Central – Wan Chai Bypass

and Island Eastern Corridor Link

Air Quality Monitoring Plan

(under Condition 2.9 of EP-482/2013/A)

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Air Quality Monitoring Plan

(CONDITION 2.9 OF OPERATION ENVIRONMENTAL PERMIT, EP-482/2013/A)

1. Introduction

1.1 The approved EIA Report, AEIAR-125/2008 and AEIAR-041/2001 (hereafter referred as "the EIA report") studying for the engineering feasibility of Wan Chai Development Phase II (WDII) and Central-Wan Chai Bypass (CWB) was completed and approved in Year 2008 and 2001 respectively. Subsequently in Year 2010, the Government has decided to incorporate an air purification system (APS) in the CWB project, which will bring enhancement to the air quality of tunnel exhaust before discharging them into the atmosphere.

1.2 The Environmental Permit, EP-482/2013/A (hereafter referred as "the OEP"), for the operation phase of the CWB tunnel was issued on 22 December 2016. As stipulated in Condition 2.6(d) of the OEP, "an air purification system (APS), including an electrostatic precipitator system (EPS), with removal efficiency of at least 80% of dust to reduce the level of respirable suspended particulates (RSP, also known as PM_{10}), and a Nitrogen Dioxide (NO_2) removal system with removal efficiency of at least 80% for NO_2, shall be adopted to improve the air quality before discharging to the atmosphere via the WVB, CVB and EVB and its vent shaft."

1.3 As stipulated in Condition 2.9 of the OEP, "The Permit Holder shall, no later than one month before the commencement of operation of the Project, submit to the Director for approval four hard copies and one electronic copy of the Air Quality Monitoring Plan (AQMP), which shall contain the APS Performance Monitoring and Contingency Plan, shall be certified by the ET leader and verified by the IEC as conforming to the relevant information and recommendations contained in the approved WDII&CWB EIA Report (Register No. AEIAR-125/2008), approved CWB&IECL EIA Report (Register No. AEIAR-041/2001) and the Application of this Environmental Permit including all attachments submitted by the Permit Holder (Application No. AEP-482/2013), for the operation of the Project. The AQMP shall include the monitoring methodology, equipment, monitoring locations, criteria for the monitoring of the relevant air quality parameters mentioned in the EM&A Manual of the approved WDII&CWB EIA Report (Register No. AEIAR-125/2008), approved CWB&IECL EIA Report (Register No. AEIAR-041/2001) and Event Action Plans. In case the monitored air pollutant levels under this monitoring plan exceed the approved criteria, the Permit Holder shall complete the investigation to identify the source/reason of exceedance and submit the investigation report, with recommended remedial actions to the Director, within 2 weeks of detection of the exceedance. The Permit Holder shall fully and properly implement the recommended remedial actions according to the deposited investigation report."

1.4 In fulfillment of condition 2.9 of the OEP, this submission contains the APS performance monitoring plan, including monitoring of the removal rate of NO_2 and RSP for the operation of APS with preventative maintenance measures for the operation of APS.

2. Principle of APS

2.1 The Air Purification System (APS) is a system dedicated to remove dust particles and NO_2 in the exhaust airstream of vehicle tunnels. The APS shall consist of the dust filtering part by means of an electrostatic precipitator (ESP) and the NO_2 removing part (De-NO_2 system).

2.2 In the ESP, the dust is captured from the airstream where an electric field is created using charged metal plates in the form of anodes and cathodes by means of a high voltage DC power generator. When the collector plates are covered with dust, they shall be washed down with a water spray.

2.3 Activated carbon gas adsorption shall remove NO_2.

3. Monitoring Equipment, Methodology and Locations

3.1 The monitoring of the efficiency and the operation of the APS is through the application of air quality monitoring systems for the measurement of NO_2 concentrations and particulate sensors for PM_{10} installed before and after each APS.

3.2 The NO_2 concentration will be monitored continuously by the equipment Horiba APNA-370 model. The model uses a combination of the dual cross flow modulation type chemiluminescence principle and the referential calculation method according to EN 14211. The catalog and details of the NO_2 monitor is attached in Appendix 1 for reference.

3.3 The PM_{10} concentration will be monitored continuously by the equipment Horiba APDA-372 model. The model provides continuous and simultaneous measurements of PM10 and the particle number concentration according to EN12341. The catalog and details of the PM_{10} sensor is attached in Appendix 2 for reference.

3.4 The monitoring locations are arranged as follows. The layouts of West Ventilation Building (WVB), Middle Ventilation Building (MVB) and East Ventilation Building (EVB) with locations of air monitoring stations are attached in Appendix 3 for reference.

For WVB, 2 monitoring stations with PM_{10} monitors and NO_2 sensors (WVB001) (1 station before APS and 1 station after APS) shall be installed;

For MVB, 8 monitoring stations with PM_{10} monitors and NO_2 sensors (MVB001, MVB002, MVB003 and MVB004) (4 stations before APS and 4 stations after APS) shall be installed;

For EVB 2 monitoring stations with PM_{10} monitors and NO_2 sensors (EVB001) (1 station before APS and 1 station after APS) shall be installed.

As confirmed by HyD, the locations of PM_{10} monitors and NO_2 sensors were installed according to the Particular Specifications for HyD's Contract No. HY/2011/08 – Central – Wan Chai Bypass – Tunnel Buildings, Systems and Fittings, and Works associated with Tunnel Commissioning PS37.16(1)(i), (ii) and (viii); and the PM_{10} monitors and NO_2 sensors were approved by Engineer's Representative. Details are in Appendix 6 for reference.

4. Criteria for the Monitoring of the Relevant Air Quality Parameters

4.1 Respirable Suspended Particles (RSP/PM_{10}) – Removal efficiency

a. when inlet concentration equal to or greater than 0.5mg/m^3, not less than 80% of RSP/PM_{10} shall be removed;

b. when inlet concentration is lower than 0.5mg/m^3, the outlet concentration shall not be greater than 0.1mg/m^3.

4.2 NO_2 – Removal efficiency

a. when inlet concentration equal to or greater than 0.25ppm, not less than 80% of NO_2 shall be removed;
b. when inlet concentration is lower than 0.25ppm, the outlet concentration shall not be greater than 0.05ppm.

As confirmed by HyD, the design standard/criteria for relevant air quality parameters were stated according to the Particular Specifications for HyD'sContract No. HY/2001/08 – Central – Wan Chai Bypass – Tunnel Buildings, Systems and Fittings, and Works associated with Tunnel Commissioning PS37.2(1)(i) and (ii). The Particular Specification is attached in Appendix 7 for reference.

5. Criteria for Non-compliance

5.1 In an 1-hour span, 12 removal efficiency (%) will be recorded with each taken at a 5-minute interval. Non-compliance occurs when 6 consecutive of 5-minute removal efficiency (%) exceedances of PM10 or NO2 criteria listed in section 4 are recorded in an 1-hour span in any pairs of the monitoring stations at WVB, MVB and/or EVB. Should there is any non-compliance recorded in any pairs of the monitoring stations at WVB, MVB and/or EVB, actions in accordance with the Action/Event Plan shall be carried out. The Central Control and Monitoring System (CCMS) will alert the operator at the Administration Building (ADB) when there is exceedance recorded. The operator will start recording on the exceedance reporting template once there is one 5-minute removal efficiency exceeds the exceedance criteria. The Event/Action Plan for exceedance, Data Record Sheet for NO_2 and PM_{10} monitoring and exceedance reporting template are attached in Appendix 4 and Appendix 5 for your reference.

The PM10 Monitors installed at ventilation buildings are set to log and record one data point at every 5 minutes over 1-hour span. Using 1-hour span for PM10 is to align with the exceedance criteria of NO_2 so that the Central Computer Monitoring System (CCMS) can alert the operator the exceedance of PM_{10} and NO_2 at the same time span. The proposed criteria for non-compliance had been agreed by the supplier of APS.

Exceedance Criteria	Time Span	Number of Consecutive 5-minute Removal Efficiency Exceedances
*Removal efficiency of PM10 of not less than 80% / outlet concentration not greater than 0.1 mg/m3	1 hour	6
** Removal efficiency of NO2 of not less than 80% / outlet concentration not greater than 0.05ppm	1 hour	6

Remarks:

* Refer to Section 4.1 for the exceedance criteria of PM_{10}.
** Refer to Section 4.2 for the exceedance criteria of NO_2.

6. Operation and Maintenance Overview

6.1 The APS for CWB project operates on a simple on/off principle when the tunnel is opened to traffic. The whole APS is controlled and run fully automatic without any manning requirement once activated. The start-up procedure includes switching on the HV transformer, starting up the duty ventilation fans for drawing air from the CWB tunnel, and opening the APS isolation dampers for allowing tunnel air to be drawn through the APS filters before exhausted into the ambient air via the tunnel ventilation buildings. As long as the duty ventilation fans are running and the APS equipment is functioning, the APS operates.

6.2 The ESP is required to be cleaned daily in order to maintain the RSP removal efficiency. During the 1-hour cleaning operation, pressurized water is sprayed on the EPS filter to remove the dust particles collected. The EPS filter will then be dried by pressurized air and become ready for use. The De-NO2 system (with the use of activated carbon) is a static element and requires no start-up or control. The activated carbon requires to be replaced regularly (typically every 2 to 3 years subject to the actual traffic condition) in order to maintain the NO2 removal efficiency.

6.3 The main components involved in the operation and maintenance of APS and their respective design life are provided in the table below:

Component	Description	Design Life
TVS (Tunnel Ventilation System)	Electrical cables, tunnel motorized damper, fan starter, tunnel fans, etc.	Approximately 20 years
APS	HV transformer, automatic screen, water recycling plant, electrical cables, electrostatic precipitator particle filters, wash down plant, etc.	Approximately 20 years
APS Control Equipment	APS programmable logic controller, air monitoring instruments, HV transformer controller	Approximately 5 years

6.4 Spare parts of different components will be kept in stock to ensure that they are in readiness for operation. The measures will be detailed in Section 7 below.

6.5 In order to maintain the proper functioning of the APS, the APS needs to be switched off from 01:00 to 06:00 for carrying out regular maintenance/inspection of APS on daily, weekly, monthly, 6 monthly and annual basis and the replacement of activated carbon in each carbon wall will take longer time as the replacement process will include implementation of associated temporary traffic arrangement for the logistic of activated carbon. Please refer to the table below listing the major components of APS and their inspection/maintenance frequencies.

Major APS Components	Inspection/maintenance Frequencies
General conditions of APS components	Daily
Air Quality Monitoring stations	Weekly
Water Pumps and compressors for ESP	Monthly

Major APS Components	Inspection/maintenance Frequencies
Roughing Filters for ESP	Monthly
Level sensors	Monthly
Air receivers	Quarterly
Water tanks	Quarterly
Piping	Quarterly
APS Control Panel	Quarterly
Activated carbon boxes	Quarterly
Electric cables	Half-yearly
Electric equipment of APS	Yearly
Replacement of Activated Carbon	2 to 3 years

Annual review will be conducted to review on the duration/frequency of APS shutdown process for regular maintenance/inspection as the operator will be accumulating experience on the maintenance/inspection process.

7. Preventative Maintenance Overview

7.1 The following preventive maintenance measures will be implemented to safeguard against accidental breakdown or early replacement of individual units of TVS or APS.

7.2 Routine maintenance, regular housekeeping, routine inspection and maintenance of the following components of APS will be conducted in accordance with the APS Operation and Maintenance (O&M) Manual to ensure the operation and performance of the APS remains within specification.

i) Filter System
ii) Wash Down System
iii) $DeNO_2$ System
iv) Air Monitoring System
v) Control System
vi) Electrical System

7.3 System Redundancy

i) Power Supply – Dual ring power supply from Hong Kong Electric (HKE) was designed at the upstream of the power supply network for the Motor Control Centres (MCCs) and Low Voltage (LV) switchboards so as to maintain the M&E equipment including APS in normal operation in case one of the power supply source is failed.
ii) Standby ventilation fan

Ventilation Building	Number of APS	Set of associated TVFs
East Ventilation Building (EVB)	3 sets	5 duty and 1 standby
Middle Ventilation Building (MVB)	4 sets MVB-APS-001 serving WB main tunnel / MVB-APS-002 serving Slip Road 3	2 duty / 1 duty and 1 common standby

Ventilation Building	Number of APS	Set of associated TVFs
	MVB-APS-003 serving EB main tunnel / MVB-APS-004 serving Slip Road 1	1 duty / 1 duty and 1 common standby
West Ventilation Building (WVB)	1 set	2 duty

iii) Bypass dampers – bypass dampers are provided at MVB and EVB for the operation of bypass APS if necessary.

iv) Standby wash water pump – standby wash water pump will be provided.

v) Remote monitoring and control system – remote monitoring and control system is provided so that the operator can monitor the operation of APS at Administration Building (ADB).

7.4 Consumables, mainly those required to keep the sensitive air monitoring devices within accurate operational limits required for each APS in ventilation buildings, will be in readiness for routine preventive maintenance.

7.5 Spare parts, especially for those required to be manufactured for a long period (say, more than 3 months), will be kept in stock to ensure that they are in readiness for operation.

System	Description	Unit	Quantity
Washdown System	Pipe fittings	nos.	60
	Nominal Diameter 50 Stainless Steel Pipe (6 meters length)	nos.	3
	Submersible pump spare part set	nos.	3
	Clear water pump spare part set	nos.	3
	2/2 Way Ball Valve	nos.	3
	Nozzles Bete-Maxi	nos.	10
	Flange sealings, various size (each)	nos.	3
Electrostatic Precipitator Module	Electrostatic Precipitator Insulators	nos.	9
Penumatic System	Compressor Solenoid Valve	nos.	3
	Compressor spare part set	nos.	3
Denitrification Filter	Perforated Panel	nos.	10
	Activated Carbon	kg	750
Electrical	Power Supply PS307, 120/230 VAC; 24 V DC 10A	nos.	3
Air Purification System Control Panel	Air Purification System Control Panel	nos.	1
Water Recycling Plant	Water Recycling Plant Control Panel	set	1
	Ultra Violet Lamp	no.	3
	Ceramic Membranes - 800nm, 25mm, 19 channels, 1200mm length	nos.	3
High Voltage Transformer	High Voltage Transformer (Ioniser), rated 68kVA	set	1
	High Voltage Transformer (Collector), rated 8kVA	set	1
	High Voltage Transformer (Ioniser), rated 31kVA	set	1
	High Voltage Transformer (Collector), rated 3.5kVA	set	1
	High Voltage Transformer Transformer Control Panel	set	1
Air Monitoring Station	Slime Line 19" Cabinet Varistar	nos.	1

Training as specified in the prescribed course outline will be provided to all O&M staff.

7.6 The main components involved in the operation of APS have a relatively long design life of approximately 20 years in most cases. With the implementation of preventive maintenance measures and provision of sufficient consumables and spare parts for long lead equipment or items, the chance of prolonged breakdown of TVS or APS will be brought to a practical minimum.

Contingency Plan

(CONDITION 2.9 OF OPERATION ENVIRONMENTAL PERMIT, EP-482/2013/A)

1. Introduction

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1.4 In fulfillment of condition 2.9 of the OEP, this submission contains the contingency plan. The contingency plan is to assist the Operator to restart the APS as soon as practicable after emergency situations.

2. Emergency Situations

2.1 In the current design, the APS will stop operating during the following emergency situations:

i) Emergency situations such as fire incident and activation of manual break glass unit etc.

ii) Accidental breakdown of individual units of Tunnel Ventilation System (TVS) or APS

iii) Failure of power supply

In cases (i), (ii) and/or (iii) and if the associated tunnel ventilation fans are still on, the removal efficiency of 80% for both RSP and NO_2 may not be achieved

2.2 Emergency response for emergency situations including power failure, individual component break down and fire incident would be mentioned in the following section. The emergency response and the APS Operational Procedures enable the Operator to restart the APS as soon as practicable after above emergency situations. The APS Operation Procedure is attached in Appendix 11 for reference.

2.3 The emergency response under the Contingency Plan have been consulted and agreed by Management Operation and maintenance (MOm), Electrical and Mechanical Services Department (EMSD), and Highways Department (HyD).

3. Emergency Response and Flowcharts

3.1 When there is fire incident or activation of manual break glass unit happened in the tunnel or any ventilation buildings, the Operator will follow the procedures below to start up tunnel ventilation fans (TVF) and APS as soon as practicable after the fire incident:

1. Operator to inform Fire Service Department (FSD), Transport Department (TD) and HyD of the fire incident;
2. Authorized Person by FSD to decide which TVF(s) to be manually switched on for local smoke extraction;
3. FSD to confirm the ventilation buildings/tunnel are safe to operate/reopen;
4. Operator to check and confirm if all TVFs and APS equipment are undamaged in the fire incident;
5. If there is no damaged TVF and APS equipment, Operator to switch APS to auto mode and start up the APS according to the APS Operational Procedures;
6. If there are damaged TVF and APS equipment, Operator to check the spare part list and repair the damaged equipment with spare parts or procure new parts to replace the damaged equipment;
7. Operator to switch APS to auto mode and start up the APS according to the APS Operational Procedures after finishing repair/replace damaged equipment.

The emergency flowchart for fire incident is attached in Appendix 8 for reference.

3.2 When there is an accidental breakdown of individual component causing malfunction of TVFs and/or APS, the Operator will follow the procedures below to start up TVFs and APS as soon as practicable.

1. Operator to inform TD, HyD, ET and IEC;

2. Operator to conduct inspection and identify the root cause of the breakdown;
3. Operator to check if there is any spare part available for repair;
4. If there are spare parts available, Operator to repair the broke down component with spare parts;
5. If there is no spare part available, Operator to procure the broke down component for replacement;
6. Operator to start up the APS according to the APS Operational Procedures after finishing repair/replace the broke down component.

The emergency flowchart for individual component breakdown is attached in Appendix 9 for reference.

3.3 When there is power supply failure causing suspension of operation of TVFs and/or APS, the Operator will follow the procedures below to start up TVFs and APS as soon as practicable

1. Hong Kong Electric (HKE) has two power supply sources (source A and Source B) for each ventilation building;
2. When power source A fails to supply electricity to any ventilation building, HKE power supply will automatically switch to source B to supply electricity to any ventilation building;
3. If the switch over of power supply source is successful, the TVFs and APS will continue to operate;
4. If the switch over of power supply source fails, Operator to inform HKE, TD, HyD, ET and IEC on the suspension of power supply;
5. Operator to await resume of power supply by HKE and conduct inspection and check if any component is damaged during the power supply failure;
6. If there is no damaged TVF and APS equipment, Operator to start up the TVFs and APS according to the APS Operational Procedures after power supply resumes;
7. If there are damaged TVF and APS equipment, Operator to check the spare part list and repair the damaged equipment with spare parts or procure new parts to replace the damaged equipment;

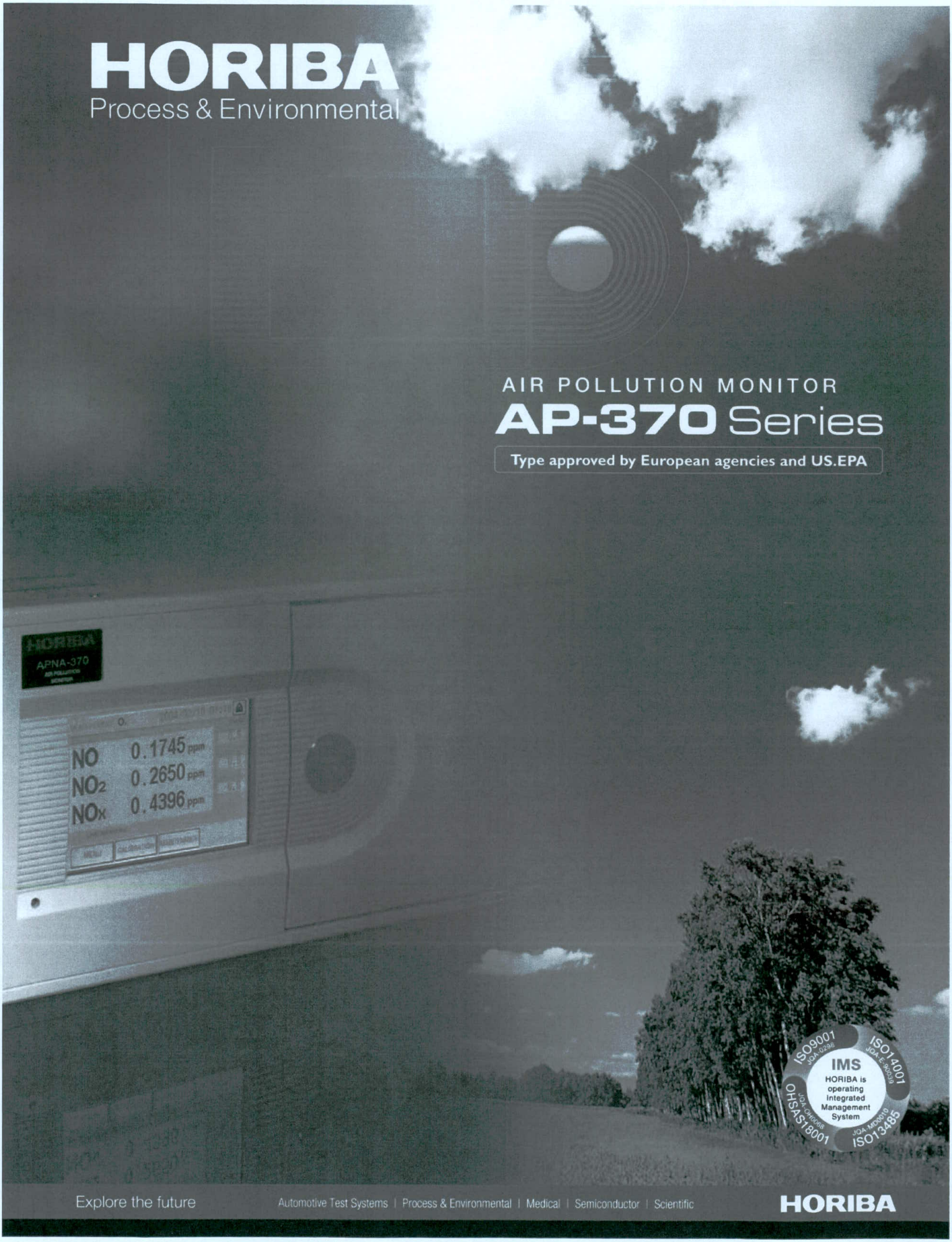
The emergency flowchart for power supply failure is attached in Appendix 10 for reference.

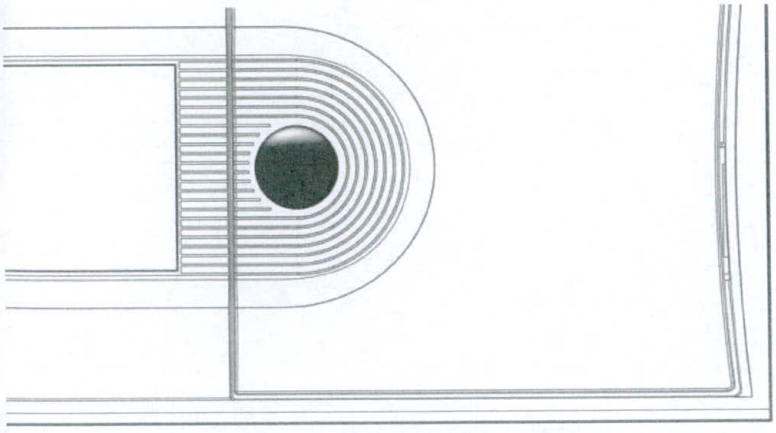
3.4 Emergency contacts for different parties are listed below, the contact person and contact number maybe different and subject to change.

Parties/Department	Contact Person	Contact Number
Transport Department	Daniel Hue	2829 5328
Highways Department	Jimmy Chan	2762 3592
Hong Kong Electric (HKE)	Emergency Reporting	2555 4000/2555 4999
Environmental Team Leader	Raymond Dai	2839 5666
Independent Environmental Checker	David Yeung	3465 2888

4. Conclusion

There are emergency situations that the APS will stop operating, including fire incident, breakdown of individual components of APS and power supply failure etc., the emergency response flowcharts and APS Operational Procedures enable the Operator to restart the APS as soon as practicable after emergency


HORIBA
Process & Environmental
AIR POLLUTION MONITOR
AP-370 Series
Type approved by European agencies and US.EPA
HORIBA
APNA-370
NO 0.1745 ppm
NO2 0.2650 ppm
NOx 0.4396 ppm
ISO9001
ISO14001
IMS
HORIBA is operating Integrated Management System
OHSAS18001
ISO13485
Explore the future
Automotive Test Systems | Process & Environmental | Medical | Semiconductor | Scientific
HORIBA



These highly sensitive a give precise, reliable me surprisingly easy to m

Features

Automatic calibration

Troublesome calibration procedures have been reduced to the push of a function key. At the Auto-Interval Calibration (AIC) menu you can set the start time, the start range, and the interval for the automatic calibration. The system clock and calendar then assure that your calibration instructions are executed precisely. To make things even easier, remote auto-calibration can also be done from your own computer, via the monitor's RS-232C serial port (optional).

Auto-range function

An auto-range function that automatically switches to the range best suited to the object gas concentration for both momentary and average values is included as a standard feature. As an option, even when randomly set to any range (within 10 times the range ratio), the auto-range function can still be used. Switching over from auto-range to manual-range is a simple task.

Selective data output

For each component measured, the system provides four types of data: momentary values, integrated values, moving averages, and simple averages. Any two these data may be output. Simultaneously to any two external devices. The time-span for both average and integrated values may be specified (i.e.,when the momentary value has not been selected). With the simple average values, three different timesettings can be specified.

Storing data in memory

Four different values may be stored in memory: three simple averages and the integrated value.
For example:

- Average value #1 (3 min)→1,000 data sets
- Average value #2 (30 min)→1,000 data sets
- Average value #3 (3 h)→100 data sets
- Integrated value (1 h)→1,000 data sets

Network Communications (option)

Serial communication is available through RS-232C serial port connected on the rear panel. The serial port makes analyzer data available using HORIBA's proprietary serial communication protocol, and can be easily converted to RS-485 for network data collection. Ethernet communication is available through an optional port using TCP/IP protocol.

ambient air pollution monitors
measurements, yet they are
maintain.

AIR POLLUTION MONITOR

AP-370 Series

Memory card for data management (option)

An available CompactFlash®(CF) can save average or integrated value, and read and collect data for off-line analysis.
With the CF it is possible to conveniently use the analyzer in a stand-alone mode.

Readout view, concentration and mass

The front panel can display the readout all that is needed concentration (ppm or ppb) and mass (mg/m^3 or $\mu g/m^3$).
(Not available on Model APHA-370, where CH_4 values are displayed as ppm, NMHC and THC as ppmC.)

Pressure-compensation

Automatic compensation for ambient pressure assures reliable data regardless of the weather or the monitor's location.

Easy-to-read, 320×240 dot LCD display with touch panel screen.

The adoption of full graphic LCD for the touch screen offers a large, easy-to-use display and user friendly, interactive operation. This user interface facilitates maintenance with displays such as the graph of lamp intensity (applicable for model APOA-370 and APSA-370 only), remaining time before replacement of pumps, valves, source lamp and converters. It also allows you to save average value, data, integrated value alarm history and calibration history.

Minimal influence from interference components and ambient temperature

These monitors use Horiba's innovative detection technology and sampling method for outstanding sensitivity. The influence from interference components is minimal and results are very stable over long periods of measurement.

Input/output via RS-232C port (option)

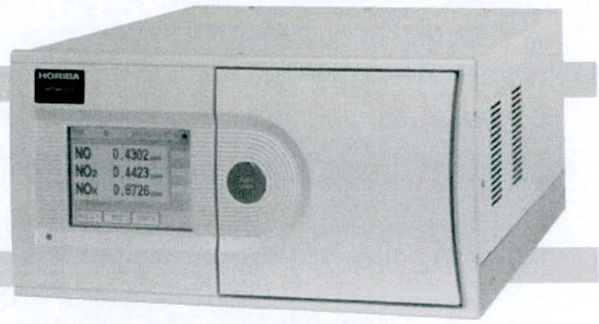
The system's RS-232C serial port can be used to transmit measured values, alarms, and other data to remote equipment. It can also be used to input changes to parameter settings and other data.

At last—a small, compact system

A small, light-weight unit for each component to be measured fits neatly into a 19-inch rack. This makes it easy to up-grade your system in the future. This new design offers great savings in valuable lab space.

NOx

Ambient NOx Monitor
APNA-370



According to EN14211 and VDI 4202/4203
TUEV Bericht 936/21204643C 07. Jul. 2006 U. S. EPA REFERENCE Equivalent Number RFNA-0506-157

Features

The APNA-370 uses a combination of the dual cross flow modulation type chemiluminescence principle and the referential calculation method.
This gives it the advantages of the single-detector method plus the ability to do continuous measurements of NOx, NO, and NO_2. The design gives great stability and extremely high sensitivity (0.1 ppm F.S.)

Standard equipment includes a drier unit with an automatic recycle function to provide dry ambient air as the ozone source. This makes long-term continuous measurements possible.

The detector uses a silicon photodiode sensor to reduce size and prolong working life.

All the necessary features are built right into a single rack-sized unit, including a reference-gas generator, an ozone-source drier unit, an ozone decomposer, and a sampling pump. No supplemental gas is required.

Principle

Cross flow modulation type, reduced pressure chemiluminescence (CLD)

The chemiluminescence method uses the reaction of NO with O_3

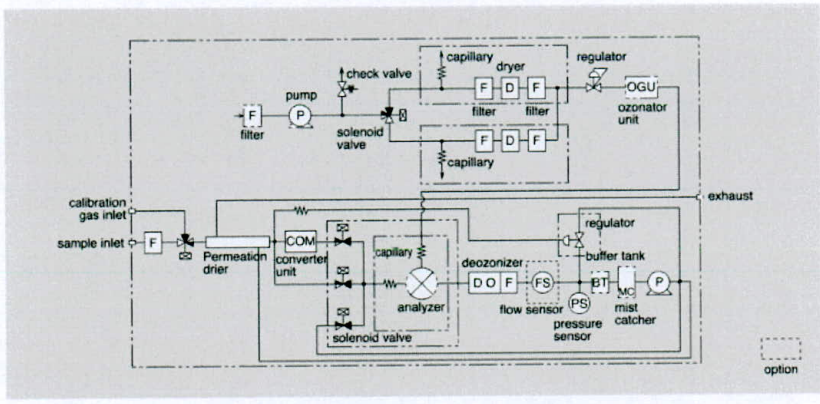
$NO+O_3 \rightarrow NO_2^*+O_2$

$NO_2+NO_2+h\nu$

A portion of the NO_2 generated as the result of this reaction becomes NO_2^*. As these excited molecules return to the ground state, chemiluminescence is generated in the range of 600 nm to 3,000 nm. The light intensity is in proportion to the concentration of NO molecules and by measuring it we obtain the NO concentration of the sample. A deoxidation converter changes the NO_2 to NO, which is measured. In other words, the NO_2 concentration can be obtained by the difference between (1) the NOx concentration measured when the sample gas is directed through a converter and (2) the NO concentration measured when the gas is not run through the converter.

Specifications

Principle: Cross flow modulation type, reduced pressure chemiluminescence (CLD)
Application: NO_2, NO and NOx in ambient air
Range: Standard ranges: 0-0.1/0.2/0.5/1.0 ppm; auto range ~ manual range selectable; can be operated by remote switching.
Optional (measurable) ranges: 4 ranges selectable from 0-10 ppm, within 10 times range ratio; auto range ~ manual range selectable; can be operated by remote switching.
Lower detectable limit: 0.5 ppb(3 sigma)
Repeatability: ±1.0% of F.S.
Linearity: ±1.0% of F.S.
Zero drift: <LDL/day, at lowest range
±1.0 ppb/week at lowest range
Span drift: <LDL/day at lowest range
±1.5 % of F.S./week
Response time (T_{90}): Within 90 sec at lowest range
Sample gas flow rate: Approx. 0.8L/min
Indication: Measured value, range, alarm, maintenance screen
Alarms: During AIC, zero calibration error, span calibration error, temperature error in converter, etc.
On-screen messages are available in four languages: English, German, French, and Japanese.
Input/output: • 0-1 V/0-10 V/4-20 mA, to be specified (2 systems: either (1) momentary value and integrated or (2) moving average value) • Contact input/output • RS-232C (option)
Ambient temperature: 5-40 ℃
Power: 100/110/115/120/220/230/240 VAC, 50/60 Hz (to be specified)
Dimensions: 430(W)×550(D)×221(H) mm
Mass: Approx. 21 kg,



H_2S/TRS Measurement

Features · Principle

Combined use of the H_2S converter unit and the APSA: SO_2 Monitor makes H_2S measurement possible. The H_2S converter unit contains two types of catalyst: SOx scrubber and H_2S converter. SOx is removed by the SOx scrubber, and then the H_2S that has passed through is converted into SO_2 by the H_2S converter. This SO_2 is then measured by the APSA: SO_2 Monitor for display as H_2S concentration.

Specifications

Range: 0.1-0.1/0.2/0.5/1.0 ppm
Power: 100/110/115/120/220/230/240 VAC, 50/60 Hz
Dimensions: CU-1: 430(W)×550(D)×221(H) mm
APSA: 430(W)×550(D)×221(H) mm
Mass: CU-1: Approx. 10 kg
APSA: Approx. 25 kg

NH_3 Measurement

Features · Principle

Combined use of the NH_3 converter unit and the APNA: NOx Monitor makes NH_3 measurement possible. The NH_3 converter unit contains two types of catalyst tubes: one which converts NH_3 into NOx, and one which allows the NOx in the ambient air to pass through directly. The difference in NOx value between the two is measured by the APNA: NOx Monitor for display as NH_3 concentration.

Specifications

Range: 0-1/2/5-10 ppm
Power: 100/110/115/120/220/230/240 VAC, 50/60 Hz
Dimensions: CU-2: 430(W)×550(D)×310(H) mm
APNA: 430(W)×550(D)×221(H) mm
Mass: CU-2: Approx. 20 kg
APNA: Approx. 26 kg

Calibration Equipment

HORIBA offers various calibration products for optional use with the AP-370. HORIBA's calibration equipment support mainly the following methods:

Option	APMA	APSA	APNA	APHA	APOA
Internal or external permeation device for SO_2, H_2S, BTX, NO_2 and many more		●	●		
External gas phase titration for NO/NO_2			●		
Ozone generation with an internal or external O_3 generator based on UV radiation					●

All calibrators can be equipped with thermal mass flow controllers or pressure regulators and capillaries depending on the precision requirements. Stationary and portable single components as well as multi-component calibrators are available upon client's specification. Corresponding interfaces as well as calibration and QC protocols can also be supplied.

Digital Calibrator

Features

HORIBA's MCC-1000 is designed to calibrate gas analyzers manually, remotely controlled or automatically, installed in air pollution monitoring stations, for quality assurance in the laboratory and also for the production of gas analyzers.
A special feature of HORIBA's MCC-1000 is the easily-to-read touch screen panel, for ease of operation. Characteristic of operation of HORIBA's MCC-1000 is the intuitive, simple and user friendly menu. (Flow rate, mg/m³, ppb/ppm, automatic cycles etc.) Via the touch screen, it is possible to enter span gas concentrations or to start autmatic routines like multi point calibration cycles.

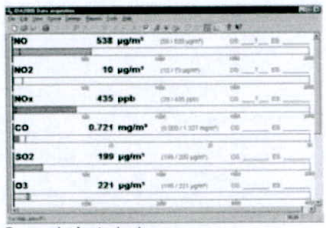
Specifications

Principle: Dynamic generation of zero and span gas with mass flow controllers
Mass Flow Controller (MFC): supports multi-point calibration
Power: 230 VAC ±10%, 50 Hz (other on request), 50 VA
Dimensions: 430(W)×400(D)×120(H) mm (19") with brackets
Mass: Approx. 10 kg

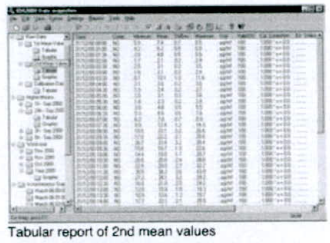
Intelligent Data Acquisition System

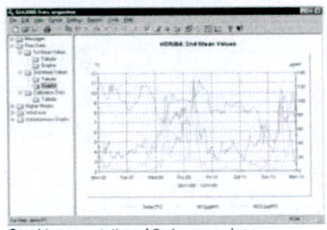
HORIBA IDA-2000

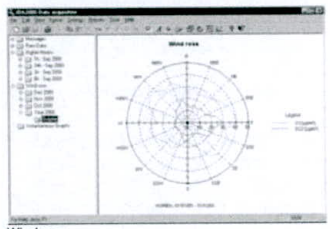
HORIBA's IDA-2000 is an intelligent data acquisition system (DAS) using a desktop or industrial PC, designed for fully automatic monitoring stations. The entire data capture and mean value calculation as well as control of the analyzers is executed by 32 bit multitasking software, running in a state-of-the-art Windows environment. It combines the power of a workstation with the ease of use, compatibility and productivity of a personal computer. The measured values as well as operating and error status messages are gathered in a 5-second interval from the analyzers. They are converted into engineering units, checked for plausibility and synchronously converted into two different averages. Automatic calibration routines in predefined intervals can be started either from the station computer or through a remote host computer. The DAS also supports the manual execution of calibration sequences as well as remote maintenance operations.



Bar graph of actual values


Tabular report of 2nd mean values

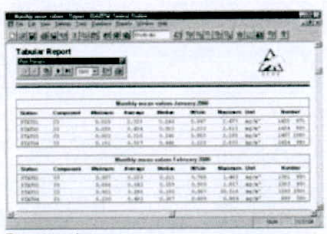

Graphic presentation of 2nd mean values


Wind rose

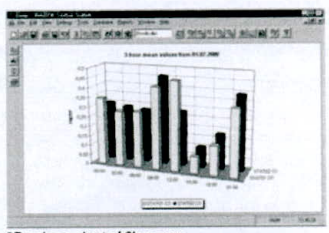
Data Management and Reporting Software

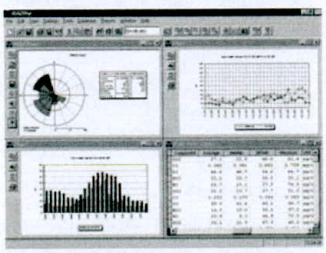
HORIBA IDA-ZRW

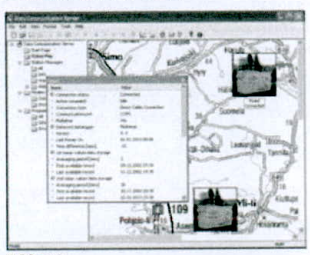
HORIBA's IDA-ZRW is a data management and reporting software for use in Ambient Air Quality and Meteorological monitoring. The software package provides data collection, management, analysis and reporting. Measured data and related information is stored in a high-end relational SQL database. The software can be used stand-alone or run on several machines in a network environment operating in Microsoft Windows environments. Communication between Central & Remote Stations works with a wide variety of communication links, such as direct connections, short-haul modems, telephone (including cellular) and multi-drop. Data can be transferred to and presented in Internet pages according to customers requirements.

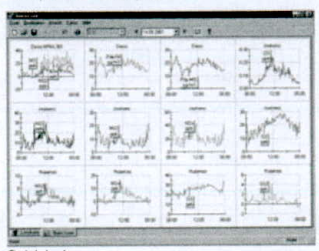


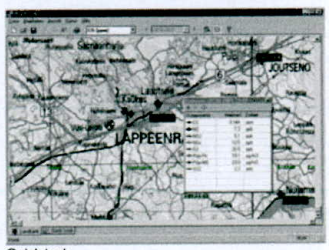
Report preview


3D-column chart of 3h-means


Example of various reports


DCS main

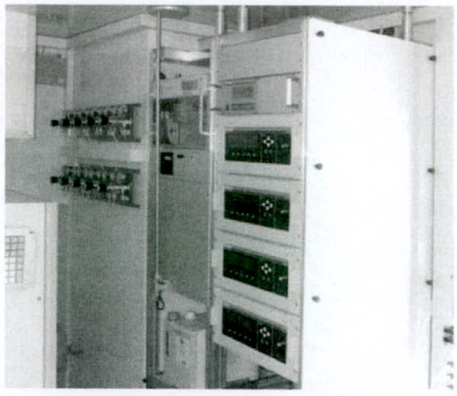

Quick look



Quick look

Complete Integrated System

HORIBA designs, assembles, calibrates and tests complete integrated systems for simultaneously measuring multiple pollutants. A system for monitoring five pollutants can typically fit into one 19-inch rack. Rack-mounted systems can be installed in equipment rooms, stand-alone shelters, trailers, vans, large trucks, or aboard marine vessels. HORIBA can integrate products into existing monitoring systems, or design and build a new system.



South african bureau of standards

Various Types of Fixed Stations and Mobile Laboratories

HORIBA designs and builds complete solutions precisely tailored to customer's requirements

●Fixed monitoring stations for continuously measuring air pollutants

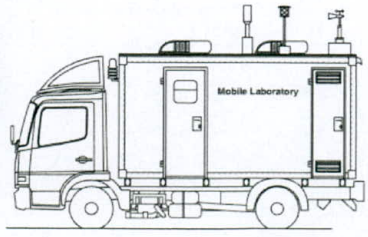
Reykjavik environment / Iceland

Agency for environmental Federal State of Bavaria
Mobile laboratory with detachable shelter

●Mobile laboratories to investigate the geographic distribution of air pollution

Professional association for civil engineering

These vans and trucks are just some of the projects we've done for customers in Europe

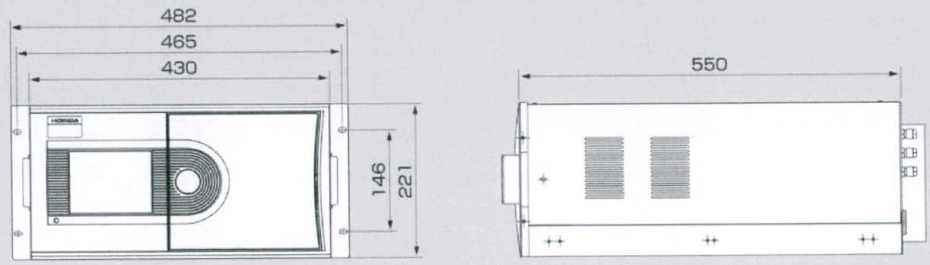


Standard 19-inch Packages

Each HORIBA AP-370 Series Monitor is packaged in a light metal enclosure with sliding chassis suitable for either a table-top set-up in a research laboratory or mounting on a standard 19-inch rack for permanent installation. All the controls and serviceable components are accessible from the front for easy maintenance while the plumbing and cable connections are neatly arranged at the back.

■ **Dimensional Outline** Unit: mm

APMA-370/APSA-370/APNA-370/APHA-370/APOA-370



HORIBA continues contributing to the preservation of the global environment through analysis and measuring technology.

Please read the operation manual before using this product to assure safe and proper handling of the product.

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Bulletin:HRE-2858E

Printed in Japan T-K(SK)53

System Integration

Ambient Air

HORIBA

Explore the future

Air Pollution Dust Analyzer

APDA-372

The APDA-372 continuous ambient air quality monitoring system provides continuous and simultaneous measurements of PM 1, PM 2.5, PM 4, PM 10, TSP (PMtot) and the particle number concentration (PM1, PM2.5 according to EN 14907 and PM10 according to EN 12341).

Functions:

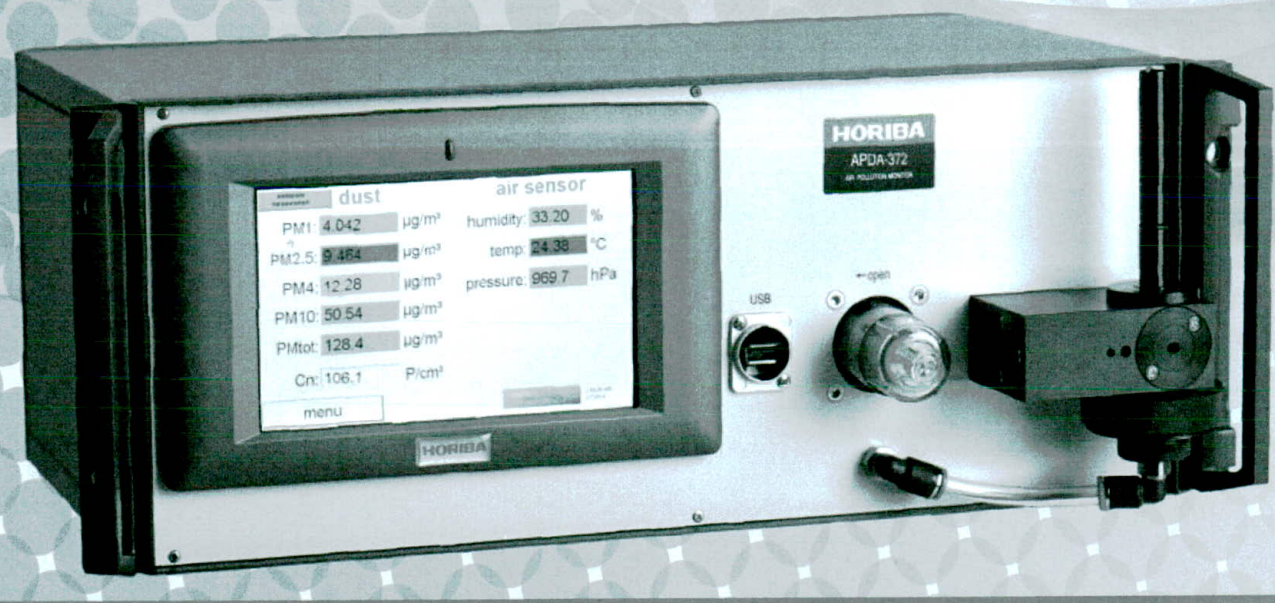
The APDA-372 uses the approved measurement technology of optical light scattering and is equipped with a LED light source with stable output and long lifetime.

The APDA-372 models operate with an aerosol flow of 4,8 l/min and are equipped with a Sigma-2 sampling head, which allows a representative measurement even at strong winds. Further, the sampling system provides an Intelligent Aerosol Drying System (IADS) as well as sensors for the measurement of ambient temperature, air pressure and relative humidity. The IADS prevents erroneous classification of particles due to moisture.

Features:

- Continuous real-time measurement of PM-values (simultaneously)
- Additional information through particle number concentration
- Time resolution adjustable from >1s up to 24h
- Light source: LED with high stability and long life time
- Long durability
- Low maintenance, calibration check on-site
- Intuitive handling
- Reliable function
- No radioactive material
- Reduction of operating cost!

The modular design of the APDA-372 system facilitates its assembly in existing 19" racks. This system includes a filter holder for the insertion of an absolute filter (ø 47 or 50 mm). This enables the user to perform a gravimetrical correlation on-site. Thus, a chemical analysis of the composition of the aerosol is also possible.



Specifications

Model	APDA-372
Application	Air Pollution Dust Analyzer
Approvals	PM1, PM2.5 according to EN 14907 and PM10 according to EN 12341
Measuring principle	optical light scattering
Reported data (simultaneous)	PM1,PM2.5,PM4,PM10,TSP,number
Size channels	64
Measurement range (particle size)	0.18 – 18 µm
Measurement range (number)	0 – 20,000 particle/cm3
Measurement range (mass)	0 – 10,000 µg/m3
Time resolution:	1 s – 24 h (or on demand)
Aerosol flow	4,8 l/min (0.3 m3/h)
Working temperature	0 - 35°C
Power supply:	115/230 V; 50/60 Hz
Power consumption (200 incl. IADS)	140 W
Dimensions (H x W x D)	19" or 18.5 x 45 x 32 cm
Weight	9.3 kg (20.5 lbs)
Interface	Touch display 800 x 480 pixels
Data logger (inclusive)	4 GB Compact Flash
Network	LAN, WiFi, RS-232/485, USB, optional external GPRS/UMTS modem
User Interface	Menu-driven interface with 8-line 40-character LCD display and dynamic keypad
Application example	• Environmental monitoring in networks • Immission • Long-term studies • Source apportionment • Propagation and distribution studies (e. g. volcano, fire)

Horiba continues contributing to the preservation of the global environment through analysis and measuring technology.

⚠ Please read the operation manuals before using the displayed products, in order to assure a safe and proper handling.

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20150514APDA372v.9.1

圖例：
LEGEND :

- 高架道路走線 ELEVATED ROAD ALIGNMENT
- 地面道路走線 GROUND LEVEL ROAD ALIGNMENT
- 隧道走線 TUNNEL ALIGNMENT
- 填海 RECLAMATION

Air Monitoring Stations (AMS) are located inside Ventilation Buildings, please refer to the layouts below for the detailed locations of AMS

尖沙咀 TSIM SHA TSUI

尖沙咀 TSIM SHA TSUI

維多利亞港 VICTORIA HARBOUR

東區走廊 ISLAND EASTERN CORRIDOR

行政大樓 ADMINISTRATION BUILDING

北角 NORTH POINT

東面通風大樓 EAST VENTILATION BUILDING

東面排風口 EAST VENT SHAFT

北角 NORTH POINT

西面通風大樓 WEST VENTILATION BUILDING

上環 SHEUNG WAN

連接路三 SLIP ROAD 3

中環填海計劃第三期 CENTRAL RECLAMATION PHASE III

連接路一 SLIP ROAD 1

連接路二 SLIP ROAD 2

擬建的灣仔發展計劃第二期 PROPOSED WAN CHAI DEVELOPMENT PHASE II

中通風大樓 MIDDLE VENTILATION BUILDING

銅鑼灣避風塘 CAUSEWAY BAY TYPHOON SHELTER

中環 CENTRAL

灣仔 WAN CHAI

天后 TIN HAU

CONNAUGHT ROAD CENTRAL 干諾道中

維多利亞公園 VICTORIA PARK

連接路八 SLIP ROAD 8

HARCOURT ROAD 夏慤道

GLOUCESTER ROAD 告士打道

銅鑼灣 CAUSEWAY BAY

金鐘 ADMIRALTY

灣仔 WAN CHAI

0 100 200 300 400 500 m 米

比例尺 SCALE BAR

圖則名稱 plan title

中環灣仔繞道和東區走廊連接路 - 工程概覽

CENTRAL-WAN CHAI BYPASS AND ISLAND EASTERN CORRIDOR LINK - PROJECT OVERVIEW

Layout of West, Middle (Central) and East Ventilation Buildings

比例 scale

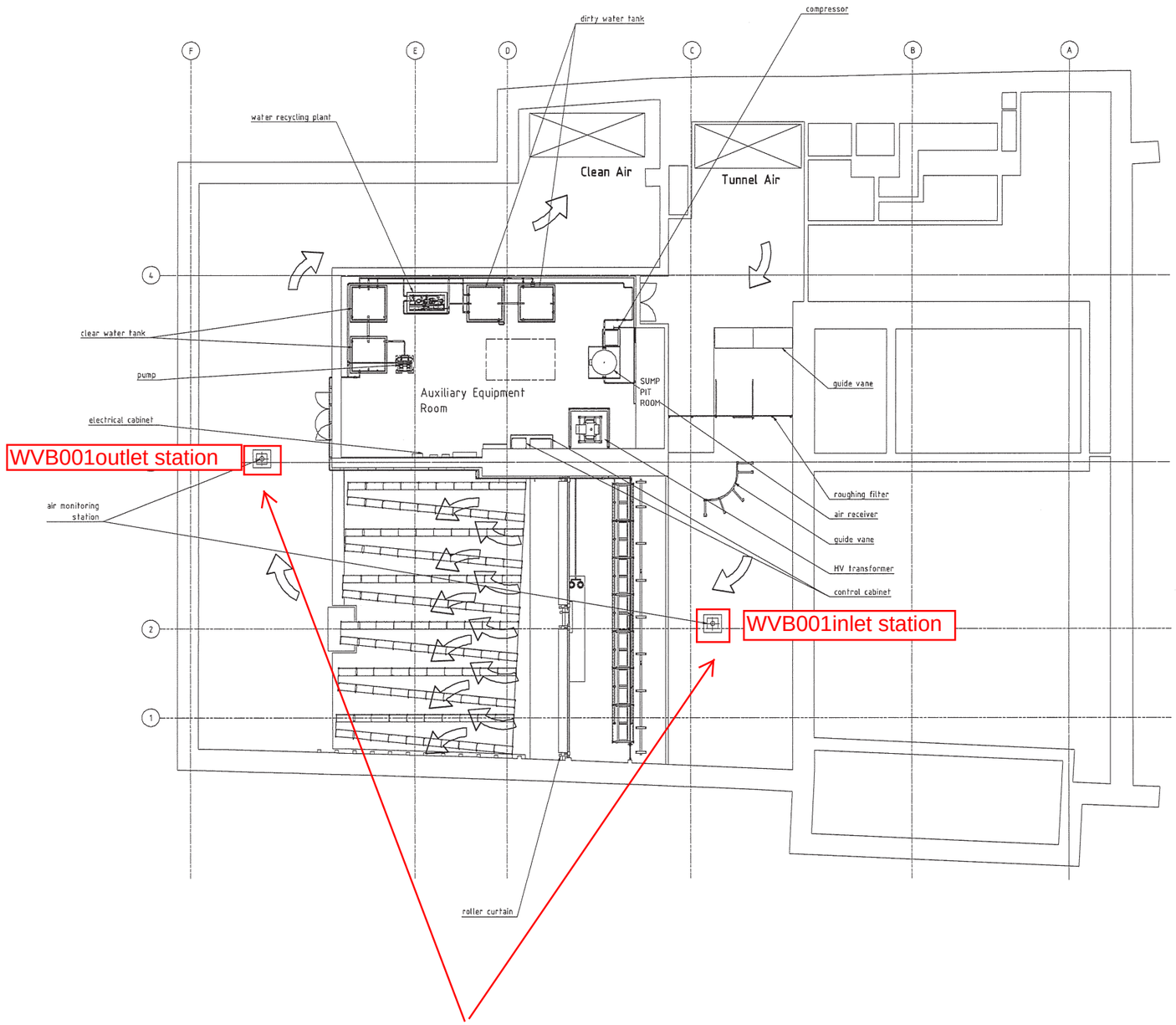
不按比例 N.T.S.

HIGHWAYS DEPARTMENT HONG KONG 路政署 香港

c:\cdms\mw\dms01719\HMW6579TH-SK0255.dgn

A3 420 x 297

plan view
(1 : 100)



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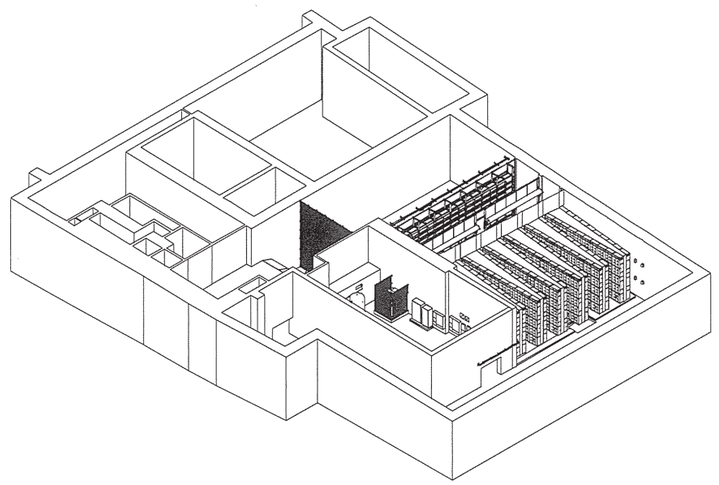


FORMAT:A0

DATE 24.05.2013

REVISIONS		
LEVEL	DATE	DETAILS
05	13.08.15	DeNO₂ layout revised (sump pit)
06	14.10.15	new DeNO₂ layout revised
07	15.03.16	roller curtain design revised
08	31.03.16	layout revised
09	18.07.16	fresh-/ waste water pipe revised
10	07.09.16	carbon wall height increased

MATERIAL

DESIGNED BY	ASuprun	DRAWN BY	ASuprun
CHECKED BY	MWendt	APPROVED BY	EDeux

Contractor:

LEIGHTON 禮頓

Customer:

Highways Department 路政署

Major Works Project Management Office
Contract No. HY/2011/08
Central – Wan Chai Bypass
Tunnel Building, Systems and Fittings, and Works Associated with Tunnel Commissioning

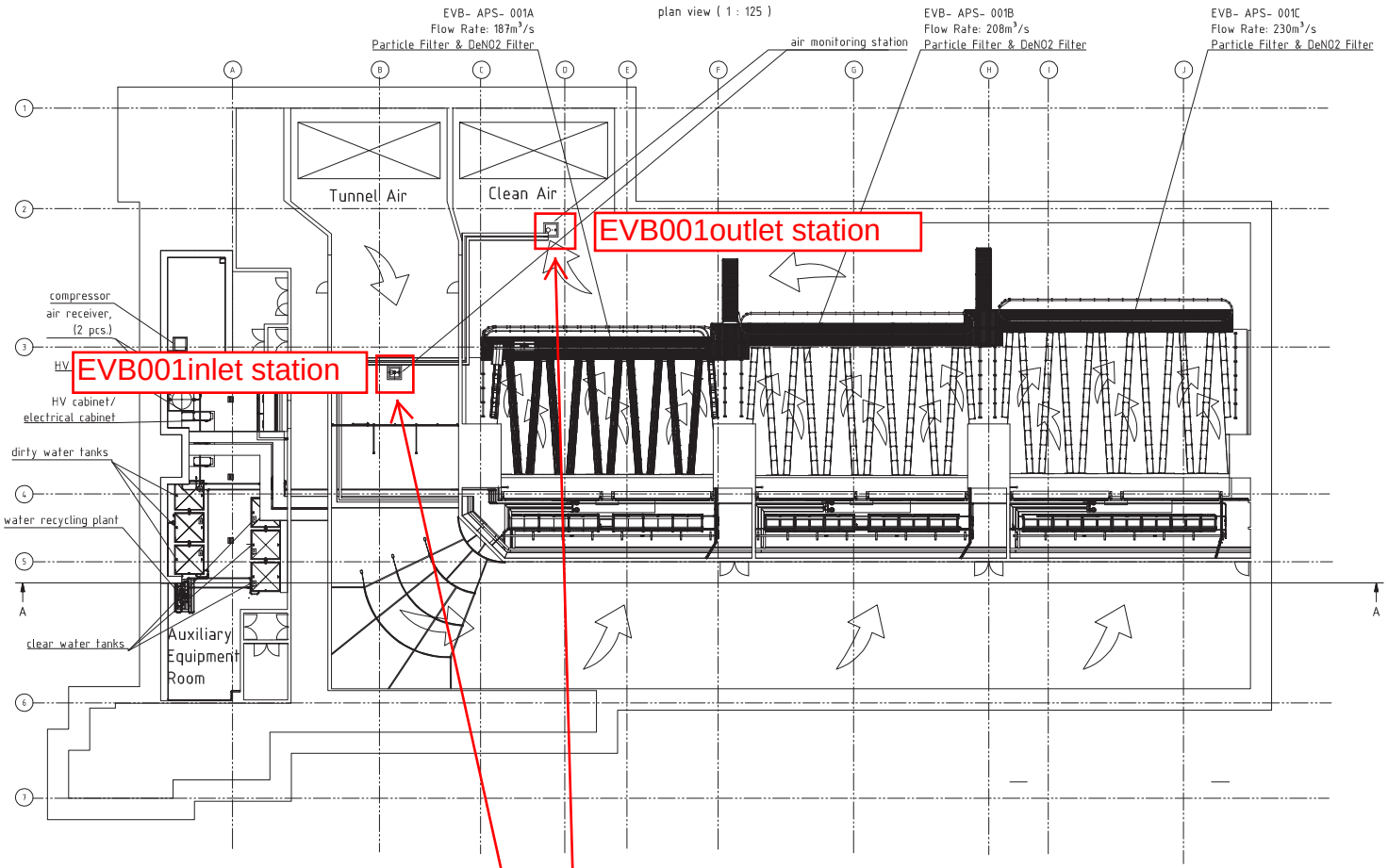
FILTRONtec®
EMISSION CONTROL SYSTEMS

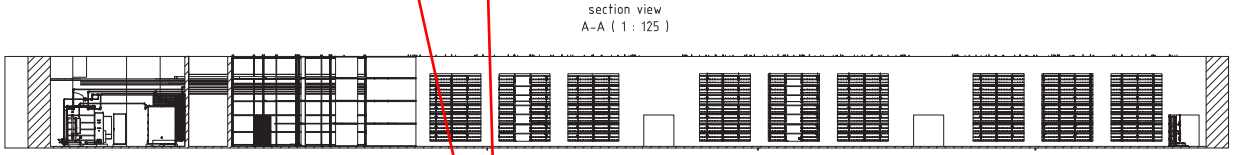
FILTRONtec:
TEL +49 (0) 3494 638327 FAX +49 (0) 3494 638397

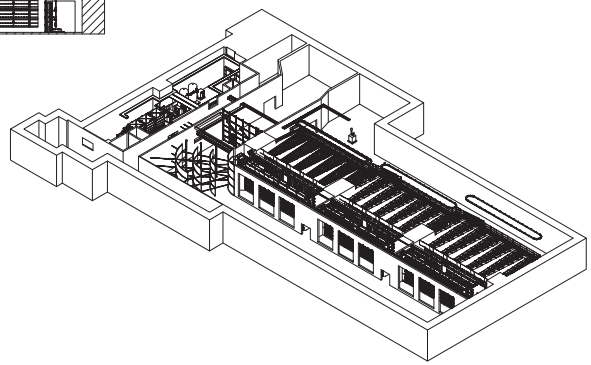
TITLE	WVB APS-001, 250m³/s Overall layout
PROJECT	Central Wan Chai Bypass
CLIENT	Hong Kong Highways Dept.
DWG. No	FT-HCWB-3111
SCALE	1 : 100 (1:200)
DATE	13.05.2014

Status: Detail Design

general tolerance ISO 2768-m







Air Monitoring Stations
EVB001

FORMAT:A0

DATE:

REVISIONS

LEVEL	DATE	DETAILS
07	14.10.15	layout revised
08	18.11.15	piping added
09	24.05.16	vertical plinths added
10	17.08.16	guide vanes updated
11	08.06.17	HVT cabinet position revised
12	24.10.17	partition wall added

MATERIAL:

DESIGNED BY	ASuprun	DRAWN BY	ASuprun
CHECKED BY	MWendt	APPROVED BY	EDeux

Contractor:

LEIGHTON 怡高

Customer:

Highways Department 路政署

Major Works Project Management Office
Contract No. HY/2011/08
Central – Wan Chai Bypass
Tunnel Building, Systems and Fittings, and
Works Associated with Tunnel Commissioning

FILTRONtec®
EMISSION CONTROL SYSTEMS

FILTRONtec:
TEL +49 (0) 3494 638327 FAX +49 (0) 3494 638397

TITLE EVB APS-001A/B/C, 625 m³/s
Overall layout

PROJECT Central Wan Chai Bypass

CLIENT Hong Kong Highways Dept.

DWG. No FT-HCWB-3121

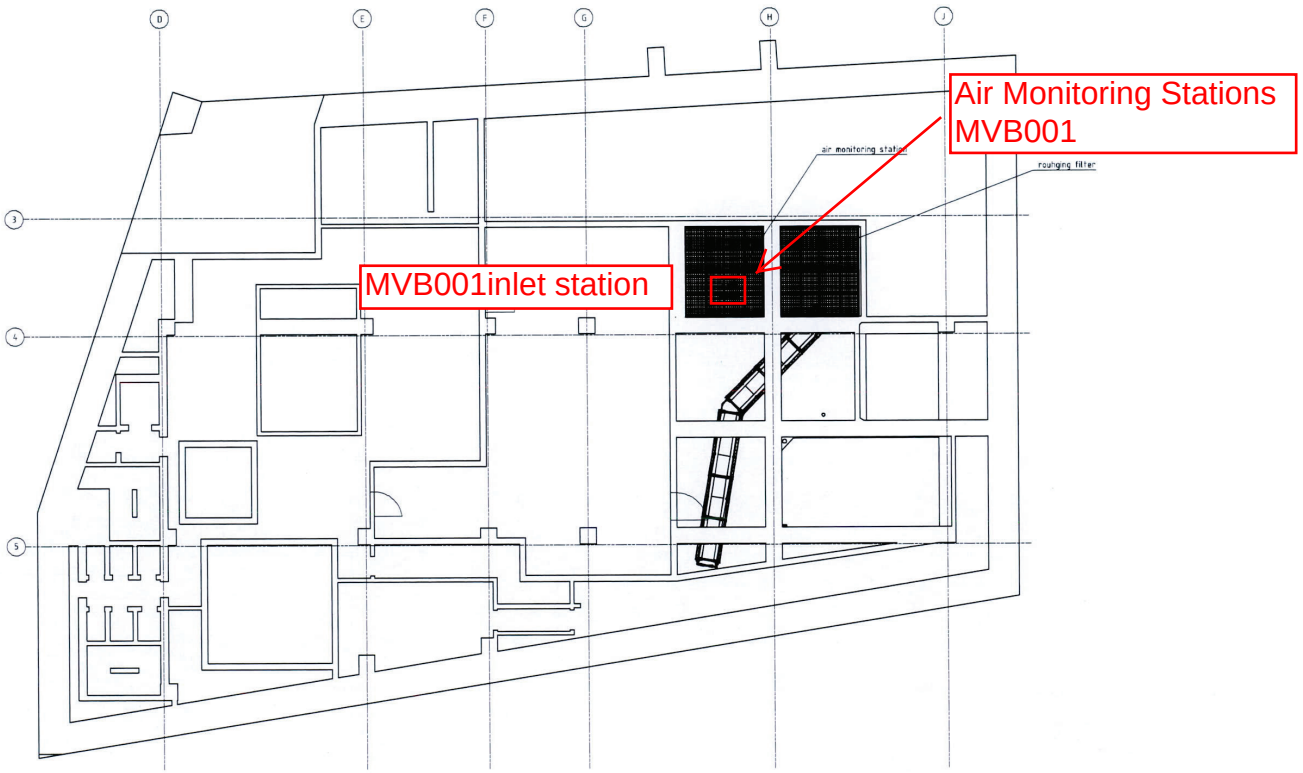
STATUS: Detail Design

SCALE 1:125 (1:300)

DATE 14.05.2014

PAGE:1

plan view (1 : 100)



FORMAT A0

DATE

REVISIONS

LEVEL	DATE	DETAILS

MATERIAL

DESIGNED BY	MWendt	DRAWN BY	MWendt
CHECKED BY	ASuprun	APPROVED BY	EDeux

Contractor:

LEIGHTON 禮頓

Customer:

Highways Department 路政署

Major Works Project Management Office
Contract No. HY/2011/08
Central – Wan Chai Bypass
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TEL +49 (0) 3494 638327 FAX +49 (0) 3494 638397

TITLE MVB APS-001, 250m³/s
Overall layout
Level B2

PROJECT Central Wan Chai Bypass

CLIENT Hong Kong Highways Dept.

DWG No FT-HCWB-3253

SCALE 1:100

DATE 28.07.2015

STATUS: detail design

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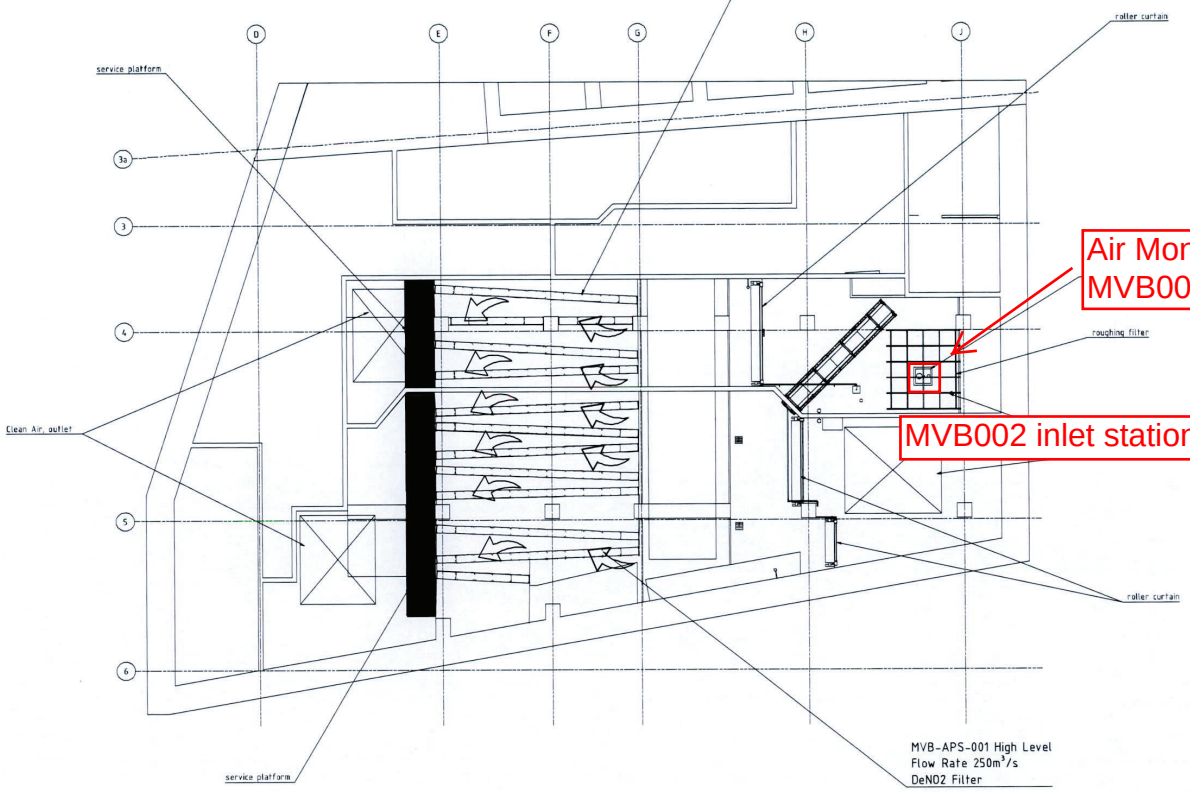
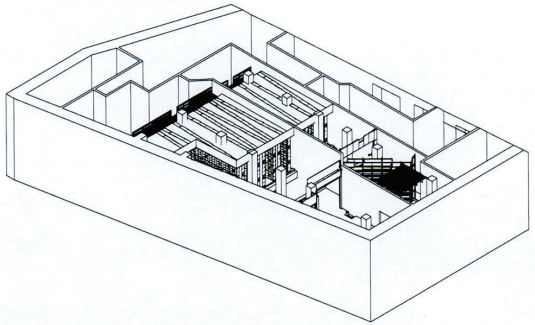


Air Monitoring Stations
MVB002

MVB002 inlet station

1 : 200



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REVISIONS

LEVEL	DATE	DETAILS
01	01.10.14	DeNO2 Design revised
02	22.05.15	DeNO2 Design changed
03	22.10.15	layout revised
04	02.09.16	ESP position APS-001 revised
05	13.02.18	service platform added

MATERIAL

DESIGNED BY	ASuprun	DRAWN BY	ASuprun
CHECKED BY	MWendt	APPROVED BY	EDeux

Contractor:

LEIGHTON 禮頓

Customer:

Highways Department 路政署

Major Works Project Management Office
Contract No. HY/2011/08
Central – Wan Chai Bypass
Tunnel Building, Systems and Fittings, and Works Associated with Tunnel Commissioning

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TITLE MVB APS-001/2, 375 m³/s
Overall layout
High level

PROJECT Central Wan Chai Bypass

CLIENT Hong Kong Highways Dept.

DWG. No FT-HCWB-3251

STATUS

SCALE 1:100

DATE

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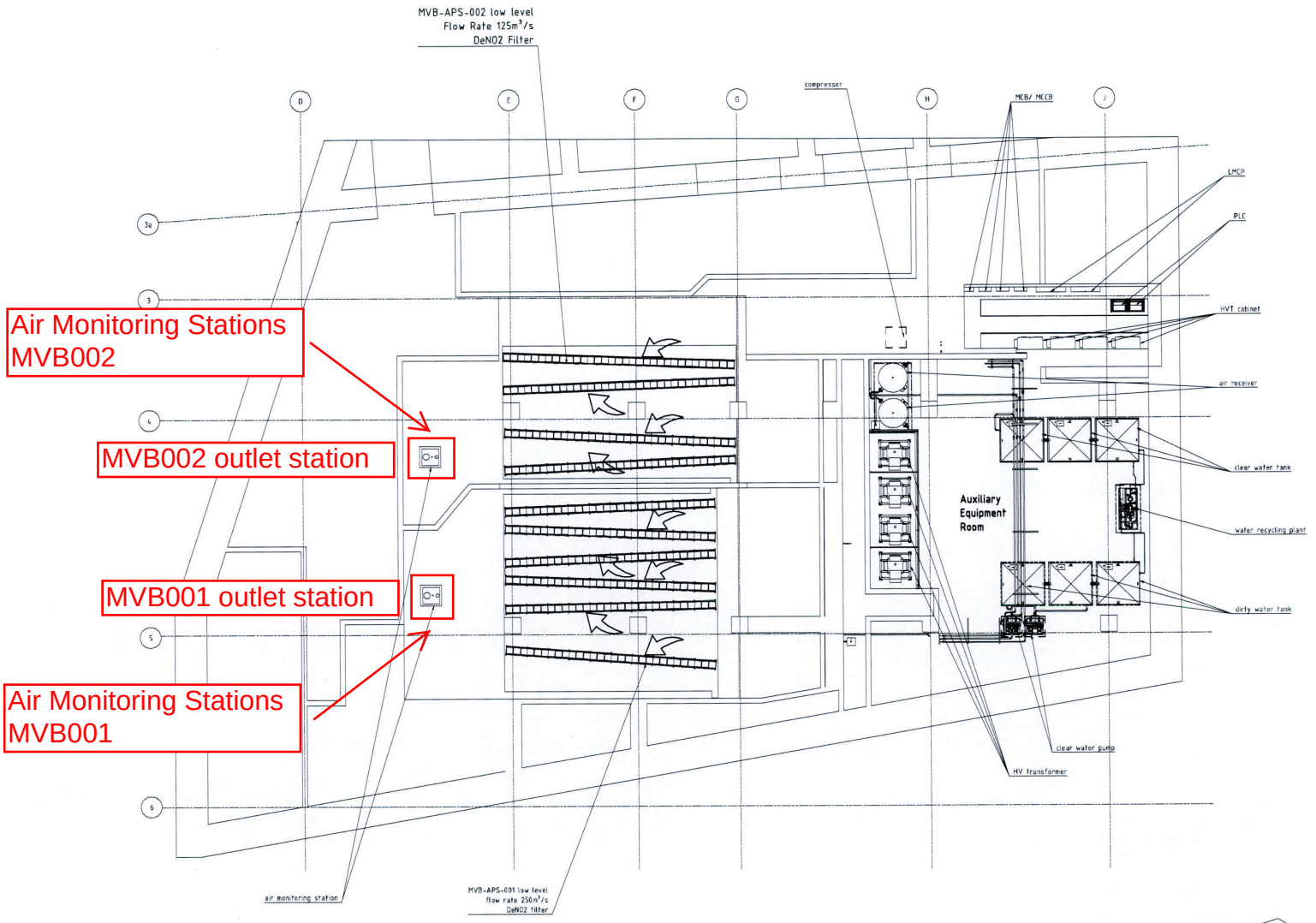

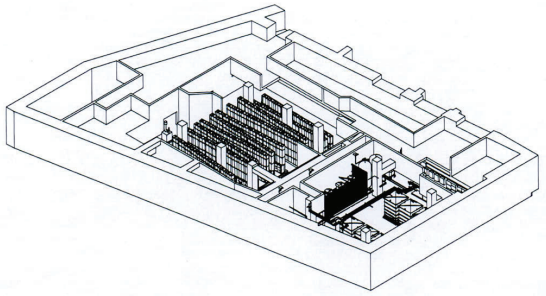

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LEVEL	DATE	DETAILS
01	01.10.14	DeNO2 Design revised
02	02.01.15	APS002 plenum layout revised
03	02.03.15	APS002 note added
04	28.05.15	HVT location revised
05	20.10.15	layout revised
06	14.09.16	location of control cabinets revised

MATERIAL

DESIGNED BY	ASuprun	DRAWN BY	ASuprun
CHECKED BY	MWendt	APPROVED BY	EDoux

Contractor:

LEIGHTON 禮頓

Customer:

Highways Department 路政署

Major Works Project Management Office
Contract No. HY/2011/08
Central – Wan Chai Bypass
Tunnel Building, Systems and Fittings, and Works Associated with Tunnel Commissioning

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TITLE	MVB APS-001/2 375m³/s Overall layout low level
PROJECT	Central Wan Chai Bypass
CLIENT	Hong Kong Highways Dept.
DWG No	FT-HCWB-3151
SCALE	1:100 (1:200)
DATE	27.05.2014

STATUS: detail design

PAGE1

plan view
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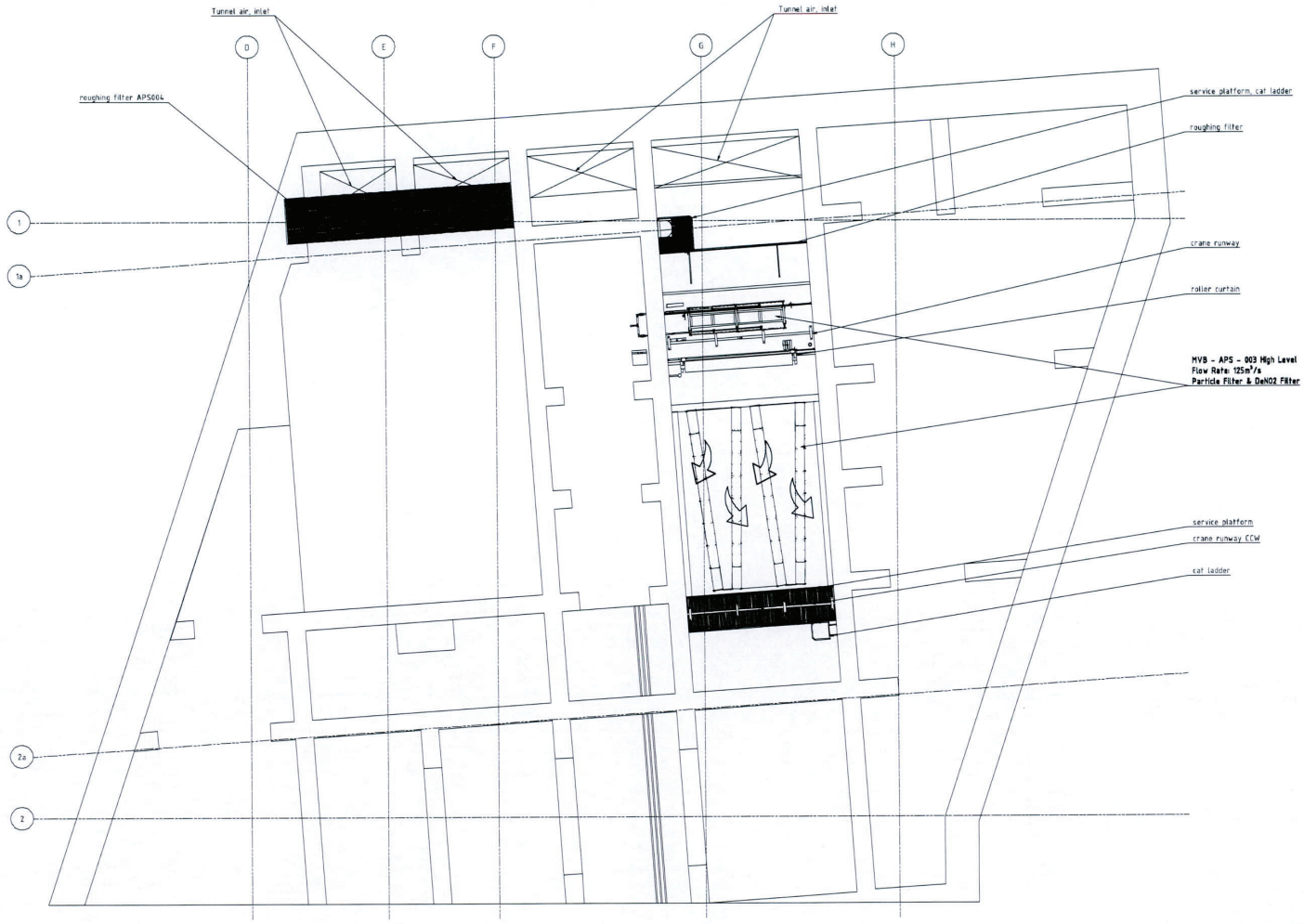

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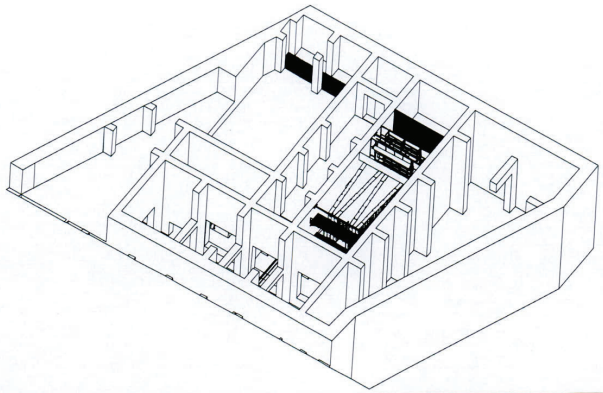

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REVISIONS

LEVEL	DATE	DETAILS
02	22.05.15	DeNO2 Design changed
03	22.10.15	layout revised
04	01.02.16	DeNO2 at low level revised
05	14.09.16	isometric view added
06	18.01.18	location crane runway revised
07	14.02.18	rouhing filter APS004 added

MATERIAL

DESIGNED BY	ASuprun	DRAWN BY	ASuprun
CHECKED BY	MWendt	APPROVED BY	EDeux

Contractor:

LEIGHTON 禮頓

Customer:

Highways Department 路政署

Major Works Project Management Office
Contract No. HY/2011/08
Central – Wan Chai Bypass
Tunnel Building, Systems and Fittings, and
Works Associated with Tunnel Commissioning

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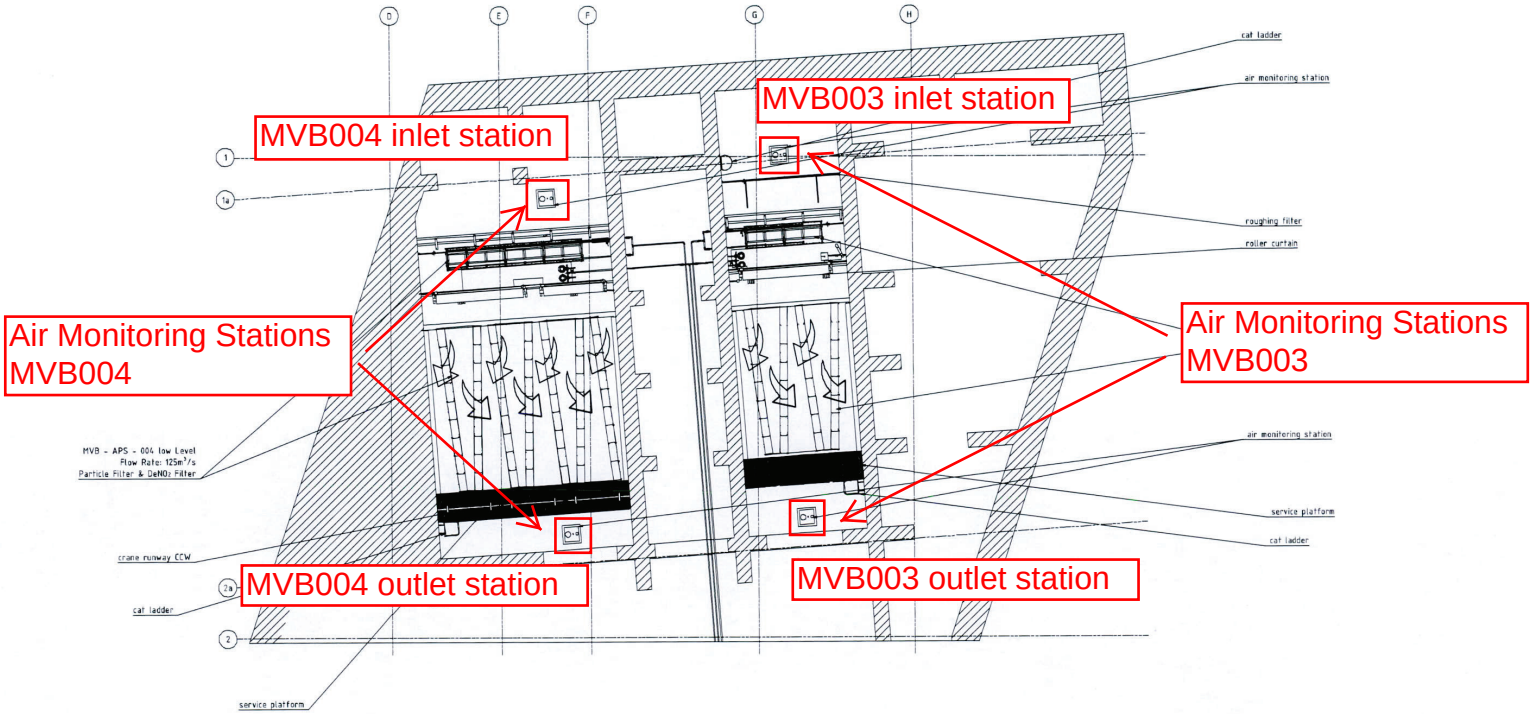
FILTRONtec:
TEL +49 (0) 3494 638327 FAX +49 (0) 3494 638397

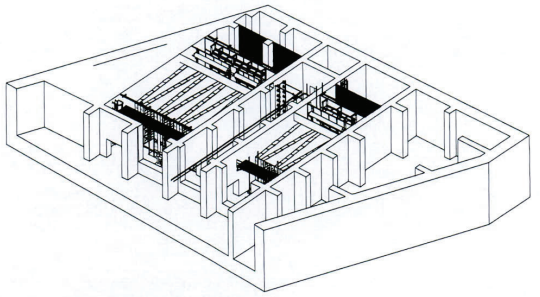
TITLE	MVB APS-003, 125m³/s Overall layout High level
PROJECT	Central Wan Chai Bypass
CLIENT	Hong Kong Highways Dept.
DWG. No	FT-HCWB-3271
SCALE	1:100
DATE	07.07.2014

STATUS: Detail design

general tolerance ISO 2768-mK

plan view
(1 : 100)





FORMAT A0

DATE

REVISIONS

LEVEL	DATE	DETAILS
01	01.10.14	DeNO2 Design revised
02	22.05.15	DeNO2 Design changed
03	22.10.15	layout revised
04	23.01.16	roughing filter updated
05	18.10.17	roller curtain location revised
06	18.01.18	roughing filter location revised

MATERIAL

DESIGNED BY	ASuprun	DRAWN BY	ASuprun
CHECKED BY	MWendt	APPROVED BY	EDeux

Contractor:

LEIGHTON 禮頓

Customer:

Highways Department 路政署

Major Works Project Management Office
Contract No. HY/2011/08
Central – Wan Chai Bypass
Tunnel Building, Systems and Fittings, and Works Associated with Tunnel Commissioning

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TITLE MVB APS-003/4, 250 m³/s
Overall layout
Low Level

PROJECT Central Wan Chai Bypass

CLIENT Hong Kong Highways Dept.

DWG. No FT-HCWB-3273

SCALE 1:100 (1:200)

DATE

STATUS detail design

PAGE1

Event/Action Plan

Event	Action			
	Operator	**Environmental Team (ET)**	**Independent Environmental Checker (IEC)**	**Permit Holder**
Limit Level				
If the criteria stated in Section 5 above cannot be met	1. If the exceedance occurs, inform and request the Contractor of Contract No. HY/2011/08 to carry out investigation, advise the findings, and rectify the defect of less than 80% removal rate 2. Inform ET, IEC, DEP and the Permit Holder; 3. Identify source/reason of exceedance; 4. Discuss with ET and IEC on the potential remedial measures and implement within 3 working days of the exceedance; 5. Keep ET and IEC informed of the result;	1. Discuss with IEC and the Operator on the potential remedial measures; 2. Review the effectiveness of implemented remedial measures and advise IEC and Permit Holder accordingly;	1. Discuss with ET and the Operator on the potential remedial measures; 2. Review the effectiveness of implemented remedial measures	1. Complete the investigation to identify the source/reason of exceedance and submit the investigation report with implemented remedial actions to the Director of Environmental Protection, within 2 weeks of detection of the exceedance.

Data Record Sheet for NO_2 and PM_{10} Monitoring

Monitoring Location		
Details of Location		
Date & Time of Sampling		
Elapsed-time	Start (min.)	
	Stop (min.)	
Total Sampling Time (min.)		
Measured NO_2/PM_{10} level (ppm)		
Remarks/Other Observations		

	Name & Designation	Signature	Date
Field Operator:			
Reviewed by:			
Checked by:			

NO_2

Date: _____ **Time:** _____

Location and Station ID [1]: **EVB001 / MVB001 / MVB002 / MVB003 / MVB004 / WVB001**

	5-minute Inlet concentration (ppm)				5-minutes Outlet concentration (ppm)				Removal efficiency (%)				Exceedance Level [1 2]	Non-compliance [1 3]	Follow up Action
1 Hour	0 min	5 min	10 min	15 min	0 min	5 min	10 min	15 min	0 min	5 min	10 min	15 min	Removal efficiency of not less than 80% / outlet concentration not greater than 0.05ppm	Yes / No	Possible reason
	20 min	25 min	30 min	35 min	20 min	25 min	30 min	35 min	20 min	25 min	30 min	35 min			Action to be taken
	40 min	45 min	50 min	55 min	40 min	45 min	50 min	55 min	40 min	45 min	50 min	55 min			Remarks

[1] delete as appropriate

[2] When inlet NO_2 concentration equal to or greater than 0.25ppm, not less than 80% of NO_2 shall be removed; when inlet NO_2 concentration is lower than 0.25ppm, the outlet concentration shall not be greater than 0.05ppm.

[3] Non-compliance occurs when 6 consecutive of 5-minute removal efficiency (%) exceedances of NO_2 are recorded in any pairs of the monitoring stations at WVB, MVB and/or EVB.

PM_{10}

Date: _____ **Time:** _____

Location and Station ID [1]: **EVB001 / MVB001 / MVB002 / MVB003 / MVB004 / WVB001**

	5-minute Inlet concentration (mg/m^3)				5-minute Outlet concentration (mg/m^3)				Removal efficiency (%)				Exceedance Level [1] [2]	Non-compliance [1] [3]	Follow up Action
1 Hour	0 min	5 min	10 min	15 min	0 min	5 min	10 min	15 min	0 min	5 min	10 min	15 min	Removal efficiency of not less than 80% / outlet concentration not be greater than 0.1 mg/m^3	Yes / No	Possible reason
	20 min	25 min	30 min	35 min	20 min	25 min	30 min	35 min	20 min	25 min	30 min	35 min			Action to be taken
	40 min	45 min	50 min	55 min	40 min	45 min	50 min	55 min	40 min	45 min	50 min	55 min			Remarks

_____

[1] delete as appropriate

[2] When inlet PM_{10} concentration equal to or greater than 0.5 mg/m^3, not less than 80% of PM_{10} shall be removed; when inlet PM_{10} concentration is lower than 0.5 mg/m^3, the outlet concentration shall not be greater than 0.1 mg/m^3.

[3] Non-compliance occurs when 6 consecutive of 5-minute removal efficiency (%) exceedances of PM_{10} are recorded in any pairs of the monitoring stations at WVB, MVB and/or EVB.

(8) The Contractor shall submit full details of the in-situ regeneration plant or the off-site process and the associated MTBF figures and down time requirements for the Engineer's approval. The Contractor shall submit the proposal within 90 days after the Date of Commencement of the Contract.

(9) Within 90 days after the Date of Commencement of the Contract, the Contractor shall provided detailed calculation for sizing the Regeneration Plant with detailed calculation in previous projects for cross reference.

Air Monitoring Stations 37.16 (1) The Contractor shall design, supply, install, test and commission the following air monitoring system in the APS plenum with proper computer hardware and software for data collection and analysis :-

(i) NO_2 concentration measurement devices shall be installed before and after the APS in each plenum and shall be used to calculate the efficiency (based on 5-minutes average, adjustable) of the De-NO_2 filter.

(ii) Particulate sensors for PM_{10}, $PM_{2.5}$ and PM_1 shall be installed before and after the APS in each plenum as a means to show relative particle concentration and shall be used to calculate the efficiency (based on 5-minutes average, adjustable) of the ESP.

(iii) Temperature sensors shall be installed before and after the APS in each plenum to monitor any abnormal temperature in the intake and exit of the APS.

(iv) Temperature sensors shall be installed before and after the De-NO_2 filter to monitor any temperature rise and the operating conditions of the activated carbon.

(v) Humidity sensors shall be installed before and after the APS in each plenum to monitor the moisture content in the air. Humidity sensors shall be installed between ESP filter and De-NO_2 filter in each plenum to monitor the moisture content in the air which may affect the operation of the De-NO_2 filter.

(vi) Pressure sensors shall be installed before and after the APS in each plenum to monitor the pressure drop across the APS.

(vii) Pressure sensors shall be installed between ESP filter and De-NO_2 filter in each plenum to monitor (with the information from the pressure sensors as stated in (vi) above) the pressure drop across the ESP filter and De-NO_2 filter.

(viii) The accuracy of the above sensors shall be selected such that the accuracy shall not exceed +/-1% for temperature, air velocity and humidity sensors, +/-2% for NO_2 sensors (for 0.05ppm or above measured value) and +/-5% for particle size monitors (for 0.1mg/m^3 or above measured value for PM_{10}). These sensors shall be able to work properly under the environment condition inside the APS plenum. Frequent manual calibration or maintenance of the sensors is not allowed as it will affect the operation of the tunnel. The Contractor shall submit the international standards for measuring PM_{10}, $PM_{2.5}$ and PM_1, NO_2, temperature, humidity and pressure, international standard for each type of sensors, full details of the air

monitoring system and the associated MTBF figures and down time requirements for the Engineer's approval.

(2) The Contractor shall design, supply, install, test and commission, in case in-situ re-generation of activated carbon as mentioned in Clause 37.3 (3) (ii) is used, equipment to control the presence of chemicals for the re-generation in the airstream in order to meet the EPD requirements.

Control System 37.17 (1) The Contractor shall design, supply, install, test and commission the APS Control System including, but not be limited to the following, to ensure fully automatic operation with minimum operation attendance :-

(i) Start up and shut down of the APS upon command from the CCMS. Local control shall also be provided to override the remote control via CCMS. Safety provisions shall be made so that working staff will not have access to the High Voltage equipment when it may be activated either locally or remotely.

(ii) Sequential operation of APS and TVS shall be in accordance with the following steps :-

Start the APS

(a) APS Control System (remote control by CCMS or local control in ventilation building) to switch on the HV DC power supply.

(b) APS Control System (remote control by CCMS or local control in ventilation building) to withdrawal of the water splash screen between ESP filters and De-NO_2 filters.

(c) CCMS to start the duty fans and open the associated tunnel dampers serving the APS after a pre-defined period (e.g. 5 minutes after the HV DC is switched on, adjustable).

Shut down the APS

(a) CCMS to stop the duty fans (if necessary, to avoid dead airflow path) and close the associated tunnel dampers serving the APS.

(b) APS Control System (remote control by CCMS or local control in ventilation building) to arrange extension of the water splash screen between ESP filters and De-NO_2 filters.

(c) APS Control System (remote control by CCMS or local control in ventilation building) to switch off the HV DC power supply after a pre-defined period (e.g. 5 minutes after the associated tunnel dampers serving the APS are closed, adjustable).

(d) In order to reduce the risk, ESP system shall be turned

25 APR 2018

08A028010

Material Submission Form

t: +852 2823 1111
f: +852 2529 8784
e: info@leightonasia.com

Ref: H2613/MSF/APS/00042-R8
Date: 25 APR 2013

Contract: HY/2011/08 – Central-Wan Chai Bypass –Tunnel Buildings, Systems and Fittings and Works Associated with Tunnel Commissioning

To: Engineer's Representative, The Chief Resident Engineer Mr. David Kwan
Your Ref.: C50-222-08B019613

Title of Submission:APS - Material Submission of Air Monitoring Stations

Specification:PS37

We are pleased to submit the following material for your review and comment

Manufacturer Name: Palas, Fidas, Horiba, Varistar and Lufft
Proposed Location of Use:WVB, MVB and EVB

Description:
Enclosed please find the responses to Engineer's comment of air monitoring stations for your approval.

Purpose of Submission: For Approval

Contractor's RepresentativeDate: 25 APR 2013
Signature:

Name: Colman Wong
Position: Joint Venture's Representative

Distribution:CW / JK / DG / KF / EC

Prepared by: Samson Leung

AECOM

- 7 MAY 2018

08B020090

RESPONSE TO CONTRACTOR'S SUBMISSION

Our Ref. : CWB/(HY/2011/08)/C50/222/08B020090

To : Leighton Joint Venture

Attn.: Mr. Colman Wong

Location : WVB, MVB and EVB	MSF No. : H2613/MSF/APS/00042-R8
Title of Submission : **APS – Material Submission of Air Monitoring Stations** *(Originated from LJV)*	Date : 25 April 2018

The Engineer's Representative's Comment(s) :

A. Major Non-Conformance to Specification / Obvious Deficiencies/ Essential Comments
Nil.

B. General Comments
Nil.

C. Other Comments
Nil

Status : ☑ Approved; ☐ Not approved and resubmission required;

☐ Approved subject to condition(s) as stated / further required information as stated.

☐ Approval not required. ☐ Others _____ *(Please specify)*

The Engineer's Representative : Patrick Wong Date of Response : 4 May 2018

Patrick Wong

c.c. CE4/MW, HyD - Attn.: Mr. Patrick Lai
SE Project 9, EMSD - Attn.: Mr. K.P. Ip
File - M25/110

e.c. AECOM - Attn.: Mr. Alex Li / Ms. Ivy Chung
RSS - PP, DK, KWC, YMS, CYL, SWM

PW/YCC/CWH/al

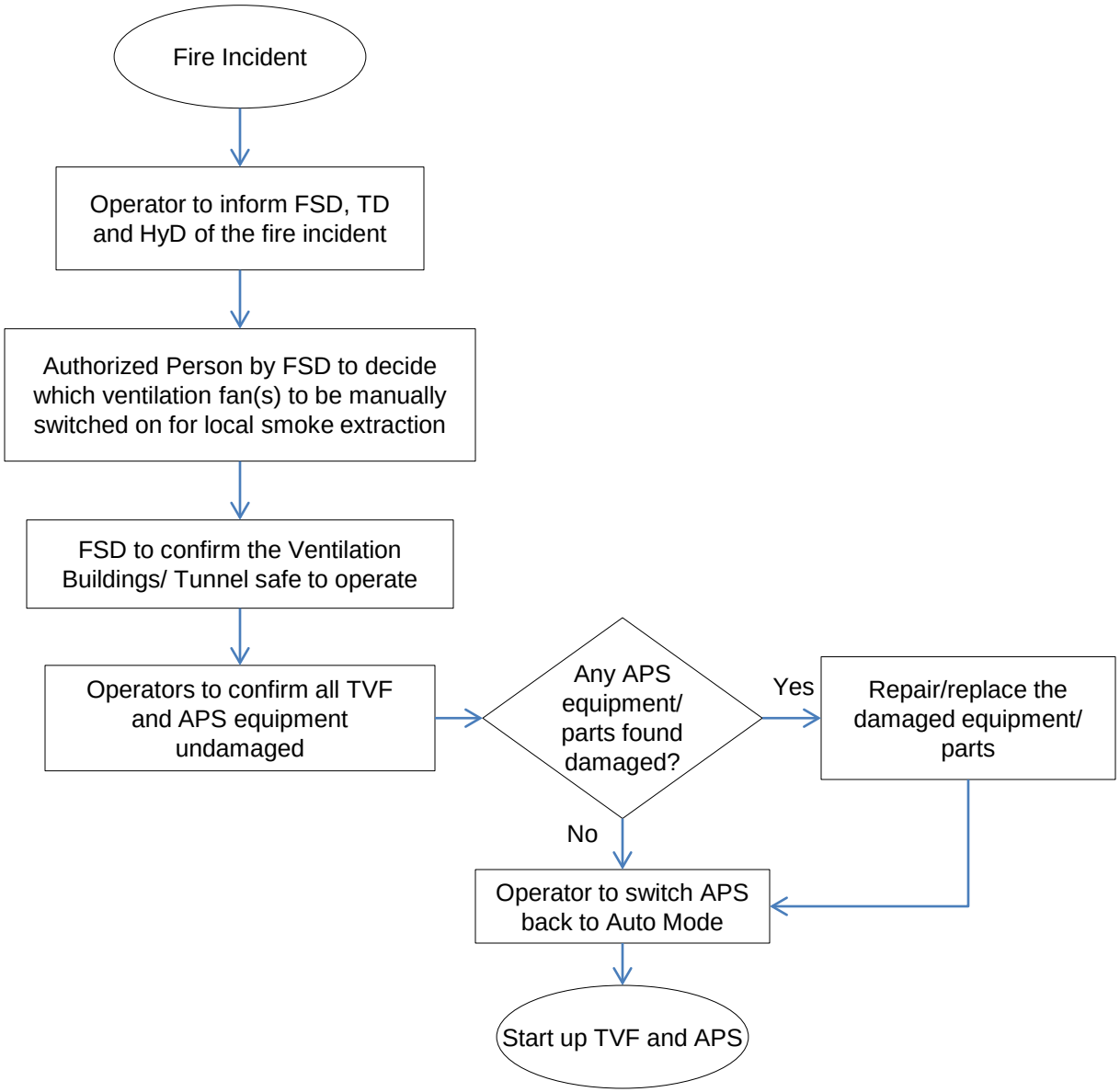
DESIGN STANDARDS/CRITERIA

General 37.2 **(1)** The APS shall be designed to the following system performance requirements :-

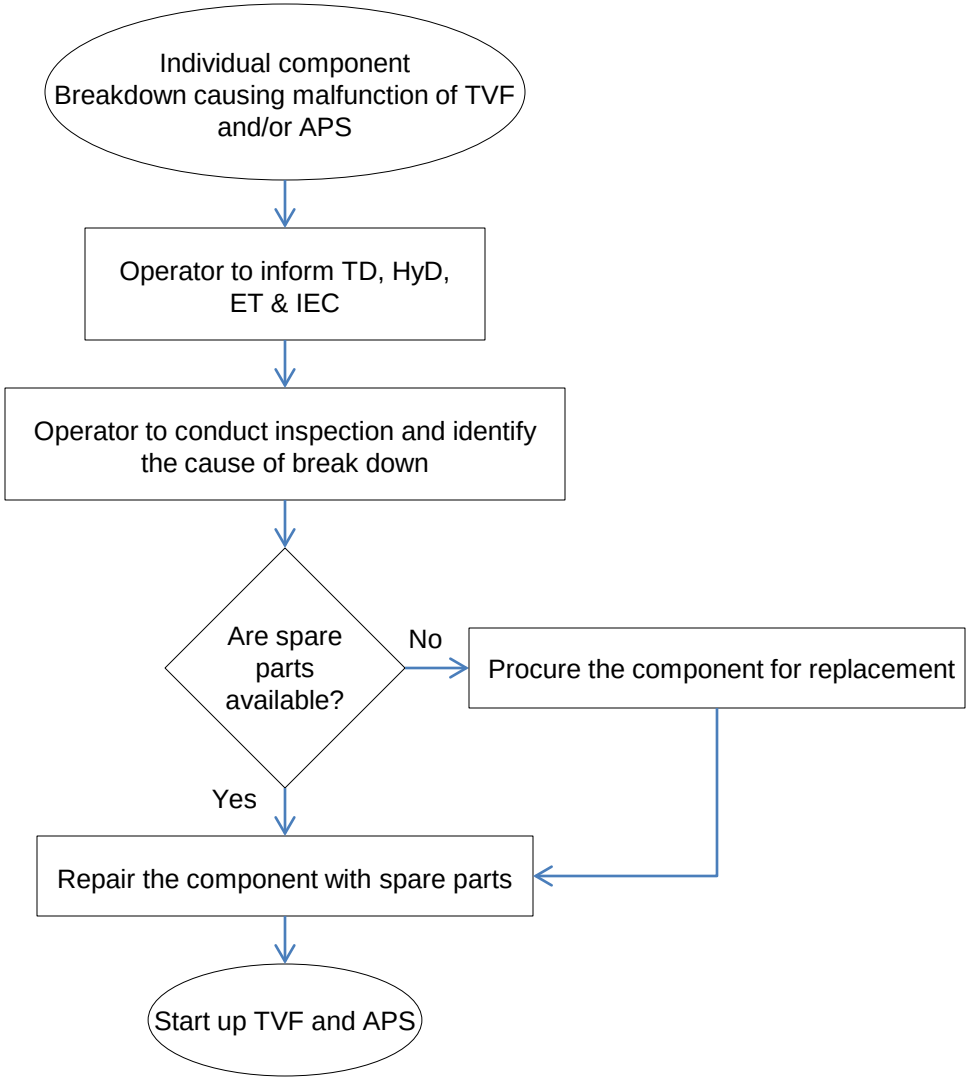
(i) For particle, when inlet concentration equal to or greater than 0.5mg/m^3, not less than 80% of PM_{10} shall be removed after the air is treated by the APS. For inlet concentration lower than 0.5mg/m^3, the outlet concentration shall not be greater than 0.1mg/m^3.

(ii) For NO_2, when inlet concentration equal to or greater than 0.25ppm, not less than 80% of NO_2 shall be removed after the air is treated by the APS. For inlet concentration less than 0.25ppm, the outlet concentration shall not be greater than 0.05ppm.

Fire Incident



Component Breakdown



Power Supply Failure

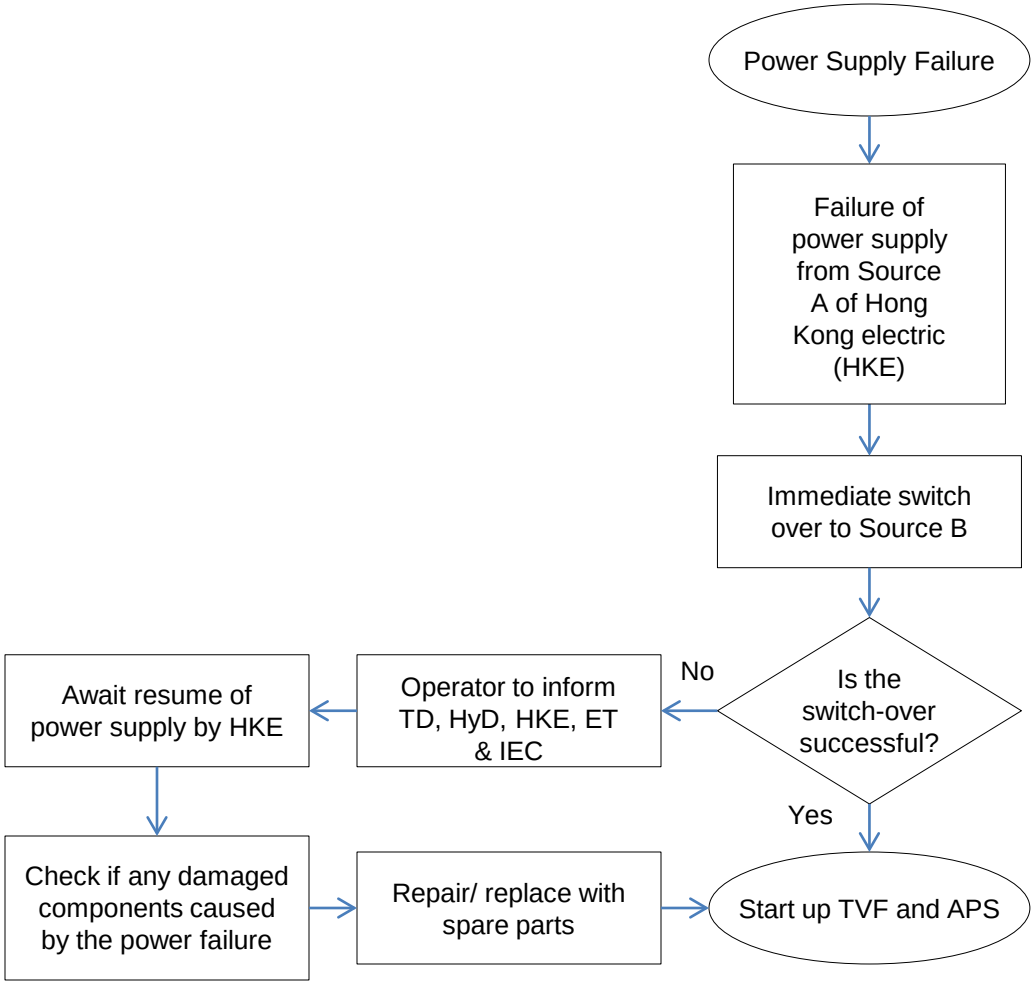


TABLE OF CONTENTS

BOOK 3 OPERATIONS

1 OPERATIONS

1.1 Operations Overview

This document contains the procedures that must be implemented by the Operator to enable operation of the Mechanical and Electrical Equipment for the Central-Wan Chai Bypass Air Purification System.

1.2 Operating Procedures Identification

Operating Procedures are identified as APS-FT-OP-AAA-XXX (where AAA is a three-letter field identifying an item of equipment and XXX is a three digit alphanumerical code commencing at A01 for each item of equipment. E.g. – ESP Operating Procedures will be identified as APS-FT-OP-ESP-A01, A02 and so on).

These procedures will provide the Operator with instructions to operate the equipment in accordance with the design intent.

1.3 Operational Phases

During the pre-operational phase, trial period and operational phases, the operating procedures will be updated according to the following schedule.

(a) The first draft will be created during the pre-commissioning phase before final testing. This draft copy will outline the processes to be followed and detail exact processes to be followed by the operator to execute equipment operation.
(b) The final version will be created after testing and before handover of the APS to the operator.
(c) During the operational phase, the Operator will be responsible for the application of these procedures. During such periods of application, the Operator may have suggestions to the modification or otherwise of the procedures. Such suggestions should be made to the Mechanical and Electrical Equipment Maintenance Manager on a regular basis. Should there be any proposed changes arising during the operational phase, the Highways Department is to be contacted to coordinate such proposed changes with the Operator, Contractor and APS supplier to review and update this manual.

1.4 Operational Staff Roles and Responsibilities

The specific roles and responsibilities of operational staff are summarised in the following table:

Table 1: Operational Staff Roles & Responsibilities

Staff Personnel Description	Role	Responsibility
Traffic Control Room Supervisor	Overall management of the day-to-day operations, staff, assets and resources.	Keeping the tunnel open and running smoothly Sufficient experienced staff, assets and resources
Traffic Control Room Operator	Operation of the CCMS, monitoring actions, reporting alarms, faults and emergencies	Tunnel is open and running efficiently that all systems are monitored and all faults, alarms and emergencies are correctly actioned
APS Operator	Operation of the remote APS	APS is ready to operate

	PLC within the CCMS, to monitor and report all faults, alarms and emergencies	when required and operational under normal and high volume traffic flow. All faults, alarms and emergencies are reported and attended to.
APS Maintenance Personnel	To undertake schedule and routine plant maintenance, attend essential and emergency repairs	Tunnel is functional and ready to operate when required

2 M & E EQUIPMENT OPERATING PROCEDURES

The following section lists the procedures that will provide guidance for the operation of the Electrical and Mechanical Equipment for the APS.

2.1 Listing of Operating Procedures

Table 2: Operating Procedures

System	Asset Item	Procedure
ESP Filter	Roughing Filter Operating Procedure	APS-FT-OP-ESP-A01
	ESP Operating Procedure	APS-FT-OP-ESP-A02
	HV Transformer Equipment Operating Procedure	APS-FT-OP-ESP-A03
	Guide Vanes Operation Procedure	APS-FT-OP-ESP-A04
Wash Down System	Rinsing Pipes and Nozzles Operating Procedure	APS-FT-OP-WDS-A01
	Collection Drain and Sump Operating Procedure	APS-FT-OP-WDS-A02
	Piping Operating Procedure	APS-FT-OP-WDS-A03
	Pumps Operating Procedure	APS-FT-OP-WDS-A04
	Actuator Valves Operating Procedure	APS-FT-OP-WDS-A05
	Tanks Operating Procedure	APS-FT-OP-WDS-A06
	Air Compressor/Receiver Operating Procedure	APS-FT-OP-WDS-A07
	Water Recycling Plant Operating Procedure	APS-FT-OP-WDS-A08
	Sludge Pump and Filter Regulator Operating Procedure	APS-FT-OP-WDS-A09
	Automatic Roller Screen Operating Procedure	APS-FT-OP-WDS-A10
$DeNO_2$ Filter	Activated carbon Operating Procedure	APS-FT-OP-DS-A01
	Activated carbon Containment Wall and Access Operating Procedure	APS-FT-OP-DS-A02
	$DeNO_2$ Cover Sheets Operating Procedure	APS-FT-OP-DS-A03
	Carbon Handling Equipment Operating Procedure	APS-FT-OP-DS-A04
Air Monitoring System	APS Air Monitoring System Operating Procedure	APS-FT-OP-AMS-A01
Electrical Systems	Electrical Systems Operating Procedure	APS-FT-OP-ES-A01
	APS Safety Circuit Procedure	APS-FT-OP-ES-A02
Control Systems	APS Control System Operating Procedure	APS-FT-OP-CS-A01

The procedures are contained in **Annexure A** following this Volume 5 Book 3.

2.2 Operating Systems Failure /Degradation

This section outlines possible operator responses to deal with a system failure or degradation. Responses are to be initiated by reference to the guidelines in the Failure Type Matrix under APS Operator discretion.

- At all times safety of users comes first, containment of the impacts of the failure second, protection of the APS asset third, and re-establishment of normal operating conditions fourth.
- Record the nature and location of the incident; recall source, and other relevant information using an Incident Log. Advise the Maintenance Team, CWB CCMS Management of failure.
- If incident is not verified as a failure or degradation, return to previous operating state after checking for control of the system.
- Refer to Failure Type Matrix to assess impact of the failure on operation of the APS and/or the control of the equipment. Note that the matrix contains guidelines only as it addresses single failure of each element of the APS. It does not consider failure of all combinations of equipment types. The actual response in each case will be at the discretion of the Operator in conjunction with CWB CCMS Management, EMSD and Highways Department.
- Always ensure that the operator has total control of the system. Advice the Maintenance Team of any alarms or loss of control identified.
- If the systems are operating in a degraded state, advise Maintenance Team, CWB CCMS Management and EMSD of failures and ensure that they are kept up to date.

Unsafe to Operate

- If CWB CCMS has lost control of APS systems or it is unsafe to continue operation of the APS, close the APS using the appropriate emergency stop facilities, **contact CWB CCMS Management, Maintenance Team, EMSD and Highways Department immediately.**
- Dispatch appropriate resources as required.

Repair Works

- Perform repair work completely or up to a point such that APS management responses are not required, or system fall back arrangements are no longer required.
- Confirm that it is safe to re-introduce APS to operation.
- Return all systems to the pre-incident state or normal state as appropriate.
- Log incident in the incident database.
- Conduct de-brief with EMSD, agencies and subcontractors if requested.

The following is a Matrix of critical equipment failure mode and response required. **Most of the following scenarios will generate various critical/warning system alarms and should be read in conjunction with the Alarms created by the APS PLC PC.**

Table 3: Critical Equipment Failure Matrix and Response

System	Failure Description	Level of Redundancy	Consequences (from system viewpoint)	Impact on Tunnel Operation	Possible fall-back arrangement
APS PLC PC Server	LCC Server Fails	CWB CCMS Clients (2) backup	If all server/clients fail, no communication with APS devices.	None. If server fails (transparent for CCMS).	None

CWB CCMS APS PLC PC	CWB CCMS Client	LCC Server	If all server/clients fail, no communicatio n with APS devices.	None. If 1 server fails (transparent for CCMS).	None
PLC PC CPU (for both APS LCC or CWB CCMS)	Server/Client	CPU running at 100%	No alarms present. System will slow considerably	Reboot	None
ESP Filter System ESP Transformers	ESP HVT Fail	None	Alarm will show failure to start for Ioniser and Collector Transformers	Plant will not run	None
Filter System ESP Module	One or two ESP modules little impact	Other units in the ESP Filter array	No Alarm HV Transformer will indicate reduced output required. Reduced separation	None	Other modules with plant running at reduced separation rates
Wash Down System Sump Pump	Pump fails	Second standby pump	Alarm will show fail to start or pump unavailable	None	Standby Pump
Wash Down System Clear Water Pump	Pump fails	Second standby pump	Alarm will show fail to start or pump unavailable	None	Standby Pump
Wash Down Plant Valves	Valve fails to open	None	Alarm, Wash Plant not be available	Wash Down will not run	None
Wash Down Plant Rinsing Valves	Valve fails to open	Other rinsing valves	Alarm, Wash Plant will function but reduced	None	Rinsing continue but with reduced capacity
Wash Down System Water Recycling Plant	Fails to start	None	Alarm will show unavailable	Plant will become inoperative within 24-48 hours as clear water will not be available and will stay in the collection drain	None

Wash Down System Compressor	Fails to start	None	Alarm will show unavailable	Plant will become inoperative within 24-48 hours as compressed air will not be available	None
Air Monitoring Cabinets	Fail to operate	None	Alarm – no data	No data	Other cabinets with plant with reduced monitoring.

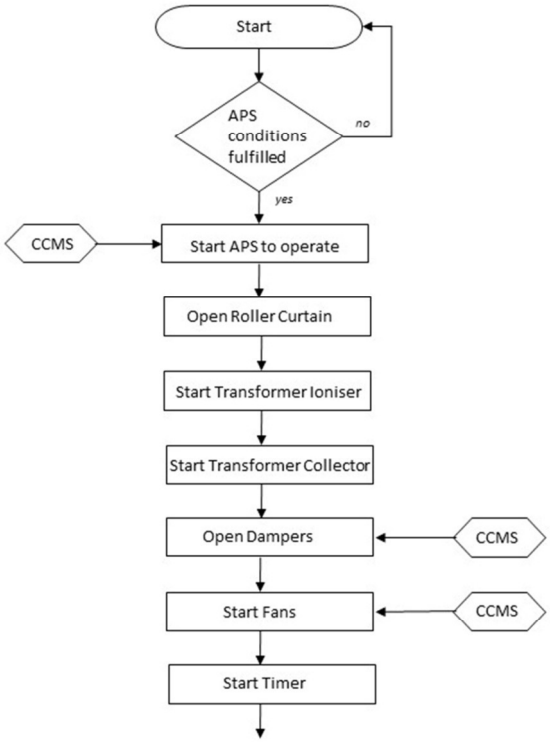
3 APS OPERATIONAL OVERVIEW

3.1 APS Start

INCLUDE SCREEN SHOT

The APS start sequence is as per following steps (refer to PS37.17 Control System):

1. APS start condition is fulfilled as
    a. tunnel air quality exceeds a specified maximum pollution level or
    b. scheduled start-up time is reached or
    c. tunnel operator initiates APS start;
2. Remote CCMS or local APS PLC commands APS to operate;
3. APS control system to start HV transformers for ESP (ioniser and collector)
4. APS Control system to withdraw the roller screen between ESP and DeNO2 filters
5. CCMS commands to start the duty fans and open the associated tunnel dampers

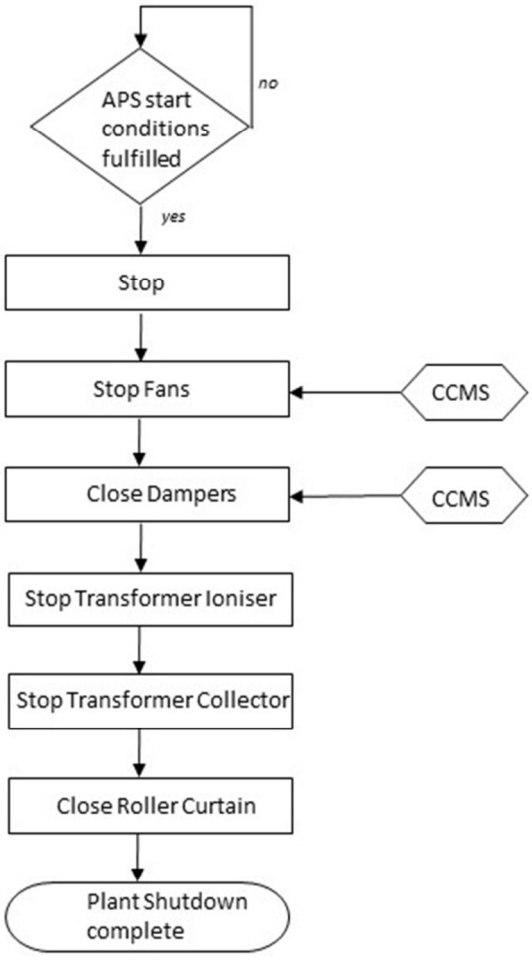


3.2 APS Shutdown

INCLUDE SCREEN SHOT

The APS shutdown sequence is as per following steps (refer to PS37 Control System):

1. APS stop condition is fulfilled as
    a. tunnel air quality level is below a specified maximum pollution level or
    b. scheduled shutdown time is reached or
    c. fire in the tunnel or APS temperature > 250°C (signal from CCMS) or
    d. tunnel operator initiates APS shutdown;
2. CCMS commands to stop the duty fans and
3. CCMS commands to close the motorised APS tunnel dampers
4. APS Control System to close the roller screens between ESP and DeNO2 filters
5. APS Control System to switch off the HV transformers (ioniser and collector)

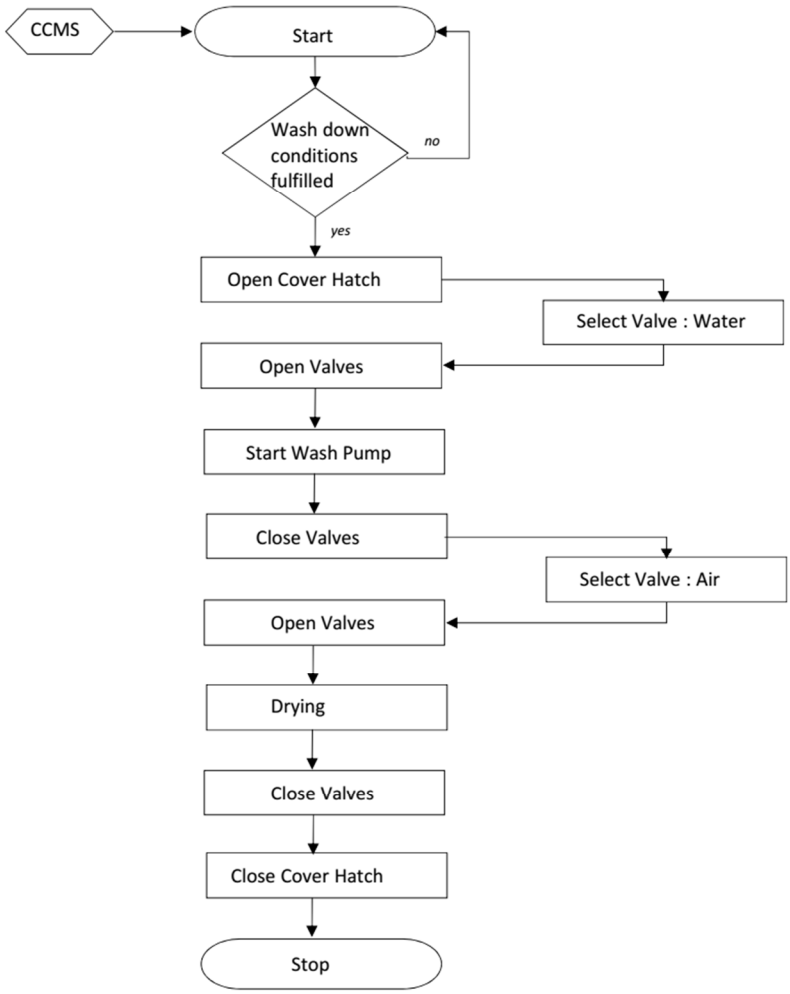


3.3 Wash Down Process

INCLUDE SCREEN SHOT

1. Wash down start condition is fulfilled as
    a. TVF are stopped and
    b. Motorised APS dampers are closed
    c. Roller screens are down between ESP and DeNO2 filters, and
    d. HV transformers for ESP (ioniser and collector) are stopped
    e. Number of APS operating hours (measured by HVT timer) is exceeded (Maximum operating hours to be determined during commissioning and performance testing)
2. CCMS commands to start wash down process
3. APS control system to start duty wash pump and to open and close cleaning valves sequentially to wash down the ESP from back and front and top to bottom
4. APS control system to stop duty wash pump
5. APS control system to activate drying process by sequential opening and closure of cleaning valves from back and front and top to bottom

APS control system to roll up screen curtain after ESP ready for next operation


CCMS
Start
Wash down conditions fulfilled
no
yes
Open Cover Hatch
Select Valve : Water
Open Valves
Start Wash Pump
Close Valves
Select Valve : Air
Open Valves
Drying
Close Valves
Close Cover Hatch
Stop

3.4 Water Recycling Process

INCLUDE CCMS SCREEN SHOT

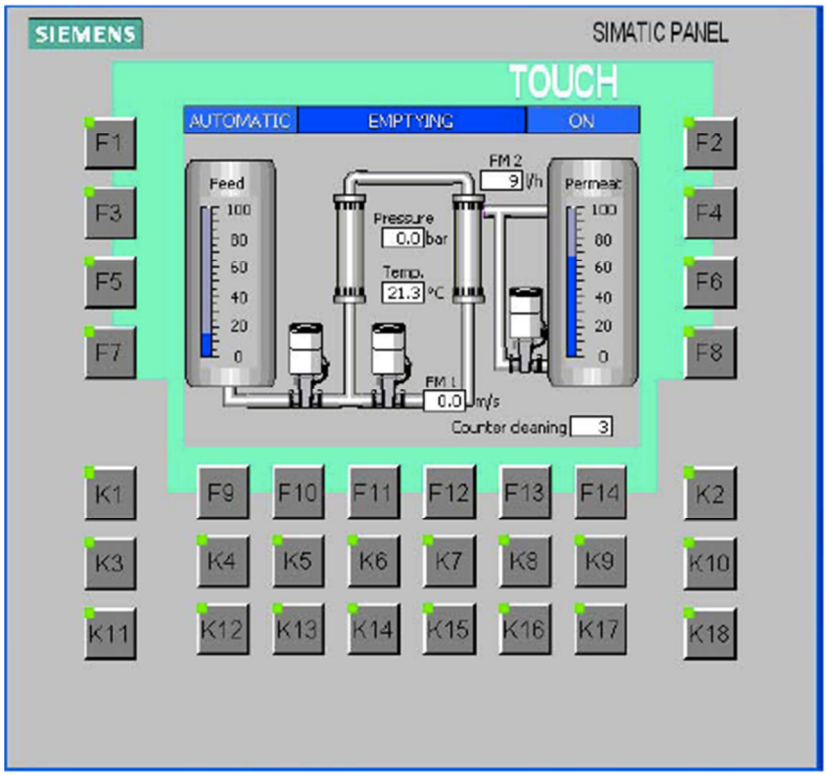


Figure: WRP Touch screen graphic
Parameter settings

The water recycling process is independent of APS operation and can operate with either APS operating or APS not operating. The sub-processes are described below.

1. The sump pit underneath the ESP will collect all the wash down water. Level sensors are installed in the pit. Once the water accumulated up to the pre-set level, the duty sump pump will be activated and pump the water to the effluent storage tank for the recycling process. The duty sump will stop automatically when the water level falls below a pre-set low level.
2. The water recycling plant is connected to the effluent storage tank. Once the wash down water accumulated to the pre-set level inside the effluent storage tank, the water recycling plan will start automatically. The circulation pump will cycle the wash down water across a ceramic membrane (cross-flow filtration principle). Clear water is extracted and pumped to the wash water supply tank for next wash down process whereas the wash down water is concentrated to form watery slurry and returned to the effluent storage tank. The UV device is activated when the clear water flow starts to further start the bacteria killing process.
3. The UV disinfection unit is included as part of the recycling plant shown on drawing FT-HCWB-1012. It is operated and monitored by the PLC of the water recycling plant and does not fall within the APS PLC control scope of work. The UV disinfection unit operates with the water recycling plant.
4. 3 nos. of flow meters and 1 no. of temperature sensor are provided. The recycling plant PLC monitors the temperature and raises an alarm should the temperature

exceed a set limit. The flow meters are also monitored by the recycling plant PLC and control the introduction of backwash acid and alkaline solutions after a set number of recycle plant operations. The OEM is to set these parameters and logic during the factory commissioning of the plant and the settings and logic forms part of the process logic documentation delivered with the complete unit.

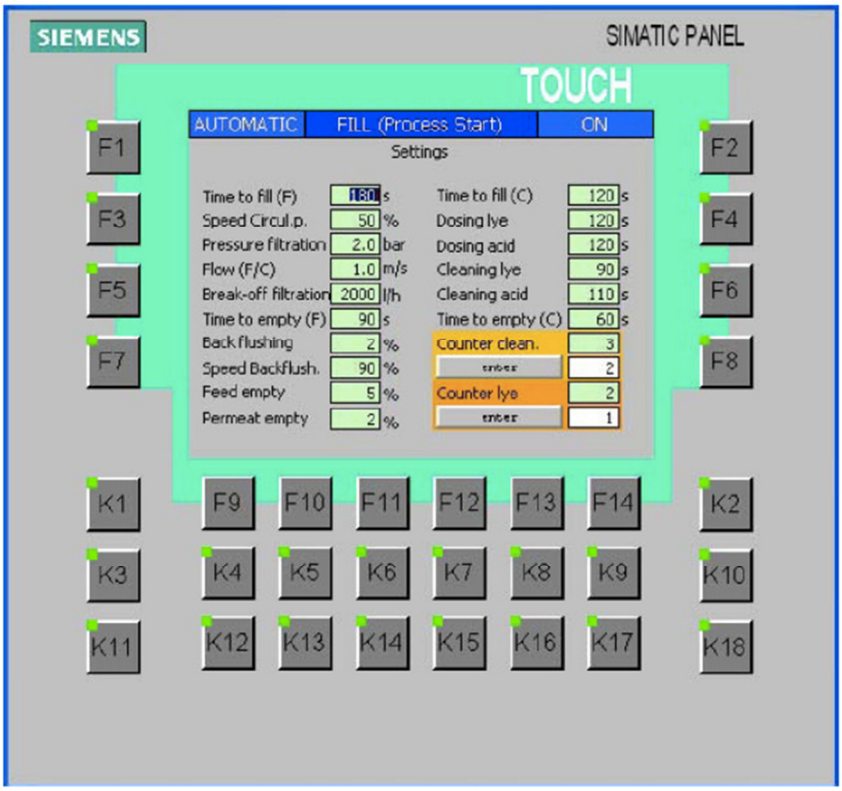


Figure: Filtration Parameter Adjustment Screen

3.5 Compressed Air Supply

The compressed air supply is independent of APS operation and can operate with either APS operating or APS not operating. Once the air pressure in the receiver falls below a pre-set pressure level, the compressor starts automatically. The compressor will stop when a pre-set maximum air pressure in the receiver is reached.
Refer OEM O&M Manual:

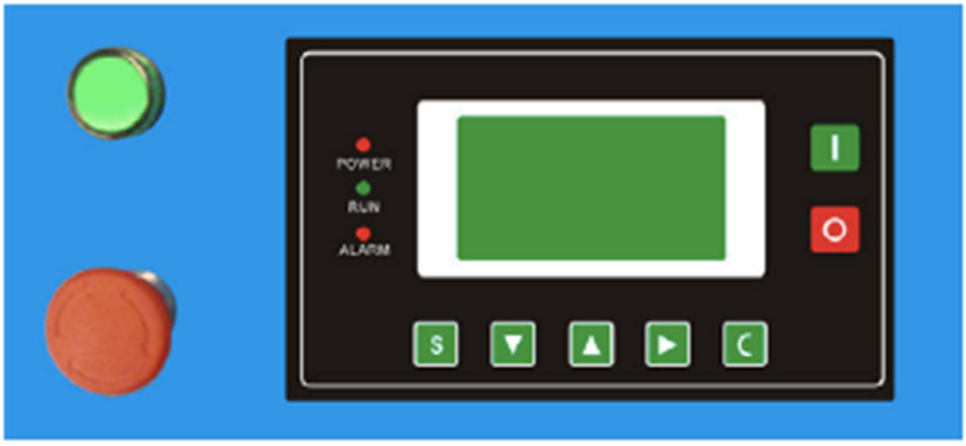


Figure: Compressor electronic display

Power LED This LED will light when the machine connects to the power.

E-stop Button Press this button only when the compressor has malfunction and the unit needs to be stopped in emergency.

Warning: Don't use this button to stop the compressor during normal operation.

CONTROLLER DISPLAY **ON CONTROLLER PANEL, THERE ARE 7 KEYS:**

, functions are as follows:

Start button for compressor

Stop button for compressor

Enter button for set value or Load/unload button

Page down or Set bit –1

Page up or Set bit +1

Move button or Enter button for menu

Exit or Reset

ANNEXURE A: EQUIPMENT OPERATION

FILTRONtec ®	**APS Air Monitoring Equipment** Procedure	APS-FT-OP-AMS-A01

Purpose

The purpose of this procedure is to define the operating instructions for the Air Monitoring System within the APS.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.6 (Air Monitoring System) and 2.6.1 (APS Air Monitoring Systems) for the listing of Equipment relevant to this procedure.

Operating Procedures

- The measurement of the separation rates, air flow and air quality is monitored by the Air Monitoring Equipment Cabinets located before and after the APS and a weather station (Temperature, Relative Humidity and Pressure) between the ESP and DeNO^2 Filters.
- The Control System monitors the Air Monitoring Equipment and stores data gathered for analysis.
- The Air Quality Monitoring Systems are designed to operate unattended for extended periods of time. The daily calibration checks are fully automated and there are alarms provided to the plant operators that will indicate whether there are any problems with any of the monitoring systems that may need attention. Failures of instruments are rare and unpredictable in nature.
- The gas analyser includes full local annunciation of alarms and descriptions of the fault on the front panels of the instrument, which can lead the service engineer through a fault-finding activity with reference to the instruments manual.
- Similarly the dust monitor includes local annunciation of alarms and fault description on the touch display
- If the cabinets have been shut down for any reason the following procedure will enable reactivation.

  System Start Up Procedure

  (i)Turn Main Switch ↑ (ON). Surge Protection green light should come on.
  (ii) Circuit Breaker ‘Power’ – Mains filter ↑ (ON).
  (iii) Circuit Breaker ‘Air conditioner’ - ↑ (ON). Wait 10 seconds until Air conditioner powers up.
  (iv) Circuit Breaker ‘Power 1’ – Analysers and Calibrator ↑ ON).
  (v) Circuit Breaker ‘Power 2’ – Zero Air Transformer ↑ (ZAG), 24 V Power Supply + ADAM,
  Further operation information is available in O&M Vol 7 Vendor Data Section 17.9 System Overview

Purpose

The purpose of this procedure is to define the operating instructions for the APS PLC Control System.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Devices covered by the APS PLC Control System include:

- APS PLC

Refer to Volume 2 Section 2.8.7 (APS PLC Control System) for the listing of Equipment relevant to this procedure

Operating Procedures

The following procedure provides general guidelines for the operation the APS MCB Safety Circuit.

Normal Operation

In accordance with PS37.4(2) and PS37.17(1)(i) the APS is started and shut down upon remote command from the CCMS. The APS is able to run fully automatically once activated without manning requirement. Furthermore, local control is provided to override the remote control via CCMS. Interlocks are included in accordance with PS37 as detailed below.

Operation of each protocol with detailed screen shots are contained within the APS PLC operations manual.

Failure or Action	Interlock
Ventilation Fans do not start and/or APS isolation dampers do not open	HV units start. If the timer of the HV unit reaches 10 minutes and no ventilation fa start and damper open signal are receiv the power HV transformers for collector and ioniser will be switched off.
Tunnel Ventilation Fans close during normal operation	APS sequence is stopped
Dirty Water Tank at a high level	Sump pumps is switched off
Dirty Water Tank at a low level	Water recycling plant is switched off
Clear Water Tank at a low level	Wash pumps are switched off
Clear Water Tank at a high level	Water recycling plant is switched off
Sump pit at a high level and Effluent Storage Tank is not at a high level	Sump pumps are switched on.
Sump pit is at a low level	Sump pumps are switched off.
Sump pit is at a high high level	No wash down sequence is possible.
Roller curtains are open	No wash down sequence is possible
Roller curtains are closed	No HV power supply is possible and the

	ventilation fans cannot start.
HV safety fence door is open	APS sequence cannot start or is stopped
Air pressure in air receiver falls below a pre-set minimum pressure level	Compressor starts
Air pressure in the air receiver reaches the pre-set maximum pressure level	Compressor stops
APS chamber doors are open	HV power to the ESP is switched off (Provision for authorised personnel to override this control via keyed lock)
Fire alarm from CCMS	APS sequence cannot start or is stopped
Tunnel Ventilation fans start during wash down sequence operation	The wash down sequence is stopped.
Abnormally high measurements of NO_2 concentration, particulates concentration or temperature	The APS stops and an alarm sent to CCMS.
Failure of ESP	APS control system to switch off the HV transformers and send an alarm to alert the operator.

FILTRONtec ®	**Activated Carbon** Procedure	APS-FT-OP-DS-A01

Purpose

The purpose of this procedure is to define the operating instructions for the Activated Carbon.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.4.1 (Activated Carbon) for the listing of Equipment relevant to this procedure.

Operating Procedures

- Activated Carbon operates as required to provide the required medium for the adsorption of NO_2 and other gaseous compounds found in the air stream.
- The APS PLC Control System does not monitor nor control the activated carbon.
- The Air Monitoring system will monitor the inlet and outlet levels of NO_2 and provide a separation rate. The activated carbon is no longer operating to its design requirements if the adsorption rate drops below 85%.
- The Air Monitoring Stations measure the inlet and outlet pressure levels and provide a differentiation rate. The activated carbon is no longer operating to its design requirements if the pressure drop across the $DeNO_2$ filter exceeds 650Pa.
- Replacement is undertaken as part of the maintenance standards and procedures contained in Volume 4 Maintenance, APS-FT-DS-MP-001 Activated carbon Inspection/Maintenance Procedure.

FILTRONtec ®	**Carbon Containment Walls & Access Platforms** Procedure	APS-FT-OP-DS-A02

Purpose

The purpose of this procedure is to define the operating instructions for the Carbon Containment Walls and Access Platforms

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.4.2 (Carbon Containment Walls and Access Platforms) for the listing of Equipment relevant to this procedure.

Operating Procedures

- Activated Carbon Containment Walls operate as required to provide the structural support and containment to the Activated Carbon.
- The Access Platforms operate to allow safe access to the top of the carbon containment walls for inspection and loading/unloading operations.
- The Carbon Containment Walls and Access Platforms are both static structures.

FILTRONtec ®	**$DeNO_2$ Cover Sheets** Procedure	APS-FT-OP-DS-A03

Purpose

The purpose of this procedure is to define the operating instructions for the $DeNO_2$ Pressure Wall.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.4.6 ($DeNO_2$ Pressure Wall) for the listing of Equipment relevant to this procedure.

Operating Procedures

- $DeNO_2$ Pressure Wall provides a barrier preventing air bypassing the $DeNO_2$ System in .
- The $DeNO_2$ Pressure Wall is a static structure.

FILTRONtec ®	**Carbon Handling Equipment** Procedure	APS-FT-OP-DS-A04

Purpose

The purpose of this procedure is to define the operating instructions for the Carbon Handling Equipment.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

The system used for replacement of activated carbon includes a hoist on a monorail with low headroom, conveyor belts, a pneumatic conveyor, a vacuum cleaner and a lifting table. Refer to Volume 2 Section 2.4.2 (Carbon Handling Equipment) for the listing of Equipment relevant to this procedure.

Operating Procedures

- The **hoist** is electrically operated with handheld controls for lifting and movement along the monorail.
- The **lifting table** is an electric/hydraulic scissor lift device for lifting carbon container bins to from platform to top of carbon containment wall.
- **Elevator conveyors** are positioned for the lifting carbon to the carbon containment wall and are electrically operated motor driven devices. The high elevator is fitted with a variable speed controller to ensure safe loading to the 6m heights.
- A **pneumatic conveyor** is an electrically operated pump for the transfer of carbon pellets from carbon containment walls to supabags using an airstream and is connected to the 3-phase 380V AC 65Amp power outlet inside the outlet plenum
- **Carbon loading hopper** is a steel hopper capable of storing 1.3m3 carbon pellets and a hand slide at the base operates and controls the loading into supabags (unloading procedure) and flow onto the elevator conveyors (loading procedure)
- **Flexible hoses** are used during unloading to transfer dust from the carbon hopper to the water filled sump.
- **Disposable G4 fabric filter** is installed downstream of the carbon filter on a steel frame immediately before silencers or dampers when the TVS is used to move dust away from the filter during carbon replacement
- An **electric vacuum cleaner** is used to clean spillage material.
- The carbon handling equipment form part of the Carbon Replacement Procedure (Refer APS-FT-DS-MP-003) and operate independently of the APS PLC.

FILTRONtec ®	**Electrical Panels** Procedure	APS-FT-OP-ES-A01

Purpose

The purpose of this procedure is to define the operating instructions for the electrical system.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.12 (Electrical System) for the listing of Equipment relevant to this procedure.

Operating Procedures

The following procedure provides general guidelines for operating the electrical boards/Panels.

- Electrical boards operate as required to provide the distributed power through the filtration system
- These include: MCB/MCCB, LMCP; PLC Panel; HV Transformer Control Cabinet; Compressor and Water Recycling Plant subsystems.
- Local Operation: There are no specific operating procedures for these Electrical boards and Panel.
    - Where local operation of a electrical board is necessary, selection of the appropriate selector switch and depression of the particular controls will activate/deactivate the equipment associated with the controls.
    - **Where such local operation is required, the operator is advised that interlocks between the associated components are not available and as such, care must be taken when operating the equipment under this local mode of operation.**

FILTRONtec ®	**APS Safety Circuit** Procedure	APS-FT-OP-ES-A02

Purpose

The purpose of this procedure is to define the operating instructions for the APS Safety Circuits.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Devices covered by the Safety Circuit include:

- E-Stops on equipment and inside the inlet plenum to the ESP
- RP7 Doors to APS area – Safety Switch
- Door to HVT enclosure – Safety Switch

Refer to Volume 2 Section 2.7.5 (APS Safety Circuit) for the listing of Equipment relevant to this procedure

In addition the Fire Alarm Indicator Panel will send a signal to the APS PLC to shutdown in the event of a fire being detected in the CWB Tunnel or ventilation buildings.

Operating Procedures

The following procedure provides general guidelines for the operation the APS MCB Safety Circuit.

- The application of an E-Stop or opening of a protected door when the plant is operating will automatically shut the plant and the APS PLC will close down all operating systems in accordance with the shutdown sequence.
- Once the issue has been rectified resetting the E-Stop or closing the door can reengage the Safety Circuit.
- Note: Activation of the Safety Circuit will automatically shut the plant down.

FILTRONtec ®	**Roughing Filter** Procedure	APS-FT-OP-ESP-A01

Purpose

The purpose of this procedure is to define the operating instructions for the Roughing Filter.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.2.1 Roughing Filter for the listing of Equipment relevant to this procedure.

Operating Procedures

- Roughing Filter is a stainless steel mesh and frame positioned in the inlet of the APS plenum prior to the ESP Filter.
- The purpose of the Roughing Filter is to filter out any debris that is larger than 50mm x 50mm preventing such items reaching the electrified filter arrays.
- The Roughing Filter should have any debris caught on it removed to ensure that it does not pass through and reach the electrified filters.
- The Roughing Filter has a lockable door for entry into the ESP Filter zone of the APS plenum
- The Roughing Filter is a static structure.

FILTRONtec ®	**Electrostatic Precipitator** Procedure	APS-FT-OP-ESP-A02

Purpose

The purpose of this procedure is to define the operating instructions for the Electrostatic Precipitator (ESP).

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.2.3 Electrostatic Precipitator for the listing of Equipment relevant to this procedure.

Operating Procedures

- ESP operates as required to provide the required particle ionisation and collection to separate the particles measuring to PM_{10}, from the tunnel airflow passing through the filter.
- The ESP Filter assembly in itself is a static structure and is only operated by energy from the High Voltage Transformer.
- The Control System monitors/controls the HV Transformers (refer APS-FT-OP-HVG-A01), which provide a voltage of up to 16V to the ionising plates and up to 7kV to the collection plates within the ESP.

FILTRONtec ®	**High Voltage Rectifier Transformer Equipment** Procedure	APS-FT-OP-ESP-A03

Purpose

The purpose of this procedure is to define the operating instructions for the High Voltage Rectifier Transformers.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.2.4 (High Voltage Transformer Equipment) for the listing of Equipment relevant to this procedure.

Operating Procedures

- High Voltage Rectifier Transformers operate as required to provide the high voltage to the ESPs
- The HV DC Transformers are monitored and controlled by the APS PLC Control System.
- The operator, via the PLC, can select these controlled Transformers for either Remote Manual or Remote Automatic operation.
- In Automatic mode, the control system will have control of the Transformers as part of the Filter System start up operation sequence.
- In Remote Manual mode, the operator will have control of the Transformers, that is, the operator can force the HV Transformers to be energised, and however the system will only allow this to occur when the Main Fans are operating.
- During Maintenance or System Testing the HV Transformers can be manually operated from the HV Transformer Control Panel when the selector switch on the HV Transformer panel is set accordingly (testing purposes) refer Vol 7 Annexes, Vendor Data, Section 1.0 High Voltage Transformer Item 1.1 HV Control Unit 835 Manual.

  WARNING – THE ESP FILTER ROOM (ESP MODULE ARRAYS) MUST BE CLEAR OF PERSONNEL AND EARTHING KITS REMOVED PRIOR TO MANUAL OPERATION OF HIGH VOLTAGE TRANSFORMER EQUIPMENT.

- Refer to Volume 3 Operations, Section 12, subsection 3.11.9 (HV Transformers) for information relating to operation of the HV Transformers.

FILTRONtec ®	**Guide Vanes** Procedure	APS-FT-OP-ESP-A04

Purpose

The purpose of this procedure is to define the operating instructions for the Guide Vanes.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 5 Book 2 Section 2.2.2 Guide Vanes for the listing of Equipment relevant to this procedure.

Operating Procedures

- Guide Vanes are galvanised steel flat sheet, straight and curved, supported and braced by galvanised structural steel sections positioned in the inlet of the APS plenum prior to the ESP Filter.
- The purpose of the Guide Vanes is direct the an even airflow onto the surface of the ESP filter.
- The Guide Vanes are static structures.

FILTRONtec ®	**HVT Safety Fence & Gate** Procedure	APS-FT-OP-ESP-A05

Purpose

The purpose of this procedure is to define the operating instructions for the Guide Vanes.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 5 Book 2 Section 2.2.2 Guide Vanes for the listing of Equipment relevant to this procedure.

Operating Procedures

- Guide Vanes are galvanised steel flat sheet, straight and curved, supported and braced by galvanised structural steel sections positioned in the inlet of the APS plenum prior to the ESP Filter.
- The purpose of the Guide Vanes is direct the an even airflow onto the surface of the ESP filter.
- The Guide Vanes are static structures.

FILTRONtec ®	**Rinsing Pipes & Nozzles** Procedure	APS-FT-OP-WDS-A01

Purpose

The purpose of this procedure is to define the operating instructions for the Rinsing Pipes and Nozzles

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.3.1 (Rinsing Pipes & Nozzles) and 2.3.6 (Piping) for the listing of Equipment relevant to this procedure.

Operating Procedures

- The Rinsing Pipes and Nozzles are provided to rinse-off built up particulate matter from the ESP.
- The Rinsing pipes and nozzles are a static structure.
- The APS PLC controls the operation of rinsing via a command that activates the clear water pump. (Refer to APS Control System Operation & Maintenance Manual APS-FT-OP-PLC-A01 in Section 12 of this Volume)

FILTRONtec ®	**Collection Drain and Sump** Procedure	APS-FT-OP-WDS-A02

Purpose

The purpose of this procedure is to define the operating instructions for the Collection Drain and Sump

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.3.2 (Collection Drain and Sump) for the listing of Equipment relevant to this procedure.

Operating Procedures

- The Collection Drain and Sump are provided to capture and store the wash down water from the rinsing process.
- The Collection Drain and Sump are static structures.

FILTRONtec ®	**Piping** Procedure	APS-FT-OP-WDS-A03

Purpose

The purpose of this procedure is to define the operating instructions for the Piping.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.3.1 (Rinsing Pipes & Nozzles) and 2.3.6 (Piping) for the listing of Equipment relevant to this procedure.

Operating Procedures

- Piping is provided to transfer air and water throughout the Wash Down System.
- The piping is a static structure.

FILTRONtec ®	**Pumps** Procedure	APS-FT-OP-WDS-A04

Purpose

The purpose of this procedure is to define the operating instructions for the Pumps.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.3.3 (Sump Pumps) and 2.3.4 (Clean Water Pumps) for the listing of Equipment relevant to this procedure.

Operating Procedures

- Sump Pumps operate as required to remove water collected in the sump from the rinsing operation.
- Clear Water Pumps are provided to transfer water from the Clear Water Tank to spray the ESPs during the rinsing operation
- Pumps operation is monitored/controlled by the APS PLC Control System.

  The control of the pump equipment can be selected for either Remote/Off/Run Automatic via a switch in the APS PLC.
- The operator is able to select and operate the pumps when the switch is in the Remote position.
- RUN is selected within the APS PLC when the pump is under Maintenance Control.
- Pumps can be electrically isolated nearby the pump for maintenance purposes only.
- Both the Sump and Clear Water pumps are provided in a duty/standby configuration. The Control System will select the pump to operate according to a 1/3 vs. 2/3 selection scheme for the operation time provided the pump has not exceeded the maximum number of starts per hour (nominally four).
- Pump operation is monitored and controlled by level sensors (Low Low/Low, High/High High) that monitor the depth of water present in the sump or holding tanks. Alarms will be raised when each level is reached.
- Refer to Section 3.9 (Modes of Operation) and 4.2.3 (Rinsing Sequence) of the Control System Operation & Maintenance Manual for information relating to operation of the Pumps.

FILTRONtec ®	**Actuator Valves** Procedure	APS-FT-OP-WDS-A05

Purpose

The purpose of this procedure is to define the operating instructions for the Valves.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.3.7 (Valves) for the listing of Equipment relevant to this procedure.

Operating Procedures

- Actuator Valves operate as required to provide the required direction and operation of air and water flow throughout the Wash Down System.
- All Actuator Valves have an automatic operation facility via the provision of an actuator. Operation is by the APS PLC Control System, the actuator/valve is operated to divert the air/water throughout the Wash Down System.
- Actuator Valve operation is monitored/controlled by the APS PLC Control System.
- The operator, via the APS PLC, can select this controlled equipment for either Remote Manual/Remote Automatic operation.
- Local/Remote can be selected at the individual valves when under Maintenance Control, allowing for the valves to be manually operated by turning the associated hand wheels to open/close the valve as required.
- Refer to Vol 3 Section 3.9 (Modes of Operation) and 4.2.3 (Rinsing Sequence) of the APS Control System Operation & Maintenance Manual in Section 12 of this Volume 5 for information relating to operation of the Valves.
- To perform a Manual Operation of the Rinsing Operation is possible at anytime by first stopping the plant, then selecting Rinsing Sequence, Remote Manual, and selecting Start. It is also possible to vary the cleaning time, drying time, number of cleaning and drying cycles.

FILTRONtec ®	**Tanks** Procedure	APS-FT-OP-WDS-A06

Purpose

The purpose of this procedure is to define the operating instructions for the Tanks.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.3.8 (Tanks) for the listing of Equipment relevant to this procedure.

Operating Procedures

- Tanks are provided to hold Clear Water ready for use in the Rinsing System and to collect wastewater pumped by the sump pump at the conclusion of the rinsing sequence.
- The Control System will automatically fill the tanks and discharge water and wastewater from the tanks.
- The Tanks are static structures.

FILTRONtec ®	**Air Compressor and Receiver** Procedure	APS-FT-OP-WDS-A07

Purpose

The purpose of this procedure is to define the operating instructions for the Air Compressor and Receiver.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.3.9 (Air Compressor and Receiver) for the listing of Equipment relevant to this procedure.

Operating Procedures

- Air Compressor and Receiver operate as required to provide the required volume of air used in the rinsing system, Water Recycling Plant and air operated sludge pump.
- The compressor can be selected for either remote or local operation via the compressor panel.
- The APS PLC Control System will monitor and control the compressor in remote mode, however the air compressor and receiver will operate independently to provide and store sufficient compressed air in readiness for the next rinsing operation.
- In local mode, the first switch on of the compressor will activate the automatic operation that turns the compressor on and off automatically according to the specified pressure band level.
- Reference O&M Vol 5 Book 6 Vendor Data, Section 7 Compressor, 7.2 Instruction Manual for manual starting procedure.

Step	Action
-	Switch on the voltage. Check that voltage on LED (6) lights up.
-	Open the air outlet valve.
-	Close the condensate drain valve (Dm).
-	Press start button (1) on the control panel. The compressor starts running and the automatic opera LED (8) lights up. Ten seconds after starting, the drive motor switches over from star to delta and compressor starts running loaded.

- Note: The Running Loaded status is met when the pressure in the air receiver is lower than the specified lower level.

Purpose

The purpose of this procedure is to define the operating instructions for the Water Recycling Plant.

Distribution

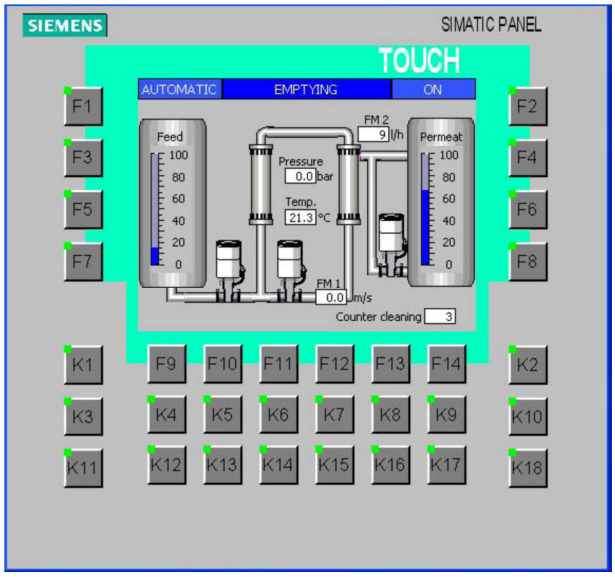
Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.3.10 (Water Recycling) for the listing of Equipment relevant to this procedure.

Operating Procedures

- Water Recycling Plant operates as required to provide the required separation of particles from the wash down water.
- The APS PLC Control System will monitor/control the Water Recycling Plant, but it is capable of running at any time on demand in parallel with the APS.
- The Water Recycling has its own PLC operating system (refer to O&M Vol 7 Vendor Data Section 10 Water Recycling, 10.4 Instruction Manual).



- For initial operation, or following a switch-off phase, it is necessary to start the plant manually. As a result of this, the signal for the main PLC of the entire plant is first released.
  In order to start the plant for the first time, select the automatic mode on the display.
  Press "Next" repeatedly until "Fill" is indicated in the display above.
  Press "Start".
  The plant now goes into automatic cycle with the selected setting-adjustments.
  After this, the plant waits for the next start signal from the PLC.
- Refer to O&M Vol 5 Book 6 Annexes, Vendor Data Section 10, item 10.4 “Operating Instructions for Water Recycling Plant”

FILTRONtec ®	**Sludge Pump and Filter Regulator** Procedure	APS-FT-OP-WDS-A09

Purpose

The purpose of this procedure is to define the operating instructions for the sludge pump and filter regulator.

Distribution

Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.3.11 (Sludge Pump) for the listing of Equipment relevant to this procedure.

Operating Procedures

- The Sludge Pump is an air operated pump.
- The Filter Regulator regulates the pressure of the compressed air into the sludge pump motor and has a condensate reciprocal
- A signal/alarm is transferred to the PLC and CCMS from the Water Recycling Plant conductivity sensor once the water quality (turbidity) reaches a set limit (set point is set during performance testing after the tunnel is open to traffic).
- Maintenance staff opens the valve adjacent the pump to allow compressed air to operate the sludge pump.
- Maintenance staff empty the condensate from the Filter Regulator
- Once the flow has ceased the valve is shut and the sludge pump stops.
- The activation of the sludge pump is independent of the Wash Down System.
- Maintenance requirements are outlined in Volume 4 Maintenance, APS-FT-WDS-MP-009 Sludge Pump Inspection/Maintenance Procedure.

FILTRONtec ®	**Automatic Roller Screen** Procedure	APS-FLT-OP-WDS-A10

Purpose

The purpose of this procedure is to define the operating instructions for the Roller Screens.

Distribution

Maintenance Personnel
Air Filtration Control Room Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

Equipment Locations

Refer to Volume 2 Section 2.2.10 (Automatic Roller Screen) for the listing of Equipment relevant to this procedure.

Operating Procedures

- The Automatic Roller Screens operate to provide isolation between the ESP Filter and the $DeNO_2$ Filter during the ESP Filter washdown sequence.
- Roller Screens operate in defined sequence with the ESP washdown sequence to prevent water and air to neither pass through nor permit the passage of air through to the $DeNO_2$ Filter.
- The APS PLC Control System governs automatic Roller Screens operation.
- The operator via the APS PLC can select these controlled screens for either Remote Manual or Remote Automatic operation.
- In Automatic mode, the APS PLC control system will have control of the screens. In Manual mode, the operator will have control of the screens but they are interlocked to the washdown operation such that they are only available for manual control when the Fans are not running.

  THE ROLLER SCREENS MUST BE OPEN AND KEPT OPEN WHEN FANS ARE RUNNING

- If the roller screens are in local mode, the up/down buttons at the access door or a manual chain to open/close the screens as required can manually operate the doors. They must always be returned to the close position after manual operation (Maintenance only).
- Refer to Vol 3 Operations Section 12 Sub Sections 3.9 (Modes of Operation) for information relating to operation of the Automatic Roller Screens.