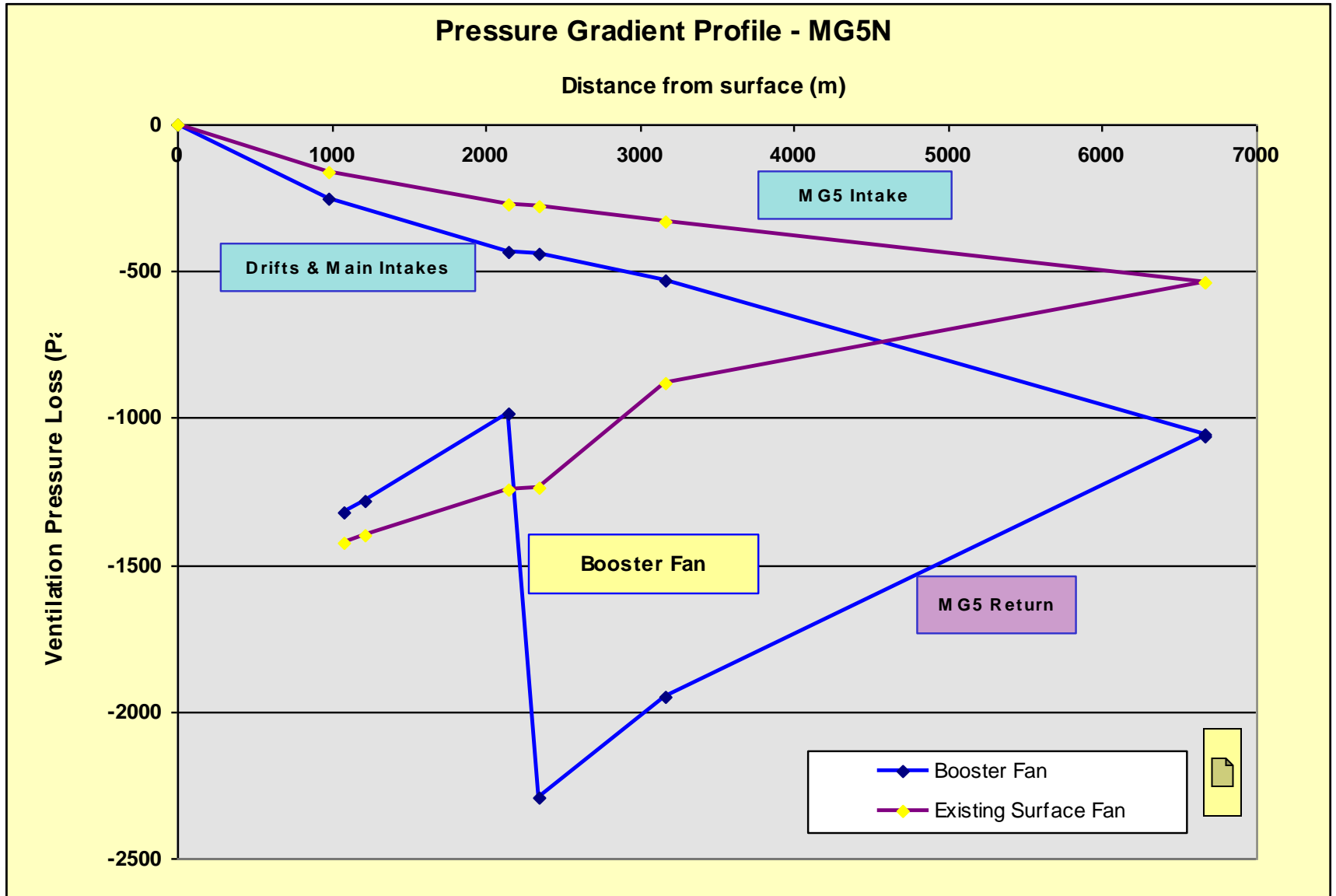
INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

COMBINED OPERATING DUTIES

MG4N	200 m ³ /s @ 1 kPa	290 kW
MG5N	270 m ³ /s @ 1.4 kPa	520 kW
MG6N	290 m ³ /s @ 1.8 kPa	700 kW
MG8N	300 m ³ /s @ 2.4 kPa	970 kW
MG9N	270 m ³ /s @ 1.7 kPa	640 kW

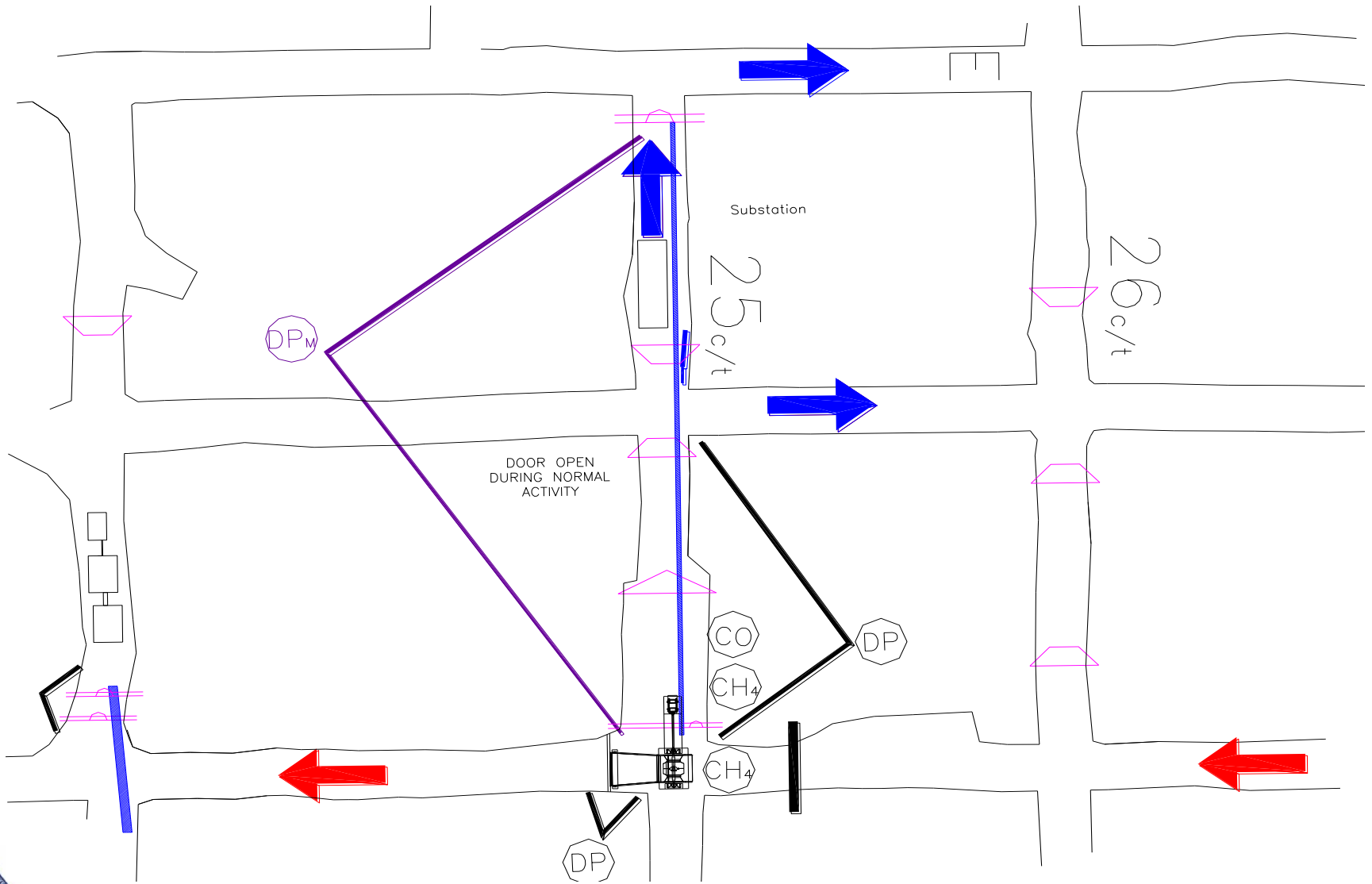


INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS



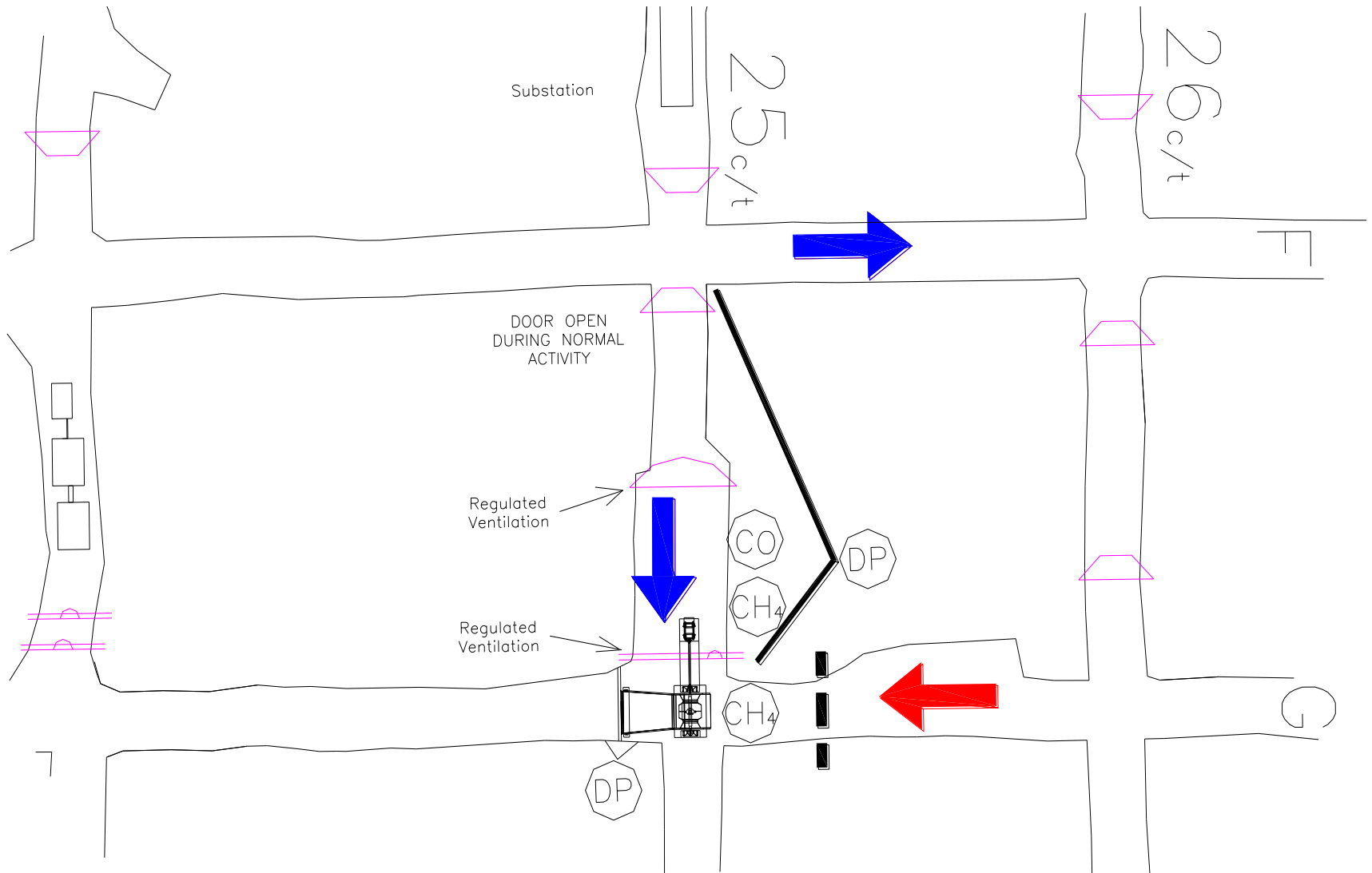
INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

SUBSTATION VENTILATION



INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

G Hdg MOTOR CHAMBER VENTILATION



INSTALLATION AND OPERATION OF UNDERGROUND BOOSTER FANS

I Hdg MOTOR CHAMBER VENTILATION

