Central – Wan Chai Bypass

and Island Eastern Corridor Link

Air Quality Monitoring Plan

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

(Revision 1)

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Air Quality Monitoring Plan

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

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/C (hereafter referred as "the OEP"), for the operation phase of the CWB tunnel was issued on 22 April 2020. 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, MVB 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), including Air Monitoring Stations (AMS)] is a system dedicated to remove dust particles and NO_2 in the exhaust airstream of vehicle tunnels. The APS consists 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 is installed for gas adsorption to remove NO_2.

3. Monitoring Equipment, Methodology and Locations

3.1 The monitoring of the APS efficiency and operation effectiveness 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 a NO_2 concentration measuring equipment such as 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 a PM_{10} concentration measuring equipment such as 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.

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

4.1 In accordance with the design standard / criteria, the 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 In accordance with the design standard / criteria, the 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.

5. Criteria for Non-compliance

5.1 Removal efficiency (%) will be continually recorded with each taken at a 5-minute interval. Non-compliance occurs when 6 consecutive of 5-minute removal efficiency (%) exceedances of PM_{10} or NO_2 criteria listed in Section 4 are recorded at any pairs of the monitoring stations at WVB, MVB and / or EVB. Should there be any non-compliance recorded in any pairs of the monitoring stations at WVB, MVB and / or EVB, actions in accordance with the Event / Action Plan shall be carried out. Regarding the updated mechanism for communication and reporting, the Central Control and Monitoring System (CCMS) will alert the Operator at the Administration Building (ADB) when there is exceedance recorded. The Operator shall 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 reference.

The proposed criteria for non-compliance had been agreed by the supplier of APS.

Exceedance Criteria	Number of Consecutive 5-minute Removal Efficiency Exceedances
*Removal efficiency of PM_{10} of not less than 80% / outlet concentration not greater than 0.1 mg/m^3	6
** Removal efficiency of NO_2 of not less than 80% / outlet concentration not greater than 0.05ppm	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.

It should be noted that the criteria for non-compliance are not applicable during the daily maintenance period from 01:00hrs to 06:00hrs and scheduled 24 hours for maintenance at extreme height, when APS and Tunnel Ventilation System (TVS) need to be switched off for regular maintenance / inspection or when any other works, which require the shutting down of the Tunnel Ventilation Fans (TVFs) (such as works on dampers, AMS, water seepage, other works inside plenum, etc.), need to be conducted, regardless of whether the tunnel was opened to traffic. For details please refer to Section 6.5

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 manual input 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 bi-daily in order to maintain the RSP removal efficiency. ESP washdown work will be carried out bi-daily automatically during the switch off period of APS and TVS from 01:00am to 06:00am. 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-NO_2 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 NO_2 removal efficiency.

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

Component	Description	Estimated Design Life
TVS	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 and maintenance. The measures will be detailed in Section 7 below.

6.5 In order to maintain the proper functioning of the APS and TVS, the APS and TVS may need to be switched off from 01:00hrs to 06:00hrs or 24 hours, regardless of whether the tunnel was opened to traffic, for regular maintenance / inspection. Note that the requirements for removal efficiency, in-tunnel air quality and zero portal emission should be exempted from Sections 5.1, 8.1 and Condition 2.6 of EP-482/2013/C during daily maintenance and scheduled 24 hours maintenance at extreme height.

The replacement of activated carbon in the carbon walls of each APS will take multiple nights 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. For the comprehensive inspection / maintenance frequencies for all equipment, please refer to O&M Manual.

Major APS Components	Inspection / maintenance Frequencies
Air Monitoring Stations (including PM_{10} monitors & NO_2 sensors)	Biweekly
Water Pumps and compressors for ESP	Monthly
Roughing Filters for ESP	Monthly
Damper for APS	Quarterly
Level sensors	Monthly
Inspection of Fullness of Carbon Containment Wall	Monthly
Air receivers	Quarterly
Water tanks	Quarterly
Piping	Quarterly
APS Control Panel	Quarterly
Activated carbon boxes	Quarterly
Electric cables	Half-yearly
Electrical equipment of APS	Yearly
Deozonizer of the NO_x monitor	Yearly
Replacement of Activated Carbon	2 to 3 years or earlier when required

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.

The followings are the regular inspection/ maintenance of TVF: Non-instruments regular checks will be done monthly. These checks consist of the start-up and a visual and noise check. Regular checks with instruments shall be carried out every 6 months, including vibration levels check, cleaning the fan surface, inspection of the motor, inspection of the impeller, inspection of inside and outside of the fan, check of vibration sensor, temperature and heating sensors, inspection of wiring and connection box, and checking of gap between blades and housing. The Operator will carry out the regular inspection/maintenance of TVFs according to the O&M Manual.

6.6 There are a total number of four emergency generators, each installed at WVB, MVB, EVB and ADB, respectively that provide emergency power supply for fire services installations, tunnel lighting and other essential E&M equipment during emergency situations. According to the Code of Practice for Minimum Fire Services Installations and Equipment and Inspection, Testing and Maintenance of Installations and Equipment issued by Fire Services Department, the emergency generators shall be maintained in efficient working order at all times, and all units should be run once per month or should be conducted after completion of any corrective maintenance under load conditions for a period of not less than 30 minutes by the owner or his agent. During this running period all operating conditions of the emergency generators should be checked. Following this running period functional tests should be carried out on all automatic and manual starting devices and safety controls.

Since the on-load test of each generator involves changeover from normal power supply of HKE to generator power supply, in case of unexpected failure, there may be black-out of partial tunnel lighting and shut down of essential E&M equipment. Hence, the test should be conducted during daytime on Saturday, Sunday or Public Holiday to minimize the chances of impact on the tunnel operation. The test for each emergency generator will last for around two hours each. The associated APS and TVS will be switched off during the test for around one hour for the changeover of power supply. To minimize the air quality impact, non-peak hours of traffics will be arranged to conduct the test. The test will also be conducted at each ventilation building or ADB separately one after another. The Operator is required to notify ET and IEC at least three working days before the commencement of the test. The APS and TVS will then resume to normal operation under Auto Mode once the

test is completed. In case of failure in restarting the systems, Section 3.3 of the Contingency Plan should be implemented.

Note that the requirements for removal efficiency, in-tunnel air quality and zero portal emission should be exempted from Sections 5.1, 8.1 and Condition 2.6 of EP-482/2013/C during the on-load tests of emergency generators, when relevant APS and TVS need to be switched off.

6.7 There are high voltage (HV) and low voltage (LV) switchboards installed at WVB, MVB, EVB and ADB, which provide power supply to all tunnel E&M systems. According to Cap. 406 Electricity (Wiring) Regulations issued by Electrical and Mechanical Services Department, Periodic Inspection, Testing and Certification (PITC) for HV installation and LV installation shall be carried out at least once every 12 months and 5 years respectively.

Since the PITC works involve changeover of power supply, in case of unexpected failure, there may be black-out of tunnel lighting and shut down of essential equipment. Hence, the works should be conducted during daytime on Saturday, Sunday or Public Holiday to minimize the chances of impact on the tunnel operation. The works will last for around twelve hours each. The associated APS and TVS will be switched off during the works for around one hour for the changeover of power supply. To minimize the air quality impact, non-peak hours of traffics will be arranged to conduct the works. The works will also be conducted at each ventilation building or ADB separately one after another. The Operator is required to notify ET and IEC at least three working days before the commencement of the works. The APS and TVS will then resume to normal operation under Auto Mode once the works are completed. In case of failure in restarting the systems, Section 3.3 of the Contingency Plan should be implemented.

Note that the requirements for removal efficiency, in-tunnel air quality and zero portal emission should be exempted from Sections 5.1, 8.1 and Condition 2.6 of EP-482/2013/C during the HV and LV tests, when relevant APS and TVS need to be switched off.

6.8 The Operator shall submit application or notice to EPD at least 48 hours in advance for any ad hoc maintenance works which would result in suspension of TVS or APS other than the daily maintenance period from 01:00hrs to 06:00hrs and scheduled 24 hours for maintenance at extreme height. The application shall clearly indicate the duration of maintenance works.

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 APS or TVS.

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 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 E&M equipment, excluding APS and associated TVFs system, in case one of the power supply source is failed.
ii) Standby TVFs

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: MVB-APS-003 serving EB main tunnel / MVB-APS-004 serving Slip Road 1:	 2 duty / 1 duty and 1 common standby 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 will be kept in stock to ensure that they are in readiness for operation and maintenance.

System	Description	Unit	Quantity
Washdown system	Pipe fittings	nos.	60
	Norminal Diameter 50 Stainless Steel Pipe	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 Insulator	nos.	9
Pneumatic System	Compressor Solenoid Valve	nos.	3
	Compressor spare part set	nos.	3
De-NO_2 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	nos.	3
	Ceramic Membranes – 800nm, 25mm, 19 channels, 12000mm 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 Control Panel	set	1
Air Monitoring Station	Slime Line 19” Cabinet Varistar	nos.	1
	PM_{10} concentration measuring device	nos	1
	NO_2 concentration measuring device	nos	1
Tunnel Ventilation Fan	M16 × 90 bolts	nos.	385
	Washers Ø125	nos.	385
	M14 × 80 bolts	nos.	385
	Washers Ø125	nos.	385

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 APS or TVS will be brought to a practical minimum.

7.7 Detailed maintenance requirements are included in the O&M Manuals for reference.

8. In-tunnel Air Quality Monitoring

8.1 According to the Practice Note on Control of Air Pollution in Vehicle Tunnels, the concentrations of carbon monoxide, nitrogen dioxide and sulphur dioxide should be kept within the following concentration limits:

Air Pollutants	Averaging Time (minute)	(Maximum Concentration)	
		Micrograms per cubic meter ($\mu g/m^3$)	Part per million (ppm)
Carbon monoxide (CO)	5	115,000	100
Nitrogen dioxide (NO_2)	5	1,800	1
Sulphur dioxide	5	1,000	0.4

The visibility in tunnel is a gross indicator of the smoke concentration. The visibility should be monitored and controlled to a level equivalent to an extinction coefficient of 0.005 per metre or less during any 5-minute interval.

8.2 Air Quality Monitoring System (AQMS) sensors were installed at each kilometer section of the tunnel section of Central-Wan Chai Bypass to monitor the in-tunnel air quality.

For sensors that have triggering function to the operation of air extraction TVFs, in case the tunnel air velocity (TAV) at East portal and exits of Slip Road 1 and 3 met the conditions stated below (Condition for Level Up of Ventilation Level for Air Extraction TVFs), the number of operating TVFs would increase to facilitate the extraction of in-tunnel air to the APS for treatment before discharge to ensure the in-tunnel air quality would meet the requirements in the Practice Note on Control of Air Pollution in Vehicle Tunnels. Once the tunnel air velocity met the condition stated below (Condition for Level Down of Ventilation Level for Air Extraction TVFs), the number of operating TVFs would decrease accordingly.

Condition for Level Up of Ventilation Level for Air Extraction TVFs:
TAV > 0m/s towards portal (outward)

Condition for Level Down of Ventilation Level for Air Extraction TVFs:
TAV > 1m/s towards tunnel (inward)

For sensors that have triggering function to the operation of air supplying / extraction TVFs, in case the concentrations of CO, NO_2 or visibility met the conditions stated below (Conditions for Level Up of Ventilation Level for Air Supplying / Extraction TVFs), which is 80% of the respective maximum concentrations, the number of operating TVFs would increase to facilitate the air supply into / extraction from the tunnel to ensure the in-tunnel air quality would meet the requirements in the Practice Note on Control of Air Pollution in Vehicle Tunnels. Once the in-tunnel air quality met the conditions stated below (Conditions for Level Down of Ventilation Level for Air Supplying / Extraction TVFs), which is 40% of the respective maximum concentrations, the number of operating TVFs would decrease accordingly.

Conditions for Level Up of Ventilation Level for Air Supplying / Extraction TVFs :
CO > 80ppm OR NO_2 > 0.8ppm OR Visibility > 0.004/m

Conditions for Level Down of Ventilation Level for Air Supplying / Extraction TVFs:
CO < 40ppm AND NO_2 < 0.4ppm AND Visibility < 0.002/m

In order to protect the TVFs from frequent start / stop, the ventilation level can only be

changed when the sensor readings meet the level up / down condition for 15 minutes according to the TVF manufacturer's requirement. Please refer to Appendix 13 for details of the TVF control philosophy.

Any exceedance of in-tunnel air quality during when the level-up of ventilation level is in progress (i.e. the 15 minutes processing time as per manufacturer recommendation) should not be considered as a non-compliance of the Practice Note on Control of Air Pollution in Vehicles Tunnels.

8.3 As agreed by ET and IEC, sensor readings in the following cases were to be excluded and should not be taken into account against the non-compliance criteria of Practice Note on Control of Air Pollution in Vehicle Tunnels:

I) Data obtained within the tunnels during the daily maintenance period from 01:00hrs to 06:00hrs and scheduled 24 hours for maintenance at extreme height;
II) Data obtained within the tunnels during major tunnel equipment overhaul, repair, replacement and upgrading;
III) Data obtained from faulty sensors;
IV) Abnormal data in comparison with nearby sensors;
V) Abnormal data near portal due to external weather / environmental factors (e.g. rain, smog, etc.); and
VI) Data obtained from sensors at East Portal (E/B), Slip Road 1, 2 and 3 of which have no triggering function to the operation of TVFs under normal / congestion operation (uni-directional traffic), including EB-CO-05 to 08, EB-NO2-05 to 08, EB-VS-05 to 08, SR1-CO-01, SR1-NO2-01, SR1-VS-01, SR2-CO-01, SR2-NO2-01, SR2-VS-01, SR3-CO-01, SR3-NO2-01 and SR3-VS-01.

8.4 The Operator will send the results of monitoring to EPD once per month by email, instead of on a floppy disk as suggested in Section 2.11.6 of the EM&A Manual of the approved WDII&CWB EIA Report (Register No. AEIAR-125/2008) (updated in December 2010 under EP-364/2009/A). Section 2.11.6 of the EM&A Manual will be updated if needed.

The calibration of AQMS, such as the zero and span test for CO, NO_2 and visibility sensors would be conducted once a year according to the recommendation from the sensor manufacturer. Please refer to Appendix 14 for the checklist of maintenance and of AQMS from the manufacturer for reference.

8.5 In case there were abnormal readings (in comparison to neighboring sensors), sensor faults, etc., which lead to abnormal ventilation level up / down of the TVF operation, the Operator shall arrange inspection of the concerned sensor and rectify it as soon as possible. If the problem persists, the Operator may implement the manual adjustment of the ventilation level as per the following steps as an interim measure:

1. Switch the APS and TVS from Auto Mode to Manual Mode at CCMS (no change in the number of operating APS and TVFs at the CCMS shall be ensured and confirmed at the time of switching);
2. Make reference to the neighbouring sensors with normal readings for adjustment of ventilation level affected by the sensor with issue to an appropriate level (in case the readings of the neighbouring sensors were also abnormal, make reference to past records of in-tunnel sensors and / or traffic flow during the particular time period for the adjustment of ventilation level);
3. Switch the APS and TVS back to Auto Mode.

The number of operating APS and TVFs should automatically adjust according to the manual change in ventilation level. Note that the above interim measure is only a short-term measure as an attempt to address the abnormal ventilation level up / down issue (usually abnormally kept at the highest / lowest ventilation level, causing all or none TVFs to operate for a prolonged period). If the ventilation level returns to the abnormal level after the manual adjustment, the Operator should not repeat the abovementioned measure. The Operator should instead arrange rectification of the concerned sensor as soon as possible as a permanent measure.

For each time when the interim measure was implemented, the Operator should fill in the record form (see Appendix 15) to record all the actions taken and notify ET and IEC.

Contingency Plan

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

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/C (hereafter referred as "the OEP"), for the operation phase of the CWB tunnel was issued on 22 April 2020. 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, MVB 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 contingency plan. The contingency plan is to assist the Operator to restart the APS and Tunnel Ventilation System (TVS) as soon as practicable after emergency situations.

2. Emergency Situations

2.1 In the current design, the APS and their associated Tunnel Ventilation Fans (TVFs) 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 component causing malfunction of APS and / or TVS
iii) Failure of power supply, including one of the power supply sources is failed
iv) Flooding / water seepage at ventilation buildings, APS and / or TVS

In cases (i), (ii), (iii) and / or (iv) 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 responses to these emergency situations would be mentioned in the following section. The emergency response and the APS and TVS Operational Procedures enable the Operator to restart the APS and TVS as soon as practicable after above emergency situations. The APS and TVS Operation Procedures are attached in Appendix 12 for reference.

2.3 A list of recommended spare parts (refer to Section 7.5 of AQMP) is readily available for emergency repair of APS or TVS equipment in case of breakdown. The service downtime could be kept minimum with the spare parts available. Once any spare part is used, the Operator shall arrange procurement of the spare part as soon as possible to replenish the recommended quantity in the spare part list. In case any spare part is used up but again needed for further rectification works, a longer service downtime is expected and the exact extent is subject to the availability of the particular spare part in the market.

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 APS and TVFs as soon as practicable after the fire incident:

1. Operator to inform Fire Service Department (FSD), Environmental Protection Department (EPD), Transport Department (TD), EMSD, HyD, ET and IEC of the fire incident;
2. Assigned person of the Operator to activate e-mode and 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 APS and TVS equipment are undamaged in the incident;
5. If there is no damaged APS and TVS equipment, Operator to switch APS and TVS to auto mode and start up the APS and TVS according to the APS and TVS Operational Procedures;
6. If there are damaged APS and TVS equipment, Operator to repair the equipment and start up the system according to Section 3.2 of Contingency Plan.

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 APS and / or TVS, the Operator will follow the procedures below to start up APS and TVFs as soon as practicable:

1. Operator to inform EPD, TD, EMSD, HyD, ET and IEC;
2. Operator to conduct inspection and identify the root cause of the breakdown;

3. Operator to check if there are spare parts 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 and TVS according to the APS and TVS 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 APS and TVFs, the Operator will follow the procedures below to start up APS and TVFs as soon as practicable:

1. HKE has two power supply sources (Source A and Source B) for each ventilation building;
2. When either one power supply source fails to supply electricity to any ventilation building, HKE power supply will automatically switch to another power supply source to supply electricity to the respective ventilation building;
3. If the switch-over of power supply source is successful,
   a. For APS and TVFs that were not in operation before the switch-over, they will resume to normal operation automatically;
   b. For APS and TVFs that were in operation before the switch-over, Operator to conduct inspection to reset the equipment faults resulted from the power failure in order for the equipment to resume to normal operation in automatic mode;
4. If the switch-over of power supply source fails, Operator to inform HKE, EPD, TD, EMSD, HyD, ET and IEC on the suspension of power supply and await the resumption of power supply by HKE;
5. When the power is resumed, Operator to follow Step 3;
6. For power failure caused by tunnel power distribution system component breakdown, Operator to repair the component and start up the system according to Section 3.2 of Contingency Plan.

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

3.4 When there is flooding / water seepage causing suspension of operation of APS and TVFs, the Operator will follow the procedures below to start up APS and TVFs as soon as practicable:

1. Operator to conduct inspection and identify the extent of flooding / water seepage and to decide whether stoppage of APS and TVFs is necessary;
2. Operator to inform EPD, TD, EMSD, HyD, ET and IEC of the flooding / water seepage incident if stoppage of APS and TVFs is necessary;
3. Operator to provide water pumps to pump out the water to avoid potential / further damage to equipment
4. Operator to check and confirm if all APS and TVS equipment are undamaged in the incident;
5. If there is no damaged APS and TVS equipment, Operator to switch APS and TVS to auto mode and start up the APS and TVS according to the APS and TVS Operational Procedures;
6. If there are damaged APS and TVS equipment, Operator to repair the equipment and start up the system according to Section 3.2 of Contingency Plan.

The emergency flowchart for flooding / water seepage incident is attached in Appendix 11 for reference.

3.5 In the event of breakdown of all the APS/TVFs and/or other emergency situations such as major system failure, power supply failure, fire incident and flooding / water seepage incident, implementing an additional air quality monitoring at the affected area of the tunnel portal and nearby air sensitive receivers would be considered by the Permit Holder, subject to the extent of damages to the APS/TVFs, the anticipated duration of the equipment breakdown and/or emergency situations and discussion with EPD.

If additional air quality monitoring is required, the selected monitoring locations, shall be able to represent the worst affected air sensitive receiver during the event of APS/TVFs breakdown. For reference and subject to the agreement from the owner of the premises, some of the possible locations of the additional monitoring are as below and the corresponding layout plans are attached in Appendix 16. The exact monitoring locations shall be reviewed and approved by EPD on case by case basis.

Breakdown of APS / TVFs	**Proposed Additional Air Quality Monitoring Locations**	
	In-tunnel Air Quality	**Nearby Air Sensitive Receiver (ASR)**
WVB-APS-001 and associated TVFs	West Portal	IFC 3/F podium
MVB-APS-002 and associated TVFs	SR3 Portal	Pedestrian Plaza
MVB-APS-004 and associated TVFs	SR1 Portal	HKCEC (New Wing)
EVB-APS-001 and associated TVFs	East Portal	Causeway Bay Community Centre

The monitoring would continue until 2 weeks after the resumption of APS/ TVFs or as advised and agreed by EPD.

4. Conclusion

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

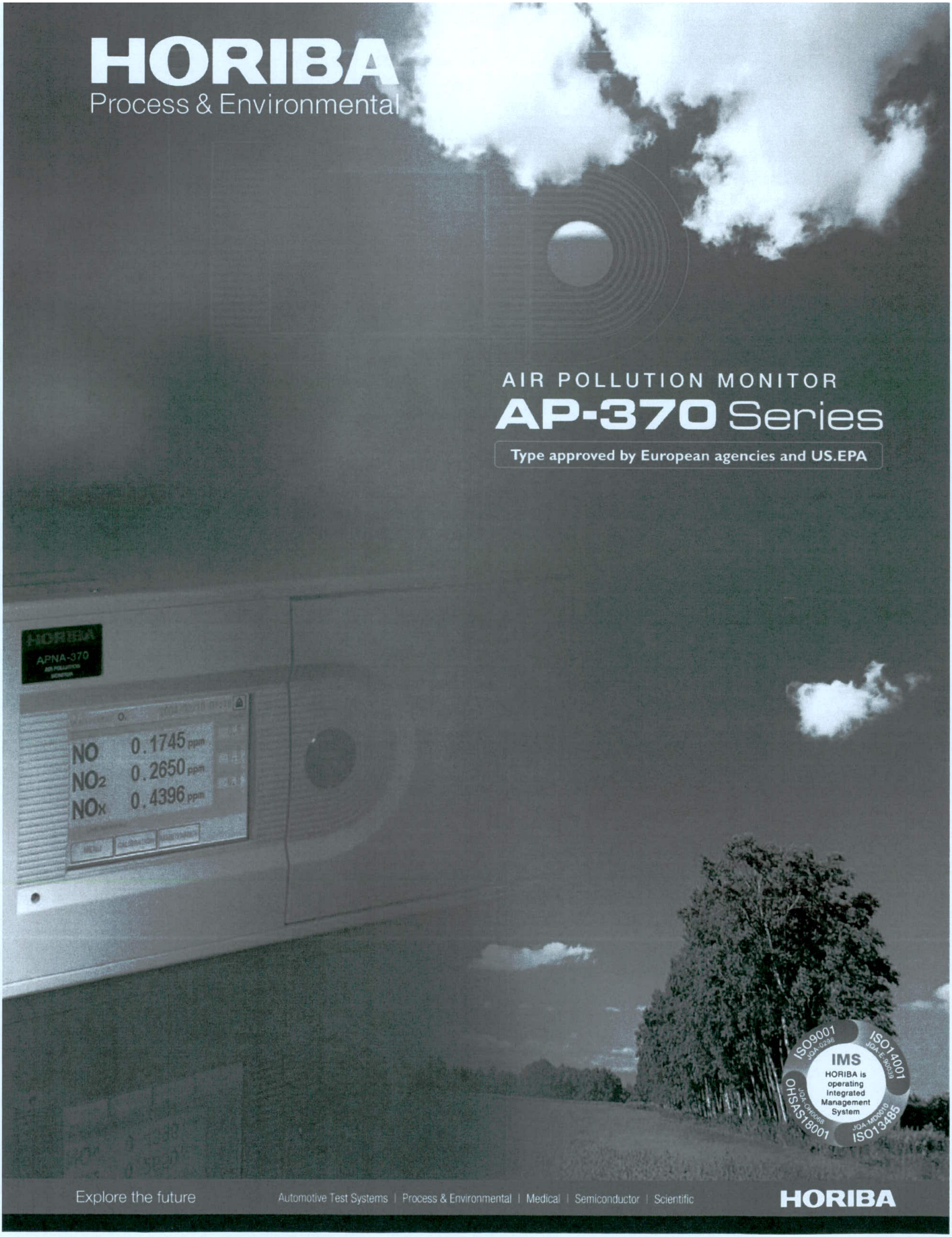
July 2022

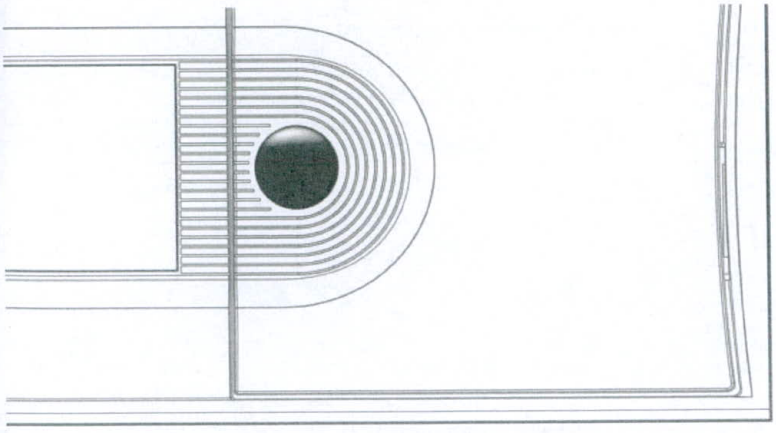
Implementation Schedule

Reference	What to implement?	Who to implement?	Where to implement?	When to implement?	What requirements or standards to fulfill?
AQMP Section 4 and 5	Monitoring of performance of APS	Operator	ADB	Outside of maintenance period from 01:00hrs to 06:00hrs	EP-482/2013/C Condition 2.9 EM&A Manual under EP-364/2009/A (December 2010) Section 2.12.1
AQMP Section 8.1 to 8.4	Monitoring of in-tunnel air quality	Operator	ADB	Outside of maintenance period from 01:00hrs to 06:00hrs	Section 8.4 of AQMP
AQMP Section 6 and 7	Operation and maintenance of APS and TVS	Operator	ADB and ventilation buildings	Operation: outside of maintenance period from 01:00hrs to 06:00hrs Maintenance: maintenance period from 01:00hrs to 06:00hrs	EP-482/2013/C Condition 2.5 and 2.6
AQMP Section 8.5 to 8.6	Operation and maintenance of AQMS	Operator	ADB and CWB Tunnel area	Operation: outside of maintenance period from 01:00hrs to 06:00hrs Maintenance: maintenance period from 01:00hrs to 06:00hrs	Section 8.5 of AQMP
AQMP Contingency Plan Section 3	Emergency responses	Operator	ADB, ventilation buildings and CWB Tunnel area	In the event of emergency situations	EP-482/2013/C Condition 2.9

Note: Operator refers to the Contractor of Management, Operation and maintenance of CWB (MOm).

Appendix 1
Catalog of NO2 Sensor


HORIBA
Process & Environmental
AIR POLLUTION MONITOR
AP-370 Series
Type approved by European agencies and US.EPA
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)

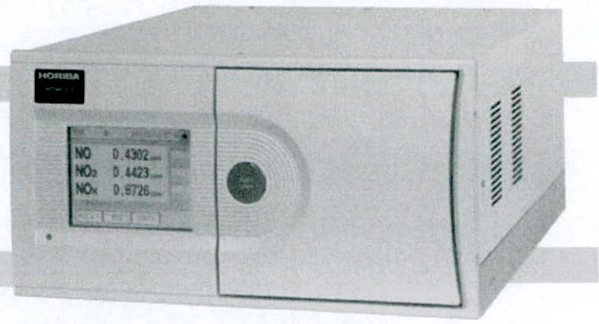
The system's RS-232C serial port can be used to transmit measured values, alarms, and other data to remote equipment. It can also be used to input changes to parameter settings and other data.

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

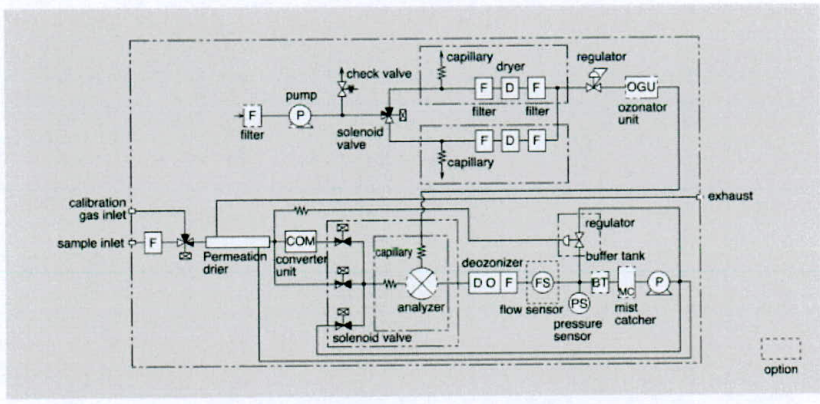
$NO+O_3 \rightarrow NO_2^*+O_2$

$NO_2+NO_2+h\nu$

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.

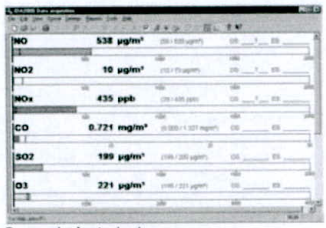
Specifications

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

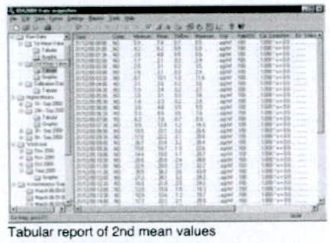
Intelligent Data Acquisition System

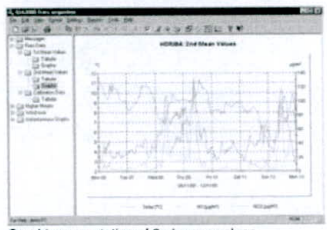
HORIBA IDA-2000

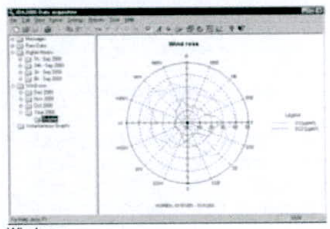
HORIBA's IDA-2000 is an intelligent data acquisition system (DAS) using a desktop or industrial PC, designed for fully automatic monitoring stations. The entire data capture and mean value calculation as well as control of the analyzers is executed by 32 bit multitasking software, running in a state-of-the-art 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

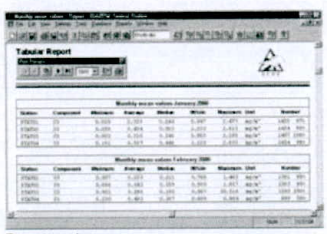

Graphic presentation of 2nd mean values


Wind rose

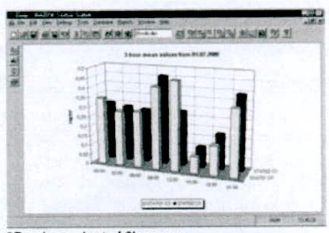
Data Management and Reporting Software

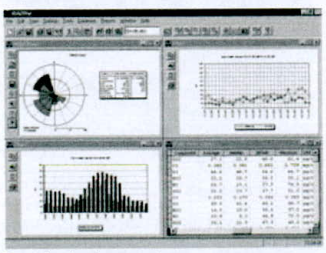
HORIBA IDA-ZRW

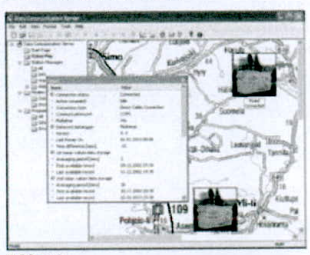
HORIBA's IDA-ZRW is a data management and reporting software for use in Ambient Air Quality and Meteorological monitoring. The software package provides data collection, management, analysis and reporting. Measured data and related information is stored in a high-end relational SQL database. The software 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.

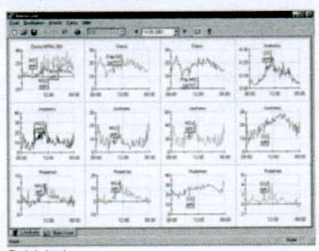


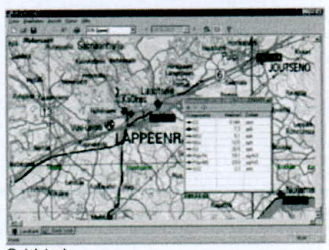
Report preview


3D-column chart of 3h-means


Example of various reports


DCS main

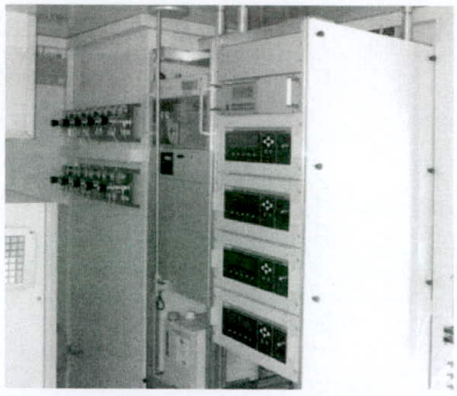

Quick look



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

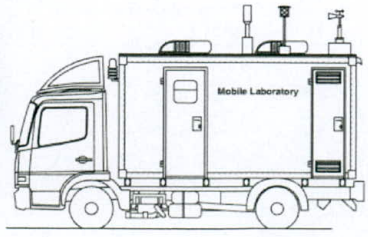
Reykjavik environment / Iceland

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

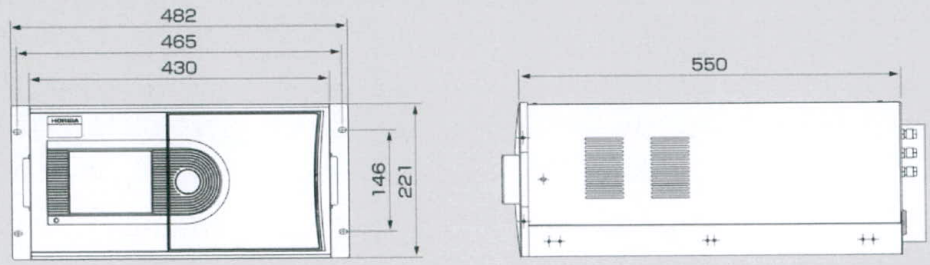


Standard 19-inch Packages

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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502, Purushottam Plaza,
Baner Road, Baner,
Pune - 411045 INDIA
Phone: +91 20-2729-1121

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Irvine Facility
17671 Armstrong Avenue
Irvine, CA 92614, U.S.A.
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Austria
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Fax: 43 (2272) 65230

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Petrohradska 13
CZ-101 00 Praha 10,
Czech Republic
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D-61440 Oberursel/Ts.
Germany
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D-42799 Leichlingen
Germany
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●HORIBA FRANCE
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France
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Fax: 33 (1) 69-29-95-77

Bulletin:HRE-2858E

Printed in Japan T-K(SK)53

Appendix 2
Catalog of PM10 Sensor

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:

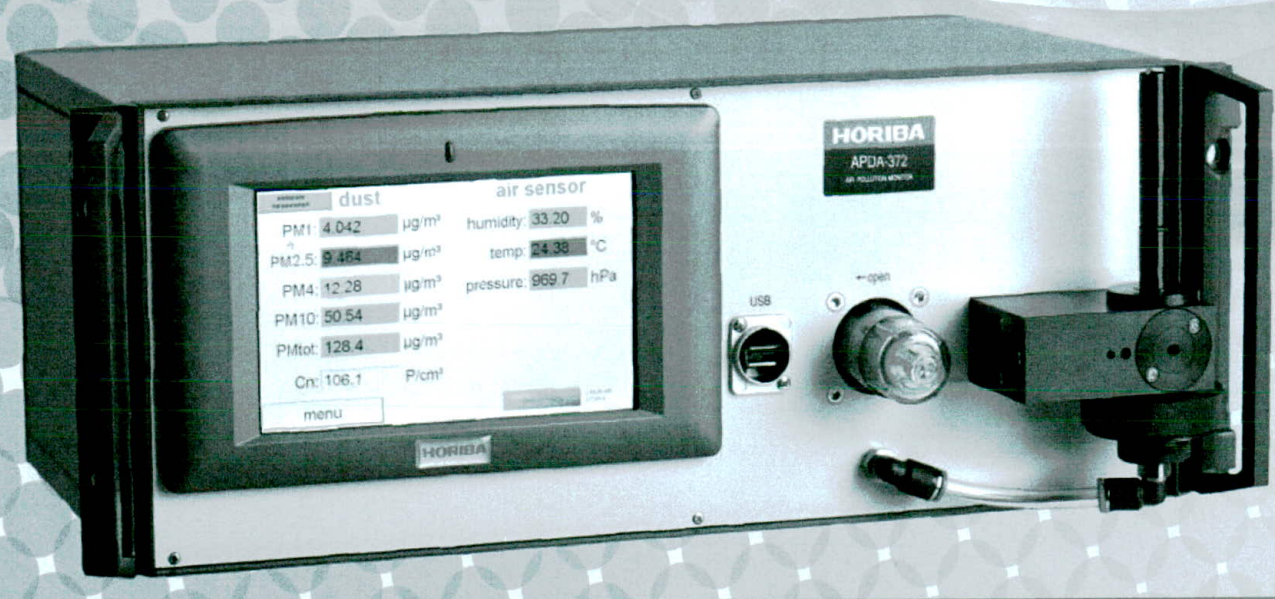
The APDA-372 uses the approved measurement technology of optical light scattering and is equipped with a LED light source with stable output and long lifetime.

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.

http://www.horiba.com/process-environmental/ e-mail: info@horiba.com

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Fax: 33 (0) 1 69-29-95-77

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NN3 6FL, U.K.
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A-3430 Tulln,
Austria
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Fax: 43 (2272) 65230

HORIBA CZECHIA
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CZ-101 00 Praha 10, Czech Republic
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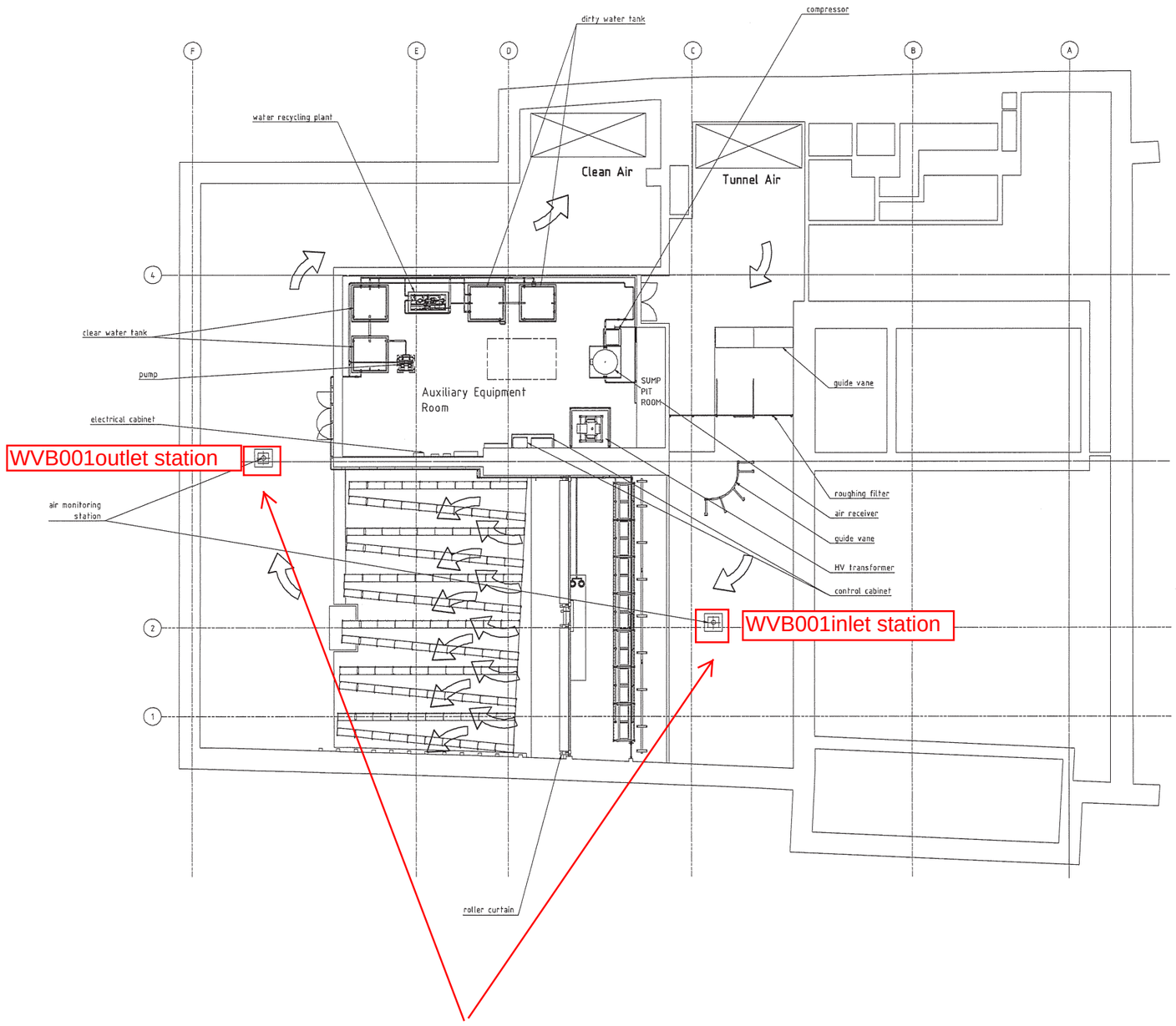
Aviakonstruktorov prospekt
Dom 45, KV 96
Saint Petersburg 197373
Russia
Phone: 7 (812) 952-21-34
Fax: 7 (812) 491-37-33

20150514APDA372v.9.1

Appendix 3
Layout of ventilation buildings with AMS

plan view
(1 : 100)



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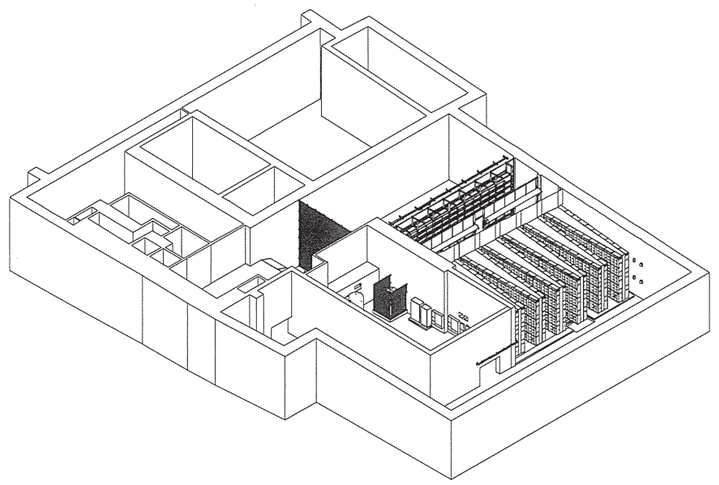

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DATE:24.5.2013

REVISIONS		
LEVEL	DATE	DETAILS
05	13.08.15	DeNOx layout revised (sump pit)
06	14.10.15	new DeNOx 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.

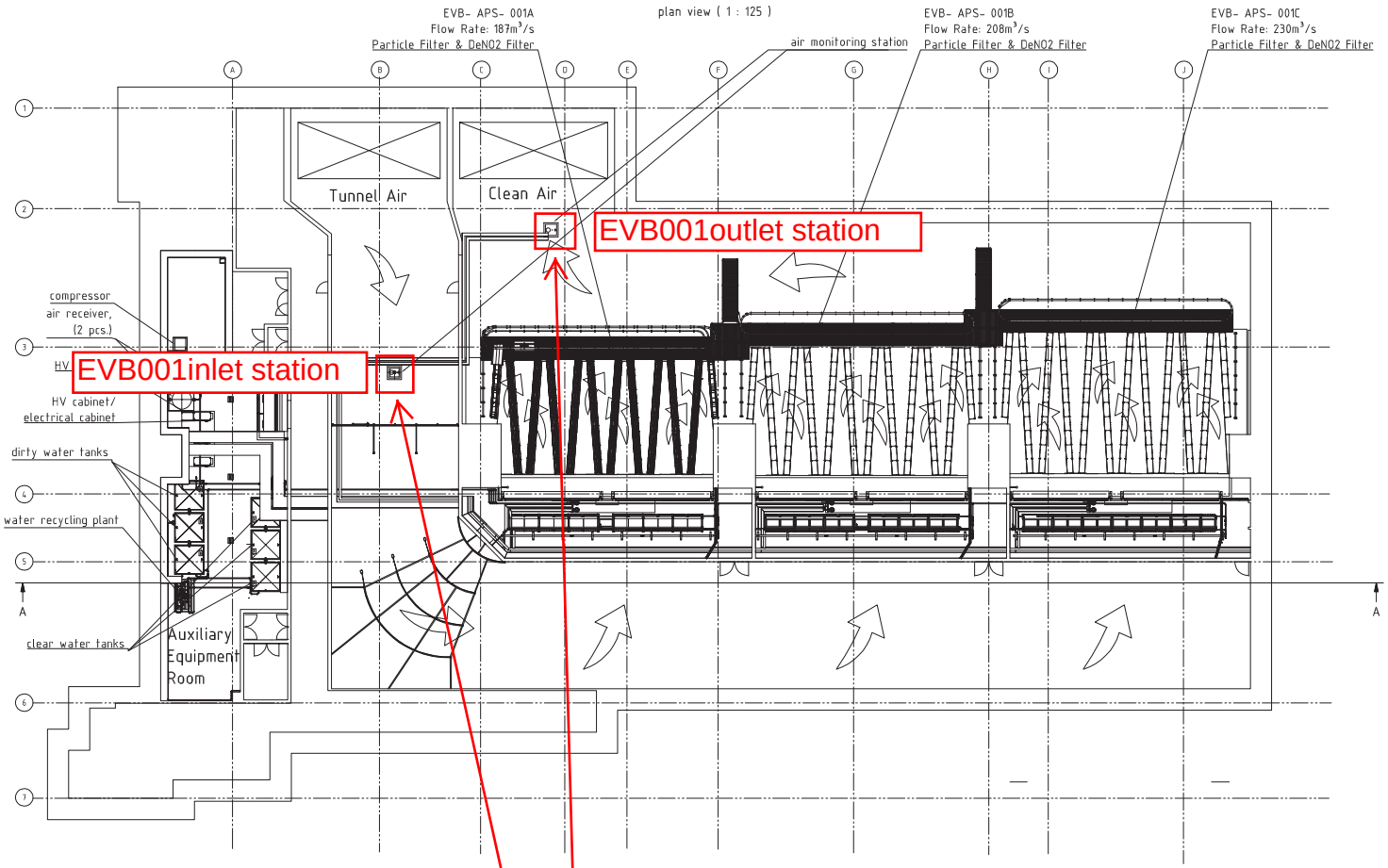
DWG. No: FT-HCWB-3111

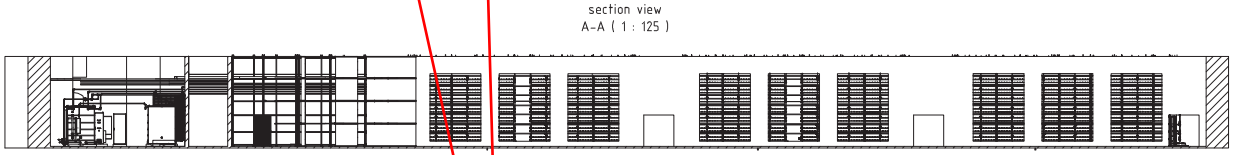
STATUS: Detail Design

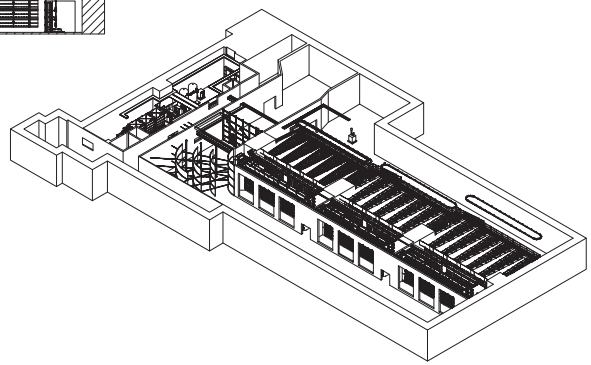
SCALE: 1 : 100 (1:200)

DATE: 13.05.2014

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
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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

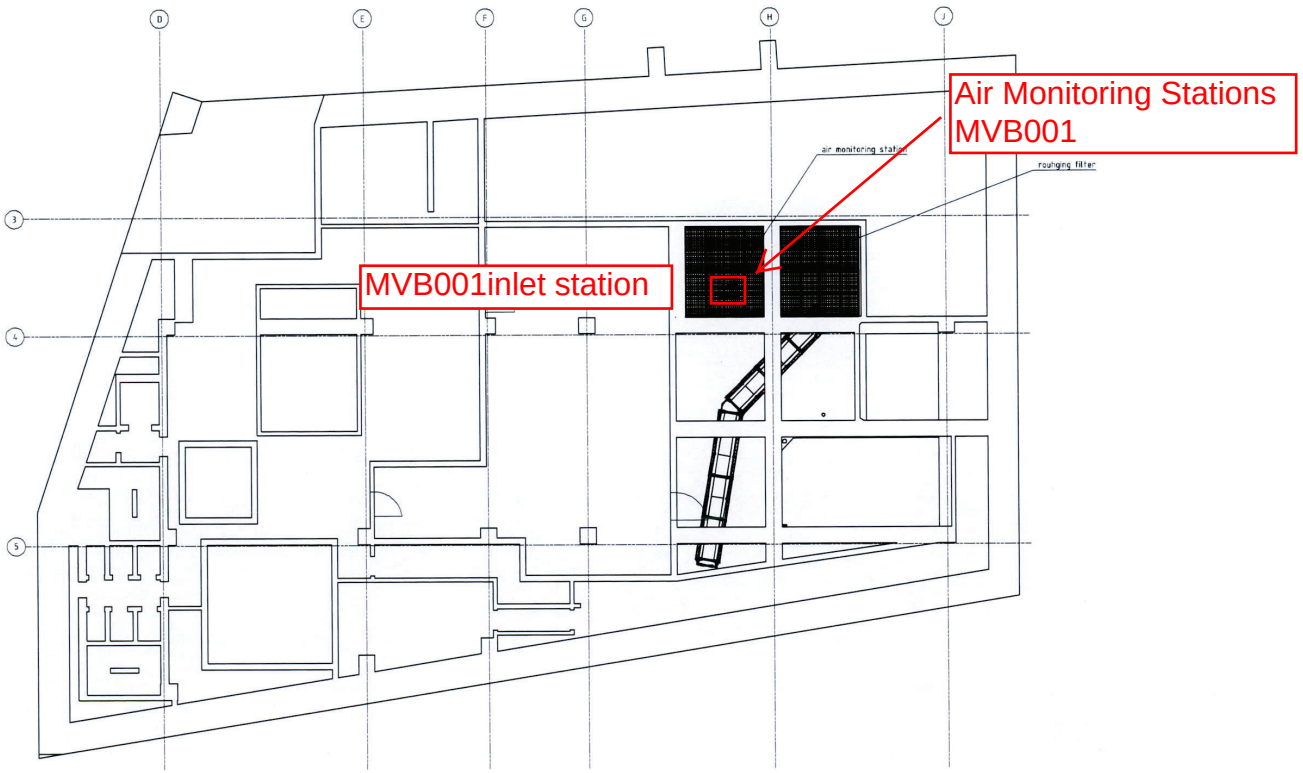
STATUS: Detail Design

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

PROJECT Central Wan Chai Bypass

CLIENT Hong Kong Highways Dept.

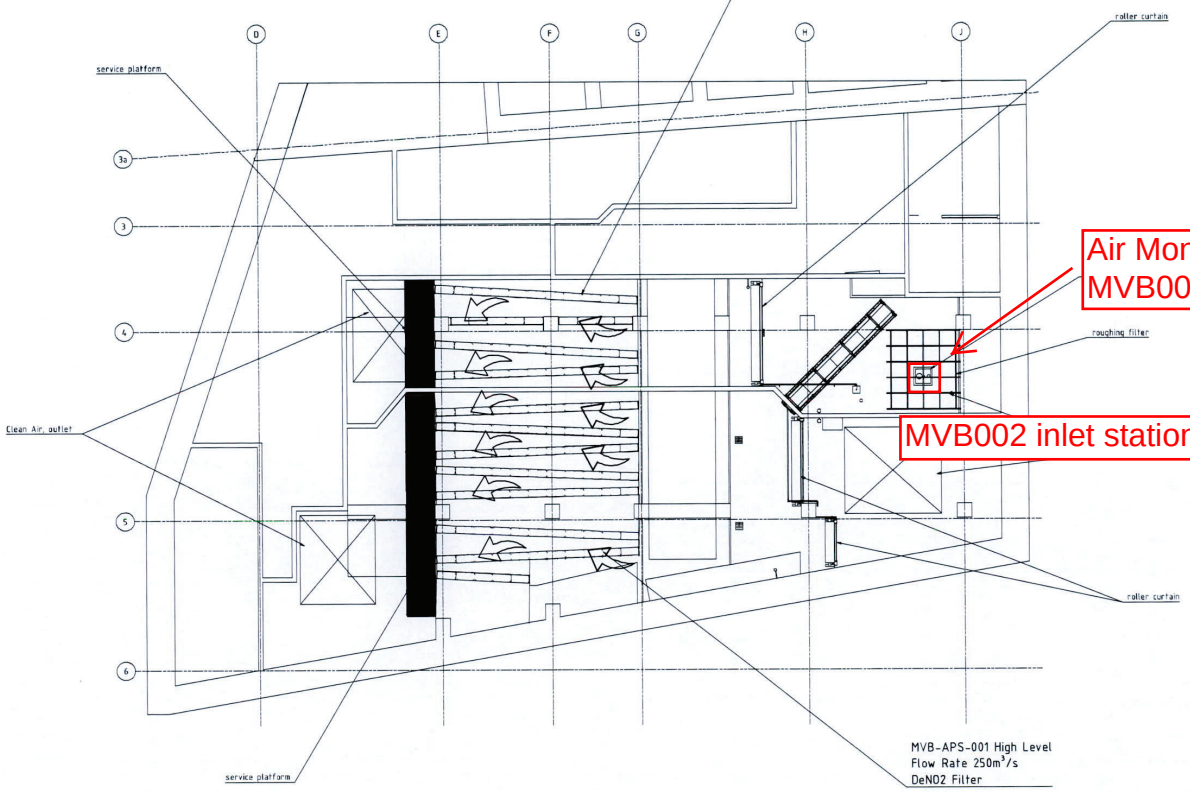
DWG No FT-HCWB-3253

SCALE 1:100

DATE 28.07.2015

STATUS: detail design

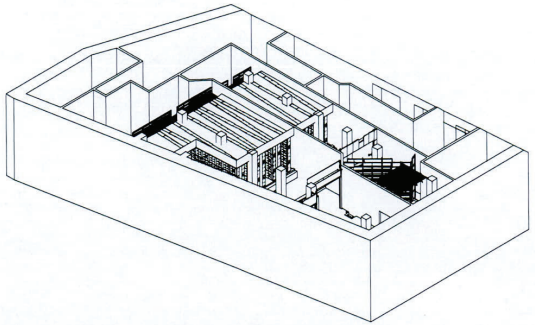
plan view (1 : 100)



Air Monitoring Stations
MVB002

MVB002 inlet station

1 : 200



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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	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
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FILTRONtec:
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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.

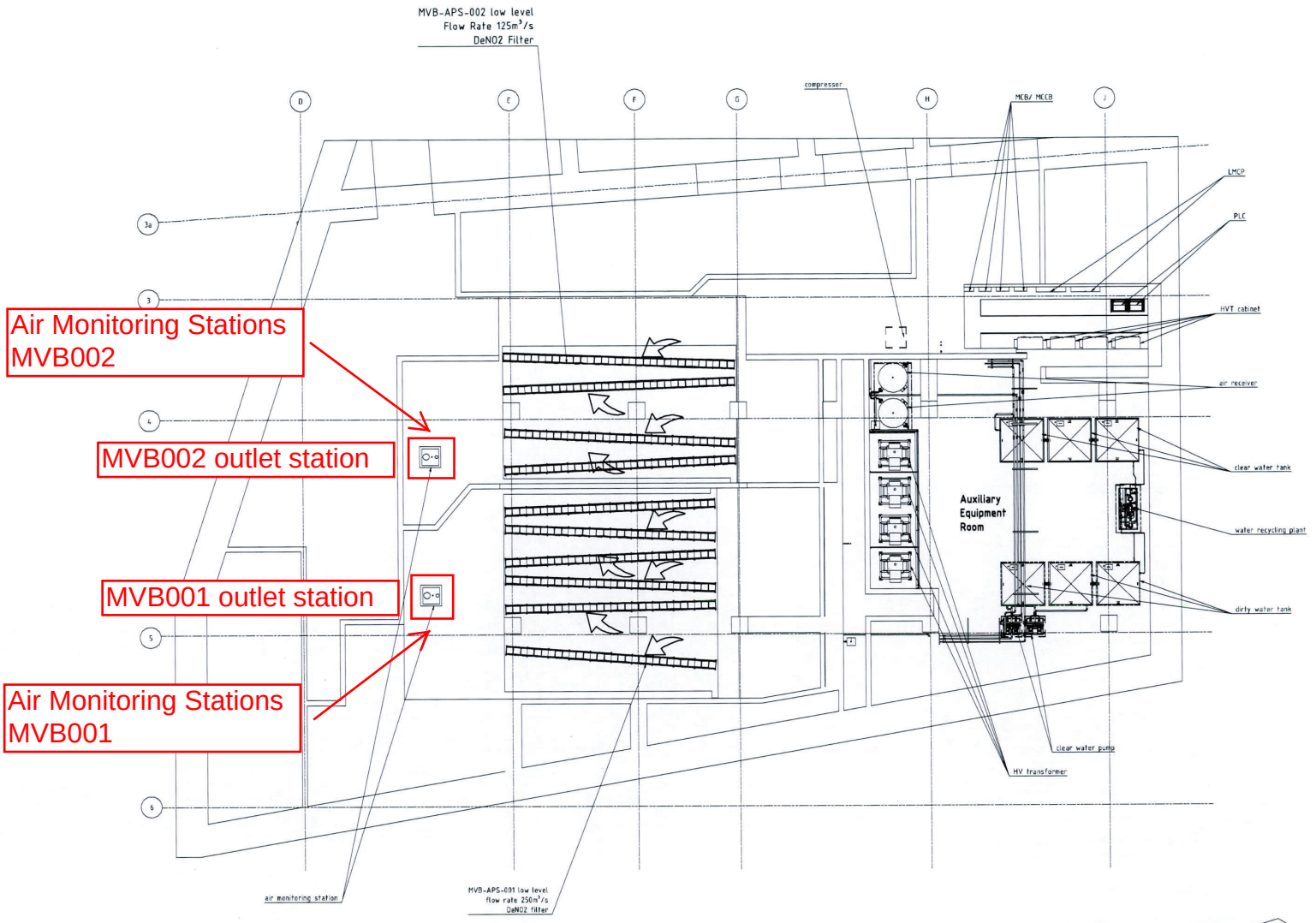
DWG. No FT-HCWB-3251

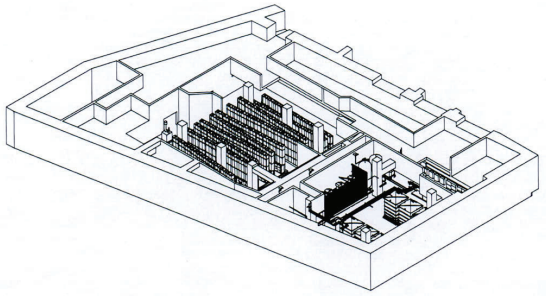
STATUS

SCALE 1:100

DATE

plan view (1 : 75)





FORMAT:A0

DATE

REVISIONS		
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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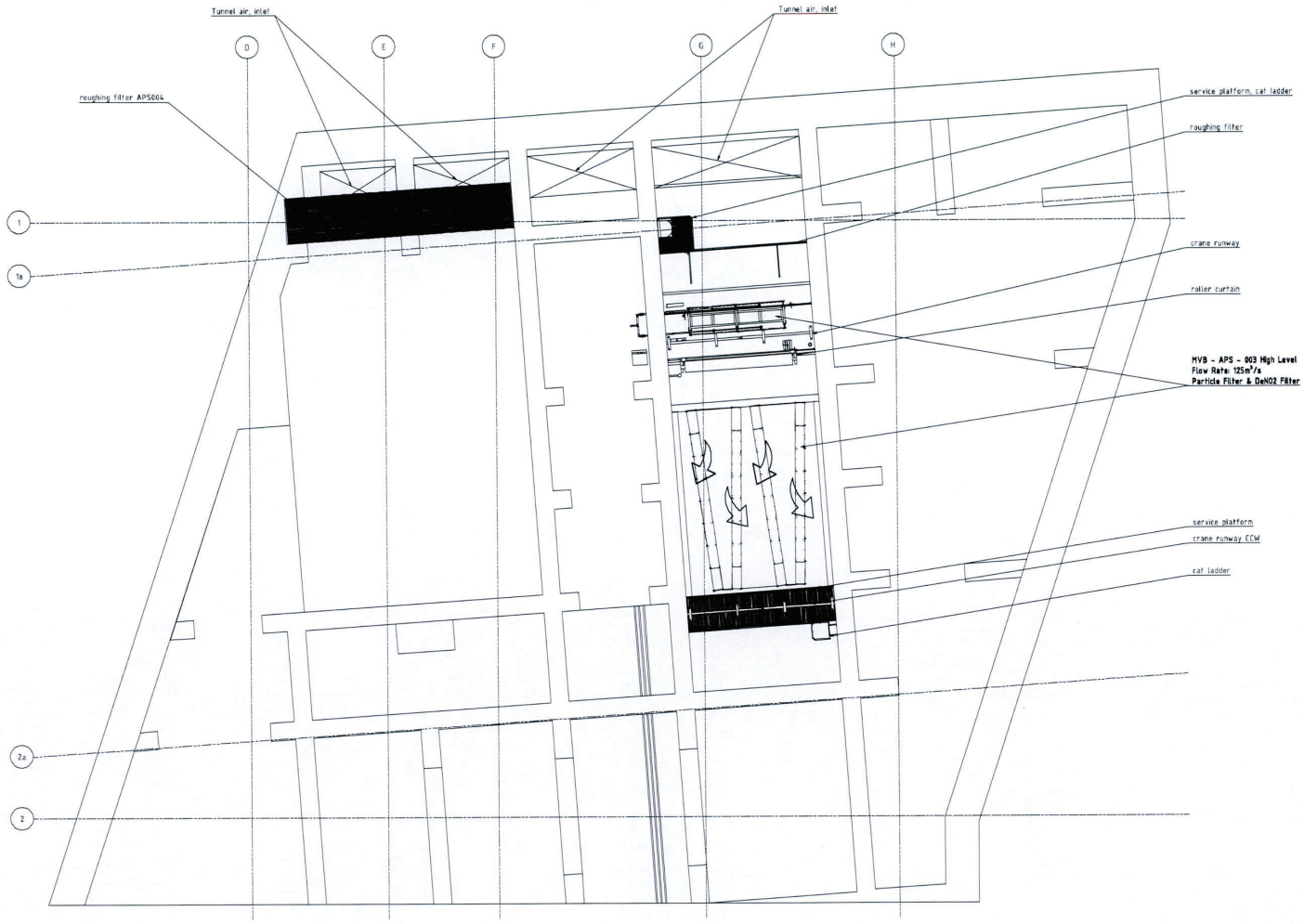
TEL +49 (0) 3494 638327 FAX +49 (0) 3494 638397

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
(1 : 75)



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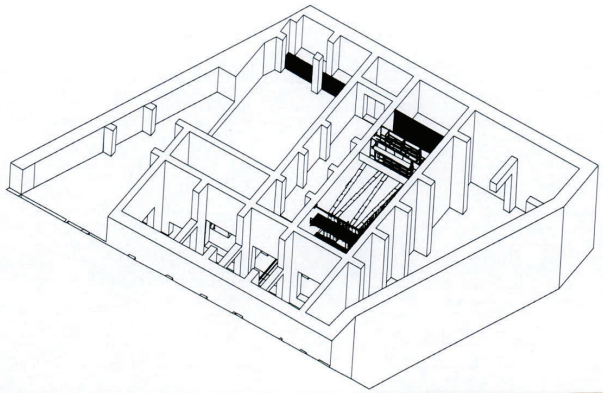

FORMAT:A0

DATE

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
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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

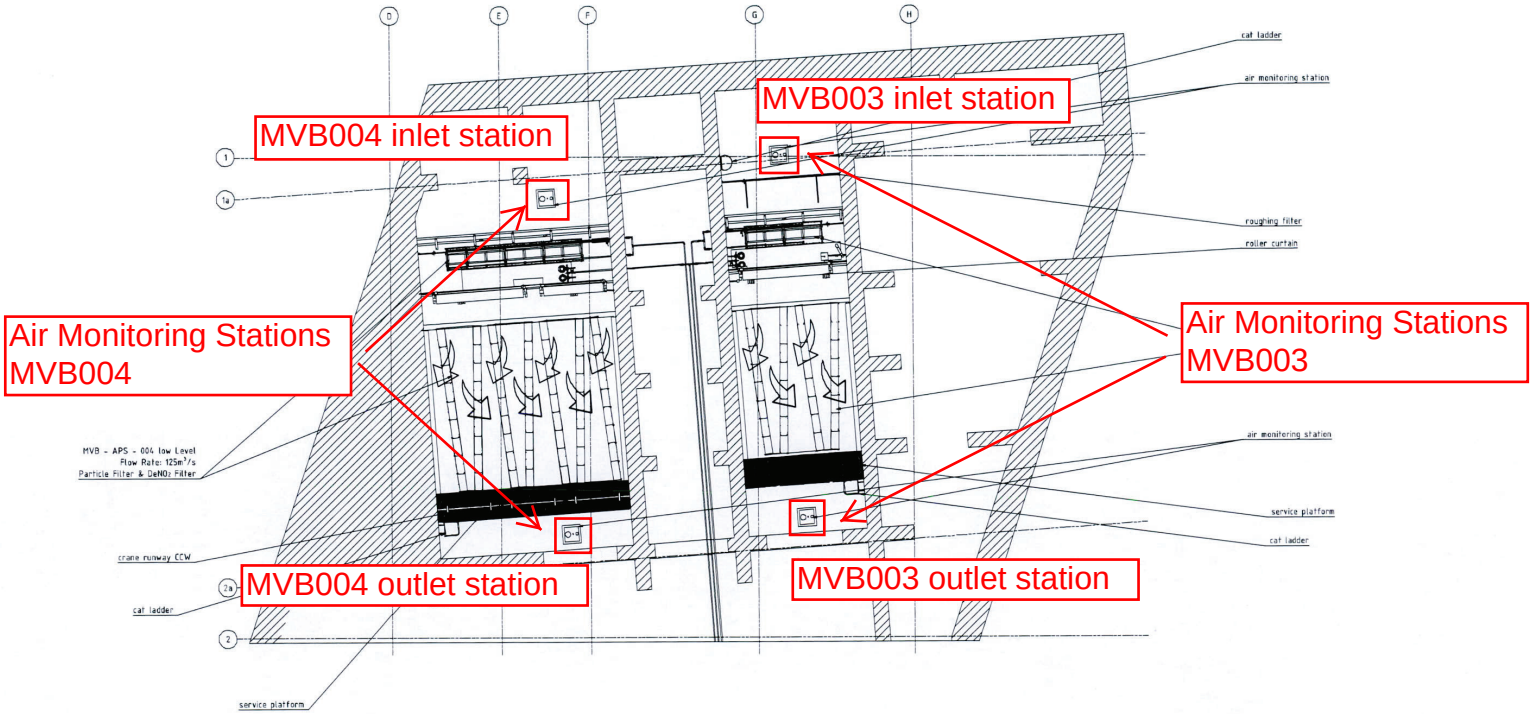
STATUS: Detail design

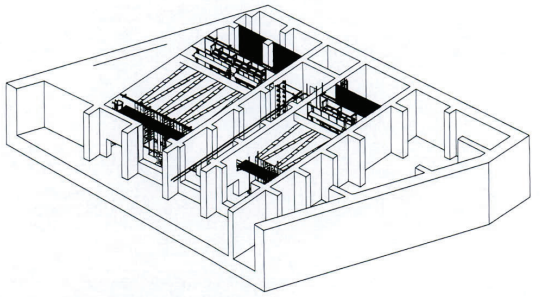
SCALE 1:100

DATE 07.07.2014

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

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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)

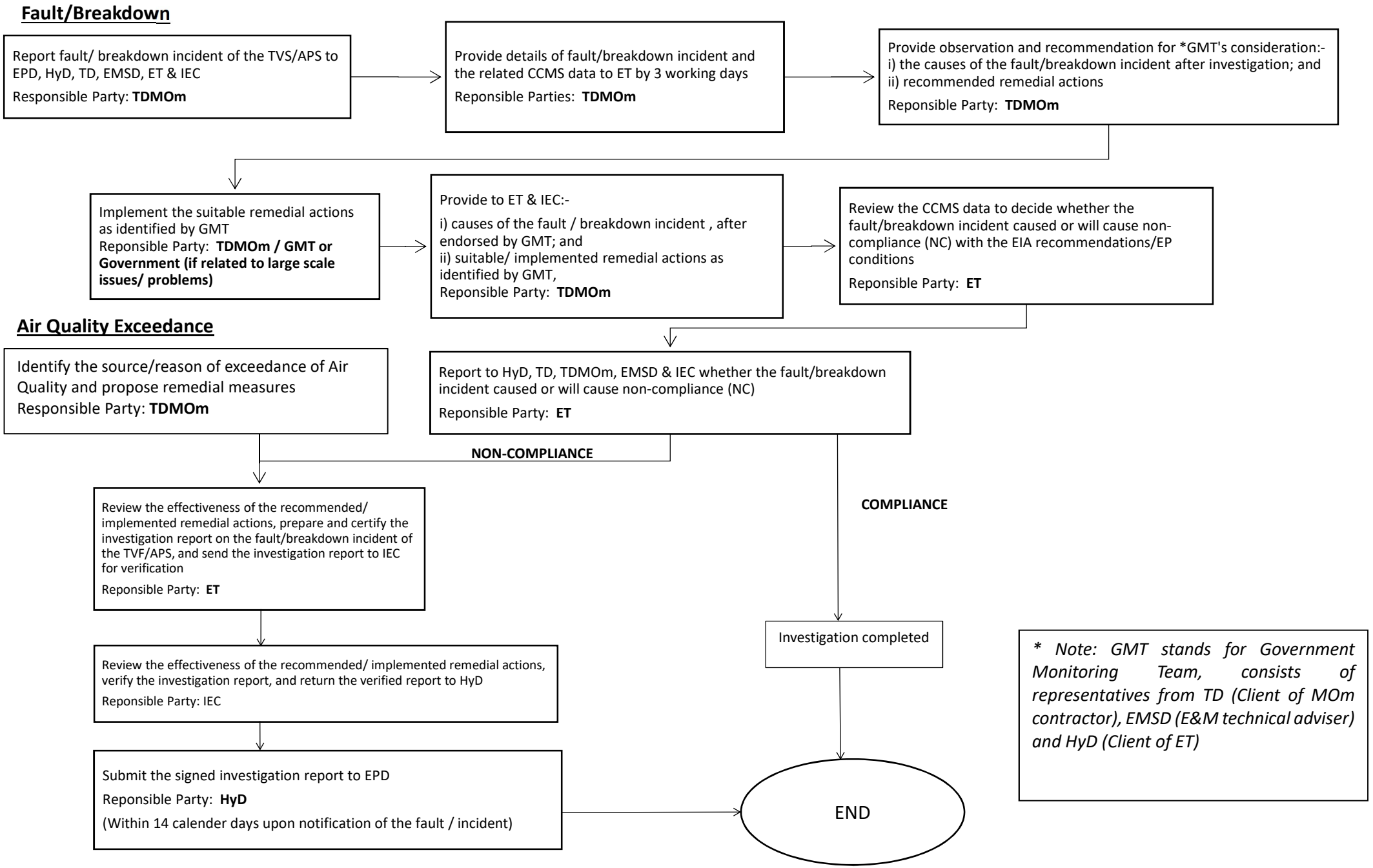
DATE

STATUS detail design

PAGE1

Appendix 4
Event Action Plan for Exceedance

Event / Action Plan
(Flow Chart of Fault/Breakdown Investigation & Exceedance Arrangement)



Appendix 5
Exceedance Report Template

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.

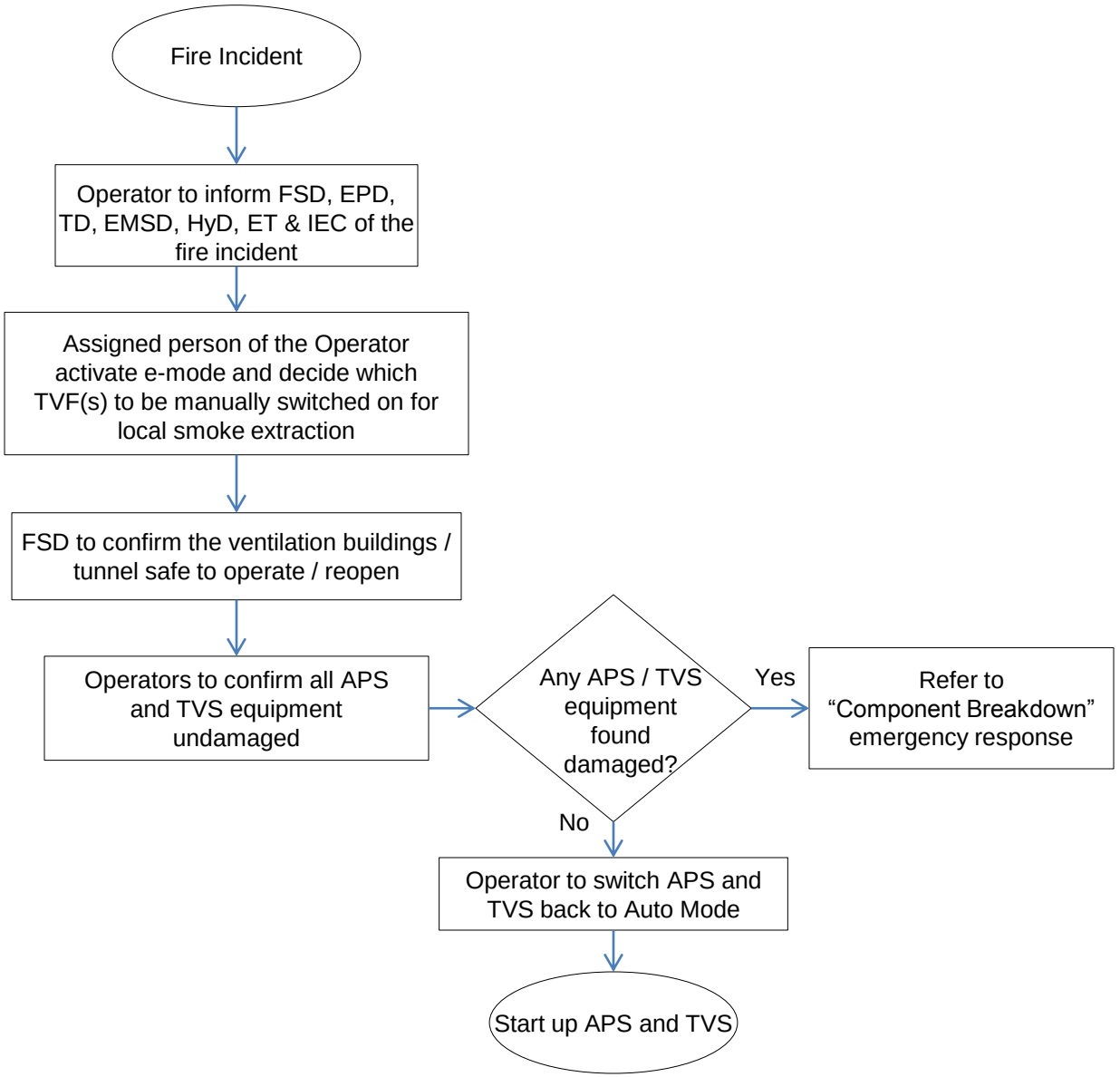
[3] Non-compliance occurs when 6 consecutive of 5-minute removal efficiency (%) exceedances of PM_{10} are recorded in any pairs of the monitoring stations at WVB, MVB and/or EVB.

Appendix 6
Not Used

Appendix 7
Not Used

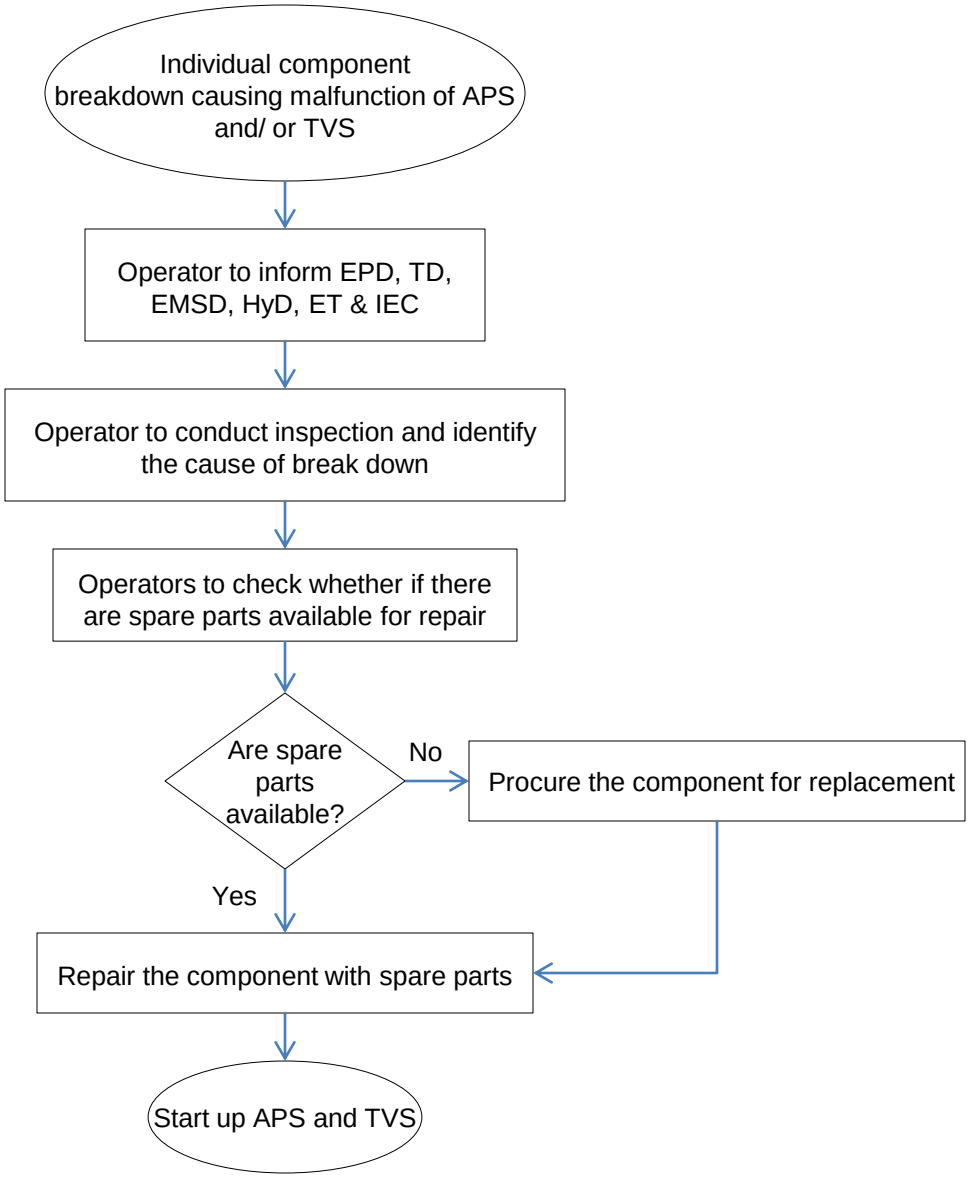
Appendix 8
Emergency Flowchart
(Fire Incident)

Fire Incident



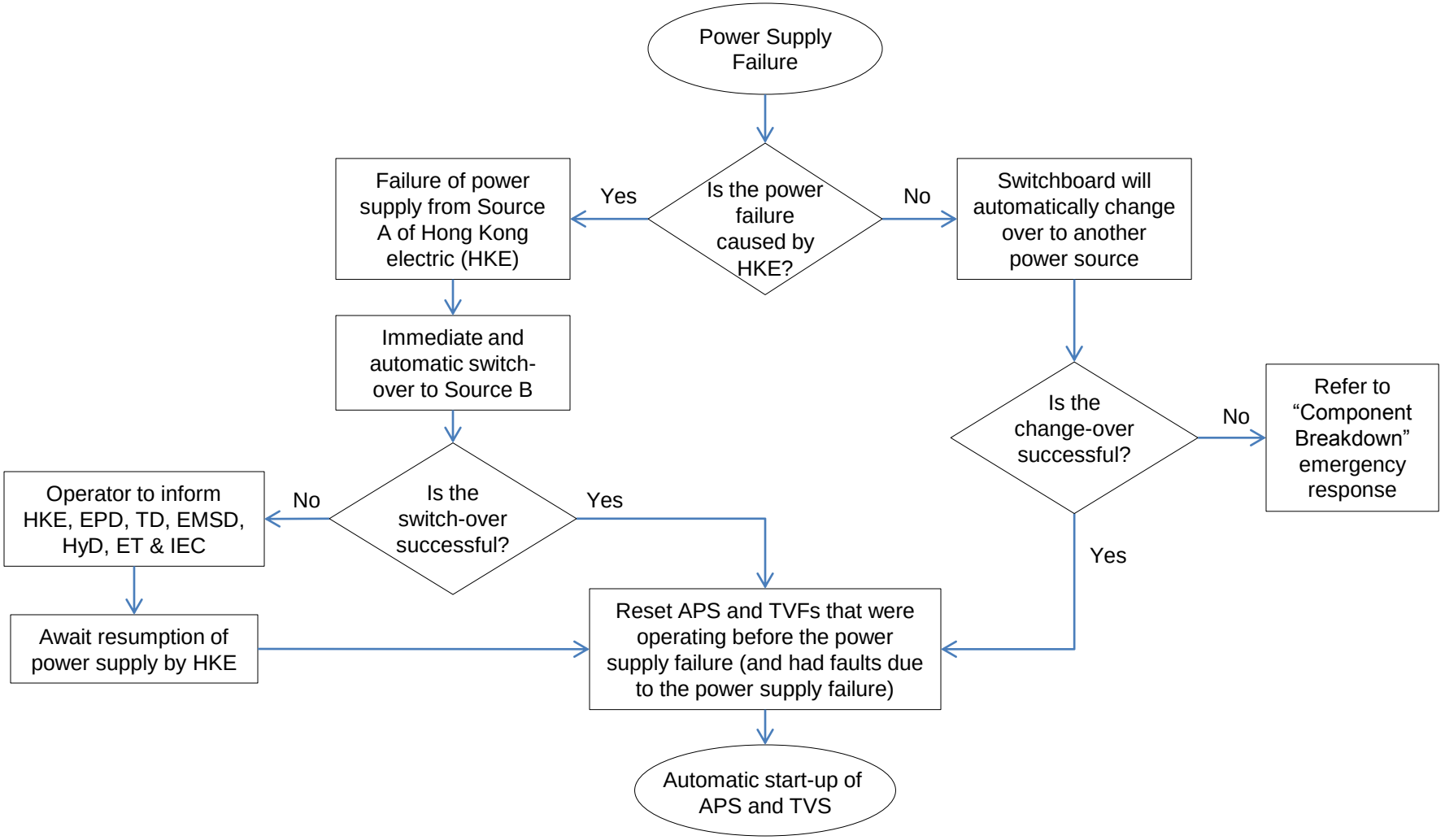
Appendix 9
Emergency Flowchart
(Individual Component Breakdown)

Component Breakdown



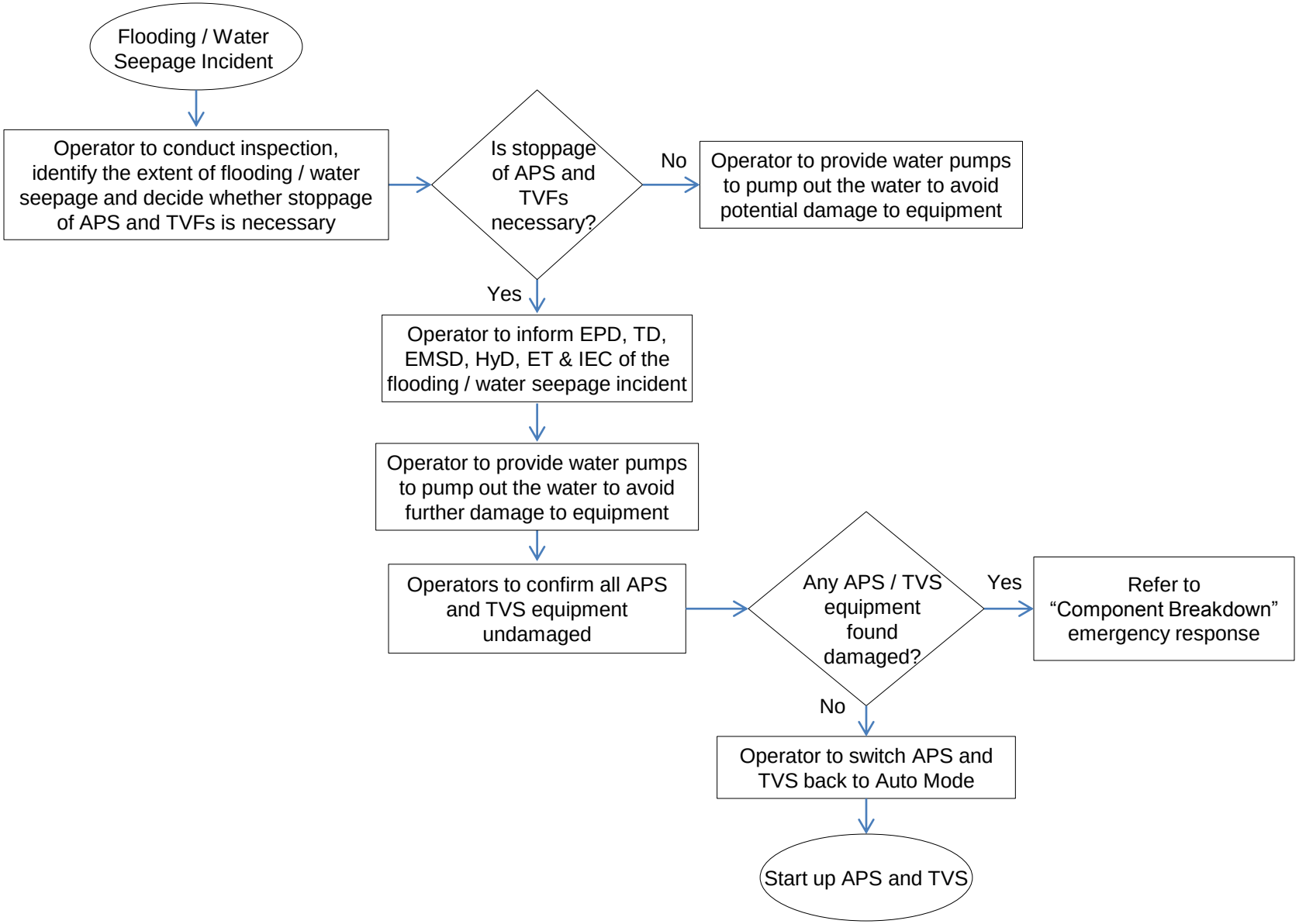
Appendix 10
Emergency Flowchart
(Power Supply Failure)

Power Supply Failure



Appendix 11
Emergency Flowchart
(Flooding / Water Seepage)

Flooding/ Water Seepage Incident



Appendix 12
APS and TVS Operational Procedures

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.

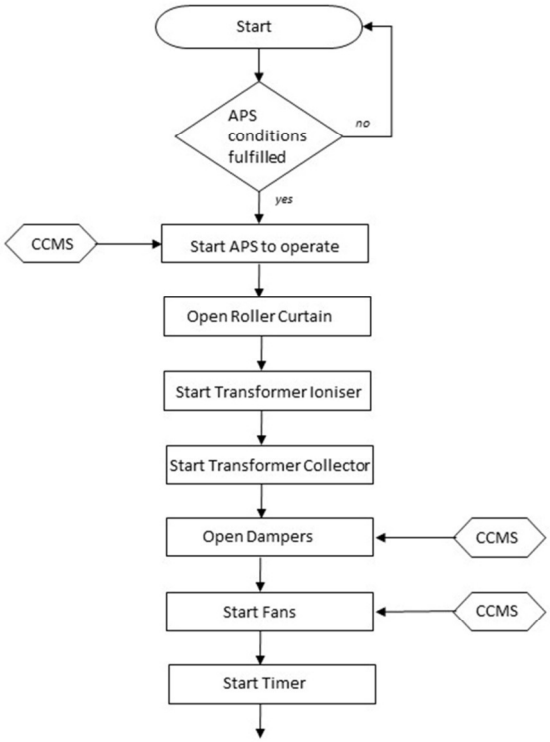
3 APS OPERATIONAL OVERVIEW

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

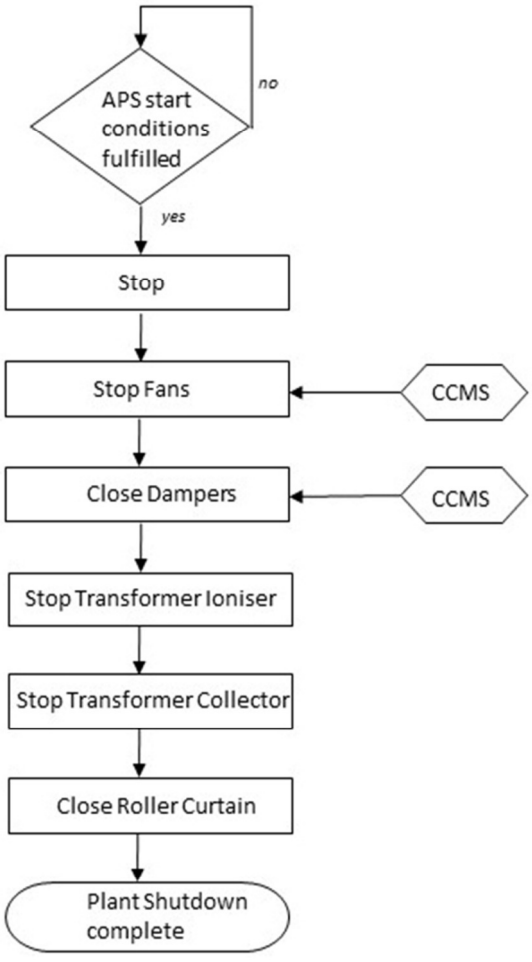


3.2 APS Shutdown

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)

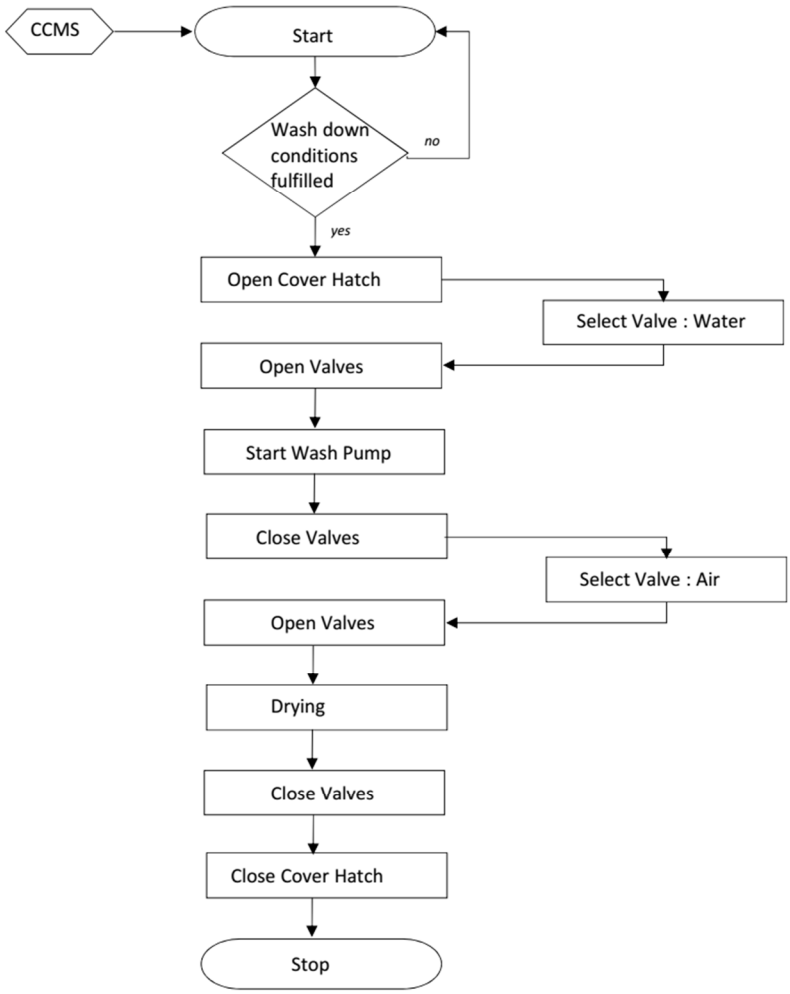


3.3 Wash Down Process

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

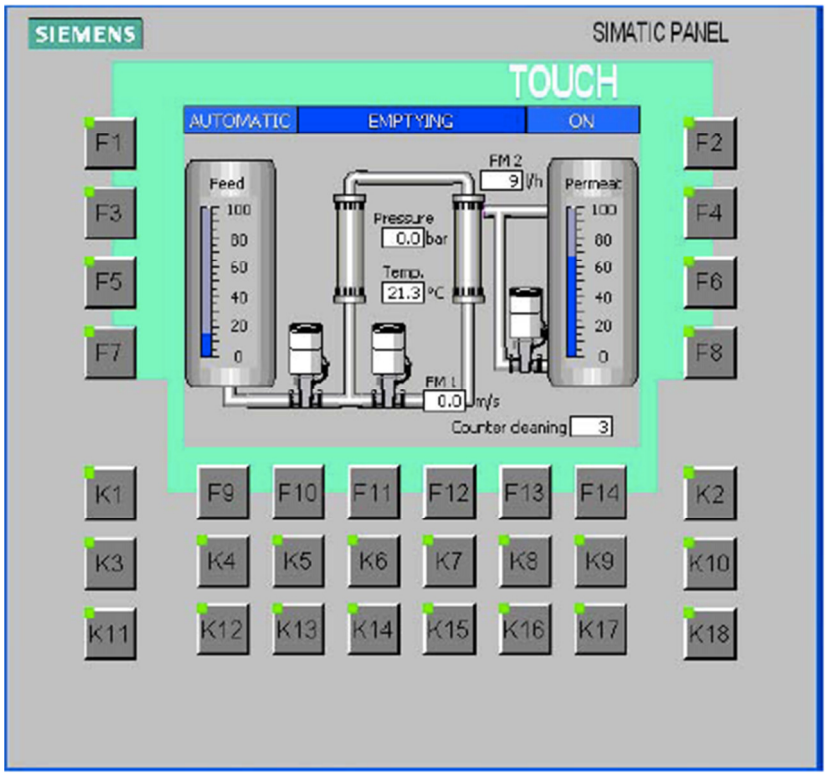


Figure: WRP Touch screen graphic
Parameter settings

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.

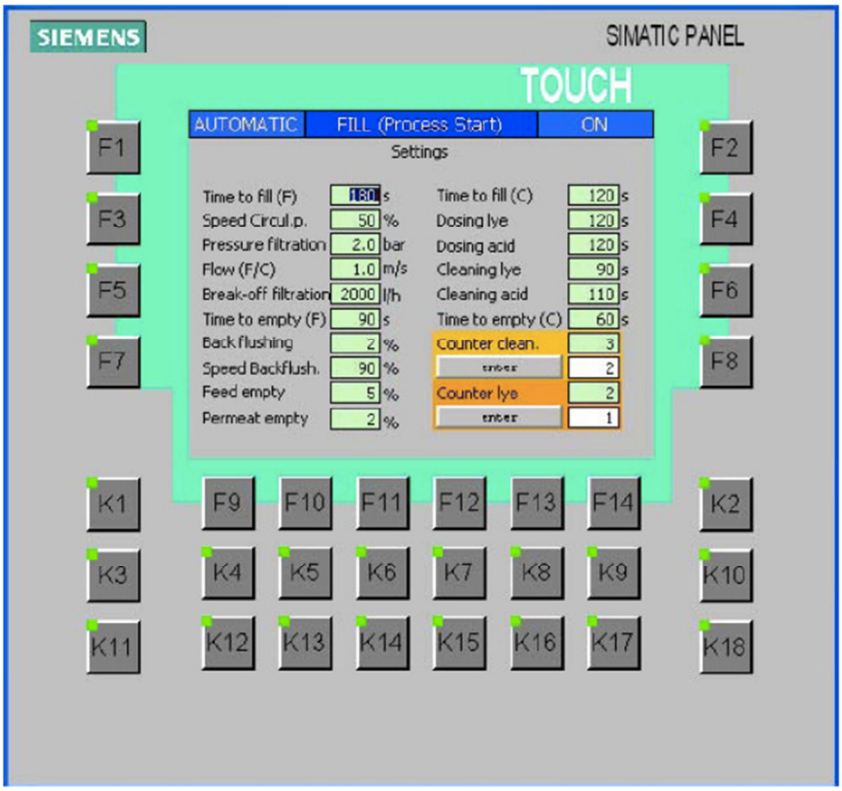


Figure: Filtration Parameter Adjustment Screen

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:

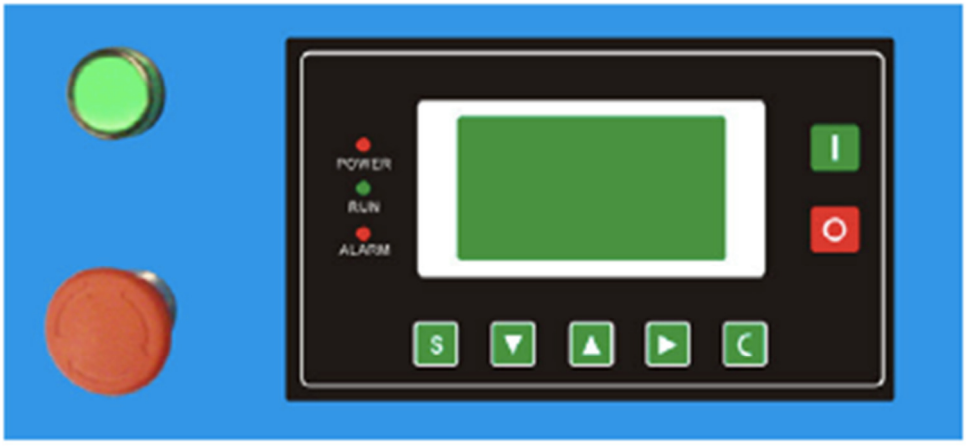


Figure: Compressor electronic display

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

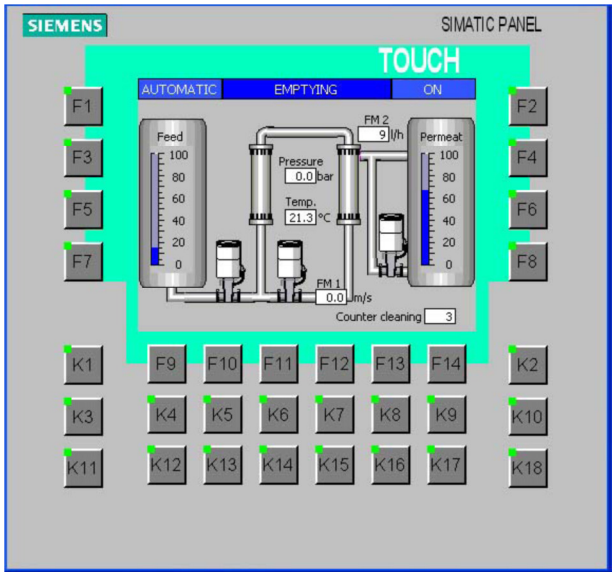
Maintenance Personnel
APS Operator
Traffic Control Room Supervisor
Traffic Control Room Operator

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

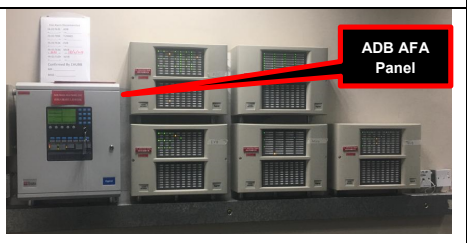
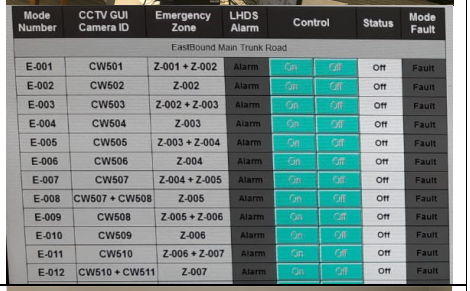
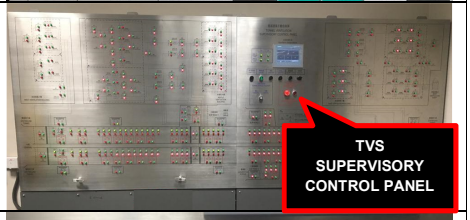
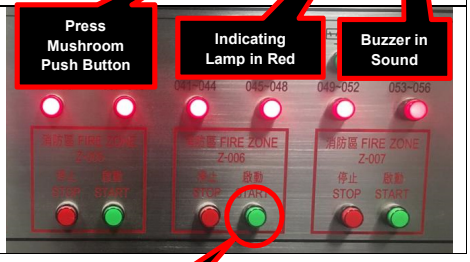
- The Automatic Roller Screens operate to provide isolation between the ESP Filter and the $DeNO_2$ Filter during the ESP Filter washdown sequence.
- Roller Screens operate in defined sequence with the ESP washdown sequence to prevent water and air to neither pass through nor permit the passage of air 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.

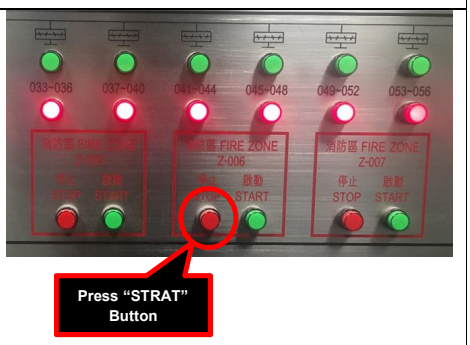
APPENDIX 6 – TVF OPERATION INSTRUCTION

Case 1 : Activate and Deactivate Fire Emergency Mode by Supervisory Control Panel at ADB Control Room

1	Activate "Emergency Mode" Procedures	
a	"Fire Zone" alarm will be activated by LHDS. Tunnel Operator will be alerted the "Fire Zone" alarm through the AFA panel at ADB Control Room All the running TVFs (which running under Normal/Congestion Mode) will be stopped to minimize the propagation of smoke and preparing for emergency operation.	
b	Tunnel Operator can observes the fire location through CCTV at ADB Control Room to confirm the fire location Tunnel Operator can use CCMS GUI- Mode Table of Emergency Mode Page to identify the CCTV Camera ID for easy location of fire incident	 
c	After confirmed the fire location is matching with the "Fire Zone" alarm from AFA panel, Tunnel Operator can activate Smoke Extraction System (Fire Emergency Mode) on "Tunnel Ventilation Supervisory Control Panel" at ADB Control Room	
d	Press the "Emergency Manual Override" Mushroom Push Button Once the "Emergency Manual Override" Mushroom Push button is pressed, an indicating lamp (Red) will be steady ON and buzzer will sound to show "Emergency" Mode is already activated.	
f	Press relevant "Fire Zone" START button and pressed "Fire Zone" START indicating lamp (Green) will be blinking to let the operator knows the button was pressed. For boundary fire, operator can press two relevant adjacent " Fire Zone" START buttons to start the boundary fire zone mode.	

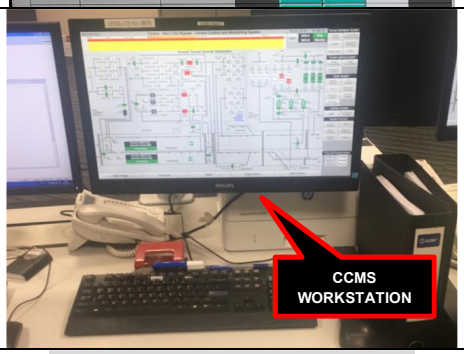
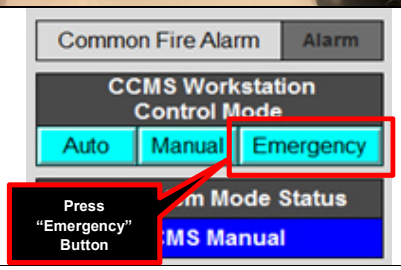
Mode Number	CCTV GUI Camera ID	Emergency Zone	LHDS Alarm	Control		Status	Mode Fault
EastBound Main Trunk Road							
E-001	CW501	Z-001 + Z-002	Alarm	On	Off	Off	Fault
E-002	CW502	Z-002	Alarm	On	Off	Off	Fault
E-003	CW503	Z-002 + Z-003	Alarm	On	Off	Off	Fault
E-004	CW504	Z-003	Alarm	On	Off	Off	Fault
E-005	CW505	Z-003 + Z-004	Alarm	On	Off	Off	Fault
E-006	CW506	Z-004	Alarm	On	Off	Off	Fault
E-007	CW507	Z-004 + Z-005	Alarm	On	Off	Off	Fault
E-008	CW507 + CW508	Z-005	Alarm	On	Off	Off	Fault
E-009	CW508	Z-005 + Z-006	Alarm	On	Off	Off	Fault
E-010	CW509	Z-006	Alarm	On	Off	Off	Fault
E-011	CW510	Z-006 + Z-007	Alarm	On	Off	Off	Fault
E-012	CW510 + CW511	Z-007	Alarm	On	Off	Off	Fault

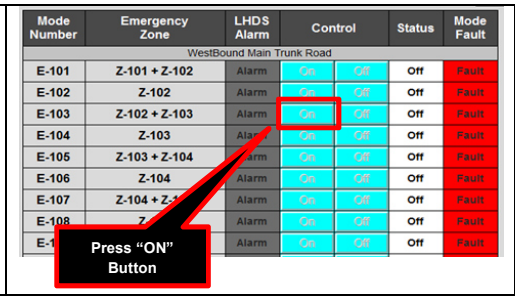
	(For example, press "Fire Zone Z001" START and "Fire Zone Z002" START button means boundary fire Z001+Z002 mode selected. Two of adjacent "Fire Zone" can be selected in maximum. There are no response for the third "Fire Zone "was selected.)	
e	After selected “Fire Zone”, Tunnel Operator can press CONFIRM button to confirm the Selected “Fire Zone”. The selected “Fire Zone” START indicating lamp will be steady ON to show the selected “Fire Zone” is started.	

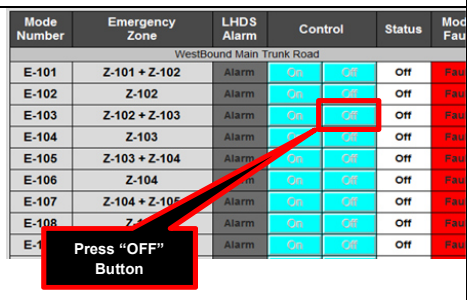
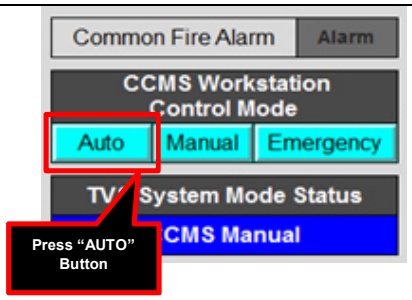
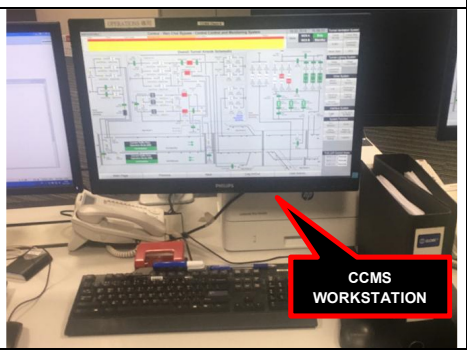
2	Deactivate "Emergency Mode" Procedures	
a	In case of any "Fire Zone" mode is started, operator needs to stop the "Fire Zone" by pressing STOP button of the "Fire Zone".	
b	Press “CONFRIM” button to confirm to stop the selected "Fire Zone" mode.	
c	After "Fire Zone" stopped, the "Emergency Mode" Mushroom Push Button can be reset.	

APPENDIX 6 – TVF OPERATION INSTRUCTION

Case 2 : Activate and Deactivate Fire Emergency Mode by CCMS Workstation at ADB Control Room

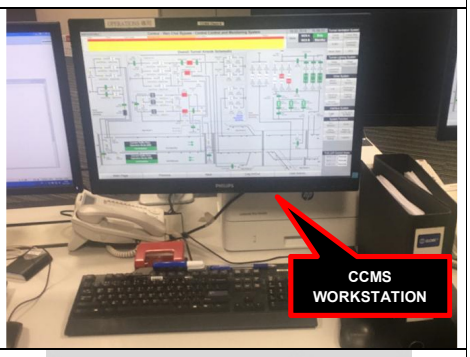
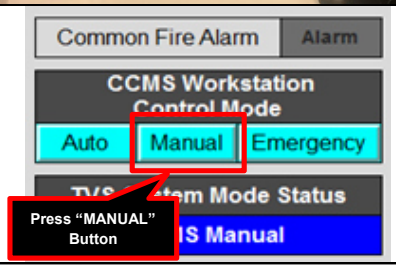
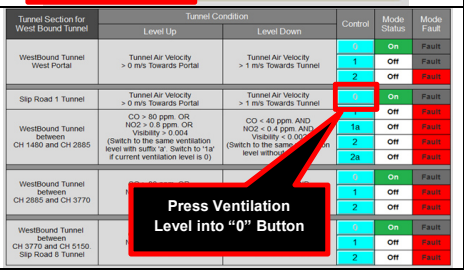
1	Activate "Emergency Mode" Procedures	
a	"Fire Zone" alarm will be activated by LHDS. Tunnel Operator will be alerted the "Fire Zone" alarm through the AFA panel at ADB Control Room All the running TVFs (which running under Normal/Congestion Mode) will be stopped to minimize the propagation of smoke and preparing for emergency operation.	
b	Tunnel Operator can observes the fire location through CCTV at ADB Control Room to confirm the fire location Tunnel Operator can use CCMS GUI- Mode Table of Emergency Mode Page to identify the CCTV Camera ID for easy location of fire incident	 Mode Number / CCTV GUI Camera ID / Emergency Zone / LHDS Alarm / Control / Status / Mode Fault EastBound Main Trunk Road E-001 CW501 Z-001 + Z-002 Alarm On Off Off Fault E-002 CW502 Z-002 Alarm On Off Off Fault E-003 CW503 Z-002 + Z-003 Alarm On Off Off Fault E-004 CW504 Z-003 Alarm On Off Off Fault E-005 CW505 Z-003 + Z-004 Alarm On Off Off Fault E-006 CW506 Z-004 Alarm On Off Off Fault E-007 CW507 Z-004 + Z-005 Alarm On Off Off Fault E-008 CW507 + CW508 Z-005 Alarm On Off Off Fault E-009 CW508 Z-005 + Z-006 Alarm On Off Off Fault E-010 CW509 Z-006 Alarm On Off Off Fault E-011 CW510 Z-006 + Z-007 Alarm On Off Off Fault E-012 CW510 + CW511 Z-007 Alarm On Off Off Fault
c	After confirmed the fire location is matching with the "Fire Zone" alarm from AFA panel, tunnel operator activate Smoke Extraction System (Fire Emergency Mode) on CCMS Workstation at ADB Control Room	
d	Press "Emergency" button in Mode Table Section Page.	

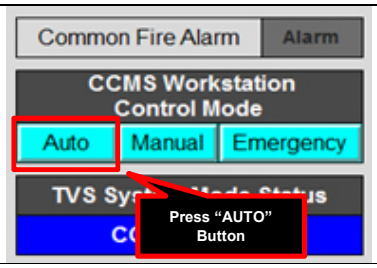
e	Press relevant "Fire Zone" button in GUI For boundary fire, operator can press two relevant adjacent " Fire Zone" START buttons to start the boundary fire zone mode. (For example, press "Fire Zone Z001" START and "Fire Zone Z002" START button means boundary fire Z001+Z002 mode selected. Two of adjacent "Fire Zone" can be selected in maximum. There are no response for the third "Fire Zone "was selected.)	

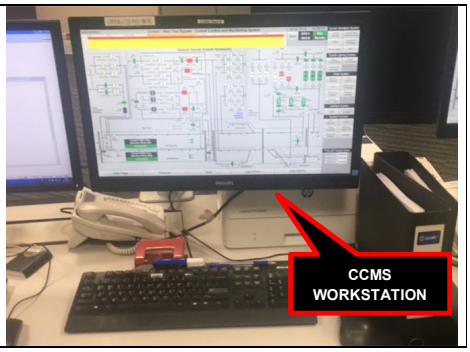
2	Deactivate "Emergency Mode" Procedures	
a	In case of any "Fire Zone" mode is started, operator needs to stop the "Fire Zone" by pressing “OFF” button of the "Fire Zone to stop the selected "Fire Zone" mode.	
b	After "Fire Zone" stopped, Press "Auto" button in Mode Table Section Page to resume the system.	
c	Tunnel Ventilation System TVS will be resumed in “Auto” Mode on CCMS Workstation at ADB Control Room.	

APPENDIX 6 – TVF OPERATION INSTRUCTION

Case 3 : Activate Manual Control of Normal Mode Operation / Resume Auto Control of Normal Mode Operation by CCMS Workstation at ADB Control Room

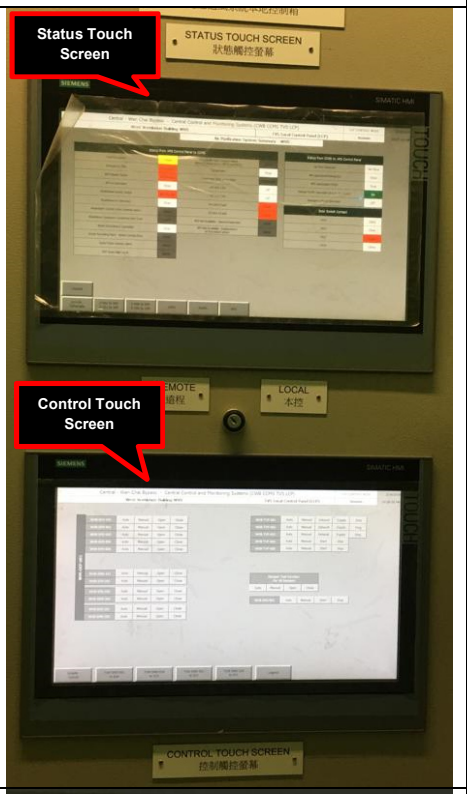
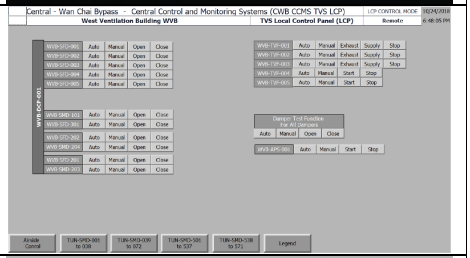
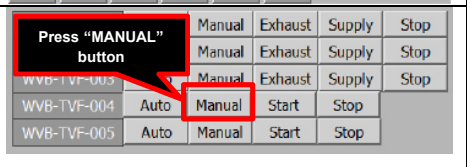
1	Deactivate "Normal Mode" Procedures	
a	Tunnel Operator deactivate TVS Normal Mode operation on CCMS Workstation at ADB Control Room	
b	Press "Manual" button in Mode Table Section Page on CCMS Workstation at ADB Control Room	
c	Subsequently, Tunnel Operator is required to select the ventilation level to the lowest level by pressing "0" button. (For example, press Ventilation Level into "0" button for Slip Road 1, Westbound Tunnel between CH1480 and CH2885.)	

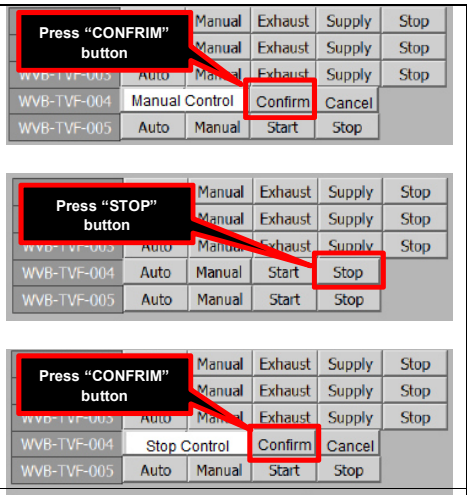
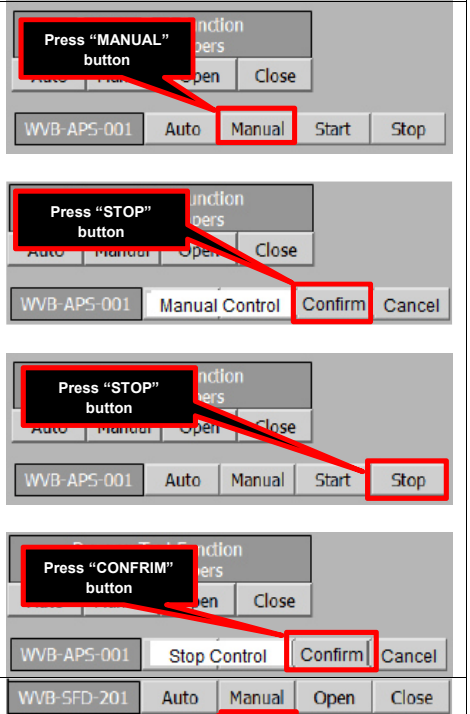
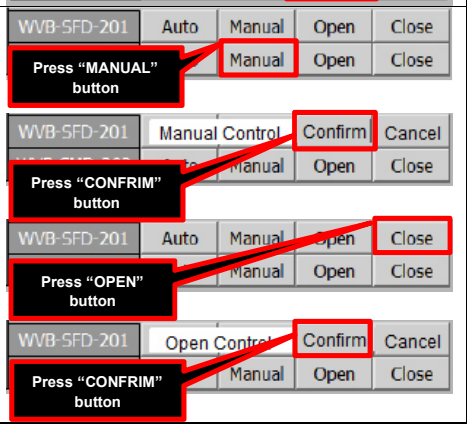
2	Activate "Normal Mode" Procedures	
a	Press "Auto" button in Mode Table Section Page to resume the system in Auto Mode on CCMS Workstation at ADB Control Room	

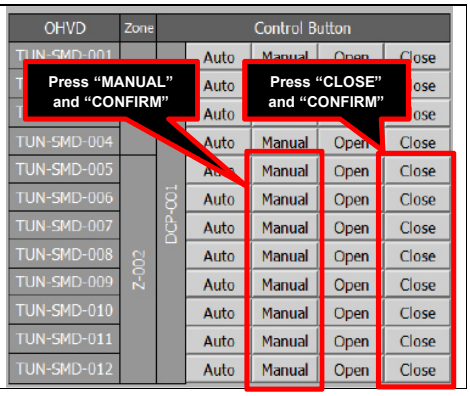
b	Tunnel Ventilation System TVS will be resumed in "Auto" Mode on CCMS Workstation at ADB Control Room.	

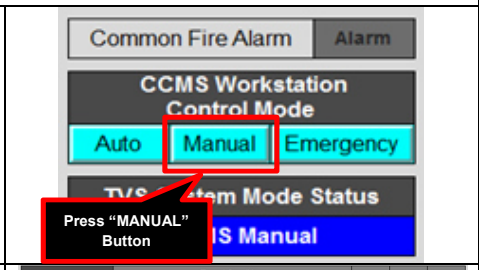
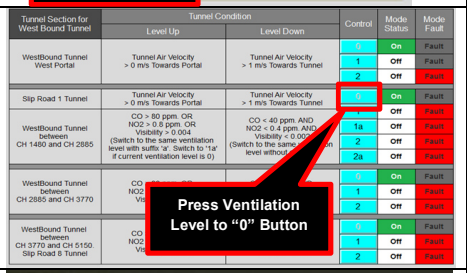
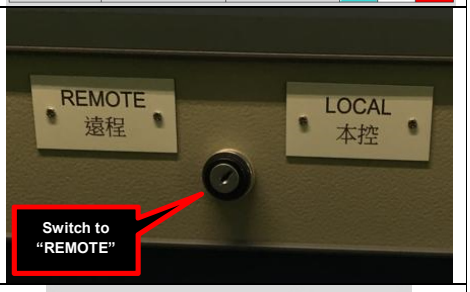
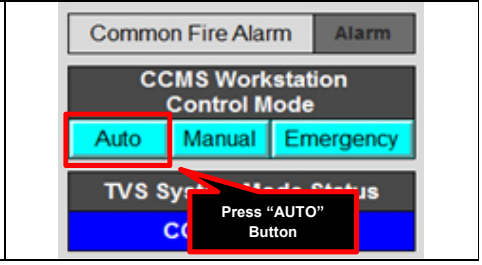
APPENDIX 6 – TVF OPERATION INSTRUCTION

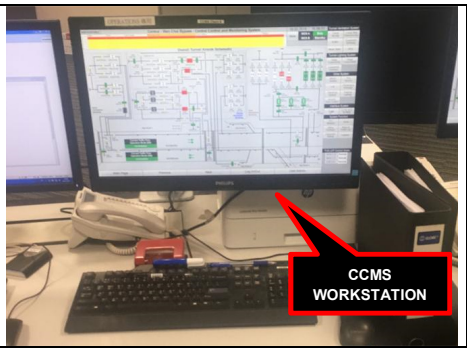
Case 4 : Activate Local Control of TVS at TVS Local Control Panel (LCP) at Ventilation Building and Resume Auto Control of Normal Mode Operation by CCMS Workstation at ADB Control Room

1	Deactivate "Normal Mode" Procedures	
a	Tunnel Operator deactivate TVS Normal Mode operation on TVS Local Control Panel (LCP) at Ventilation Building	
b	Use Remote / Local switch key to switch to local mode on TVS Local Control Panel (LCP) at Ventilation Building Remark: Once switch to local mode, the related equipment ie. TVFs, APS and Dampers will be overridden in local mode at Ventilation Building.	
c	Use control screen for selecting the control mode of the LCP (Remote / Local). Tunnel Operator follow mode table to local switch on the related APS, Dampers and TVS one by one.	
d	Manual Stop TVS Fans on TVS Local Control Panel (LCP) at Ventilation Building 1. Press "Manual" button and "Confirm" button.	

	2. Press “Stop” button and “Confirm” button to stop fun based on TVS Mode Table.	
e	Manual Stop APS units on TVS Local Control Panel (LCP) at Ventilation Building 1. Press “Manual” button and “Confirm” button. 2. Press “Stop” button and “Confirm” button to stop APS Unit (if necessary).	
f	Manual Close Building Dampers on TVS Local Control Panel (LCP) at Ventilation Building 1. Press “Manual” button and “Confirm” button. 2. Press “Close” button and “Confirm” button to close all related building damper based on TVS Mode Table.	

g	Manual Close Tunnel OHVD Dampers on TVS Local Control Panel (LCP) at Ventilation Building 1. Press “Manual” button and “Confirm” button. 2. Press “Close” button and “Confirm” button to close all related Tunnel OHVD dampers based on TVS Mode Table.	

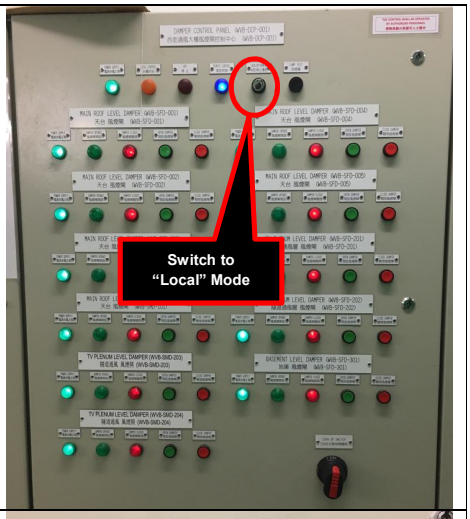
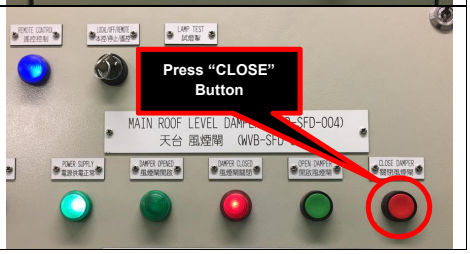
2	Reactivate "Normal Mode" Procedures	
a	In order to prevent the system running to the maximum level as soon as Auto Mode is selected. Tunnel Operator is required to set the CCMS to Manual Mode first by pressing “Manual” button in Mode Table Section Page on CCMS Workstation at ADB Control Room	
b	Subsequently, Tunnel Operator is required to select the ventilation level to the lowest level by pressing “0” button. (For example, press Ventilation Level into "0” button for Slip Road 1, Westbound Tunnel between CH1480 and CH2885.)	
c	Switch to “Remote” mode by Remote / Local switch key on CCMS Local Control Display at Ventilation Building	
d	Press "Auto" button in Mode Table Section Page to resume the system in Auto Mode on CCMS Workstation at ADB Control Room	

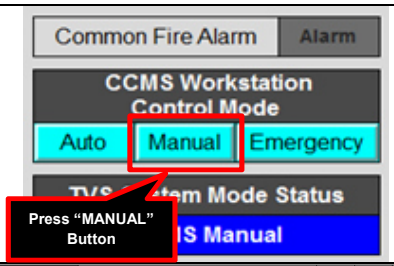
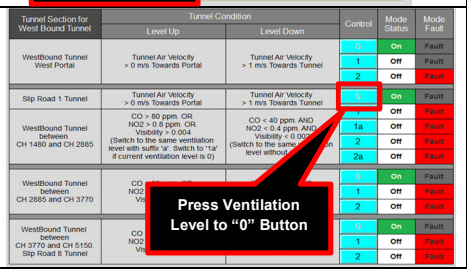
e	Tunnel Ventilation System TVS will be resumed in "Auto" Mode on CCMS Workstation at ADB Control Room.	

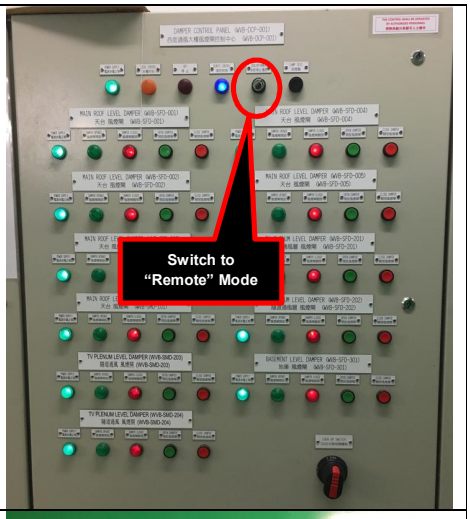
APPENDIX 6 – TVF OPERATION INSTRUCTION

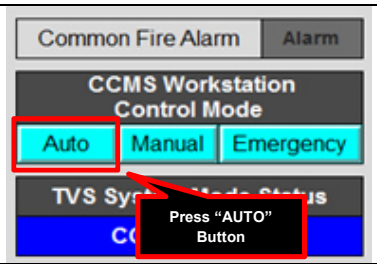
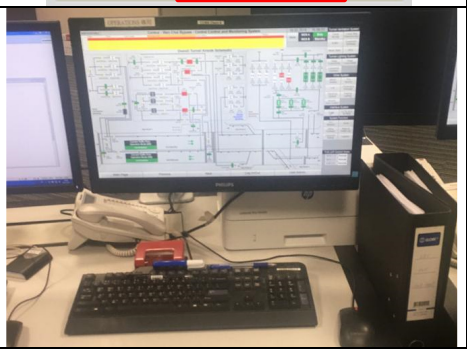
Case 5 : Activate Local Control at Local MCC, DCP and APS / Resume Auto Control of Normal Mode Operation by CCMS Workstation at ADB Control Room

1	Deactivate "Normal Mode" Procedures	
a	Tunnel Operator deactivate TVS Normal Mode operation on Local MCC, DCP and APS at Ventilation Building	
b	Press E-stop for all related TVS at Local MCC at Ventilation Building Remark : Visual and Audio Alarm will be alarmed at ADB Control Room	
c	Press E-stop for all related APS at Local Panel at Ventilation Building Remark : Visual and Audio Alarm will be alarmed at ADB Control Room	

d	Switch to local mode by Remote / Off / Local switch key for Local DCP at Ventilation Building Remark : Visual and Audio Alarm will be alarmed at ADB Control Room	
e	Press "Close" button in related Dampers in ventilation building based on TVS Mode Table.	

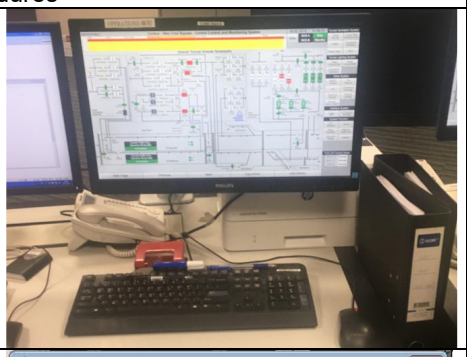
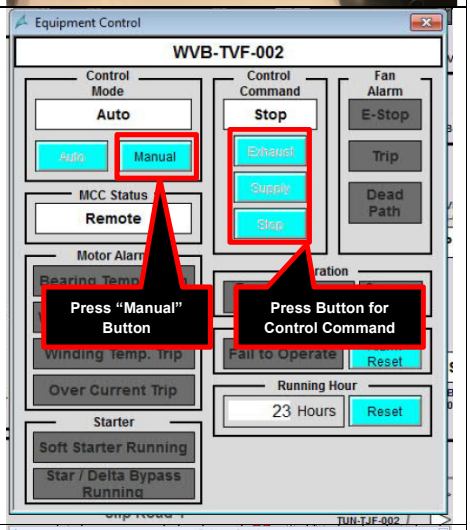
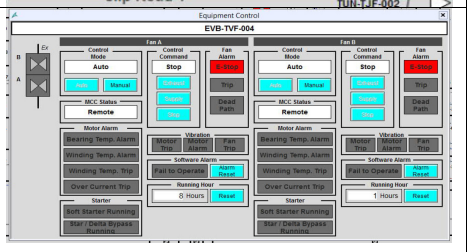
2	Reactivate "Normal Mode" Procedures	
a	In order to prevent the system running to the maximum level as soon as Auto Mode is selected. Tunnel Operator is required to set the CCMS to Manual Mode first by pressing "Manual" button in Mode Table Section Page on CCMS Workstation at ADB Control Room	
b	Subsequently, Tunnel Operator is required to select the ventilation level to the lowest level by pressing "0" button. (For example, press Ventilation Level into "0" button for Slip Road 1, Westbound Tunnel between CH1480 and CH2885.)	

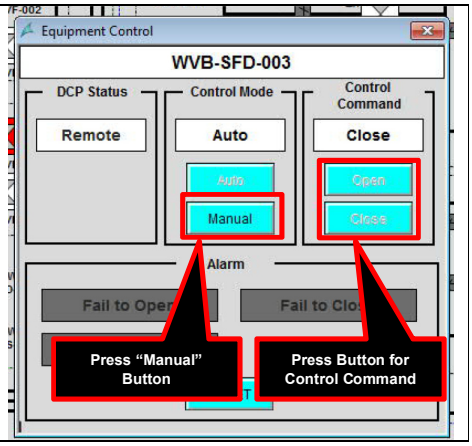
c	Switch to “Remote” mode by Remote / Off / Local switch key for Local Damper Control Panel (DCP) at Ventilation Building	
d	Release E-stop for all related TVS at Local MCC at Ventilation Building	
e	Release E-stop for all related APS at Local Panel at Ventilation Building	

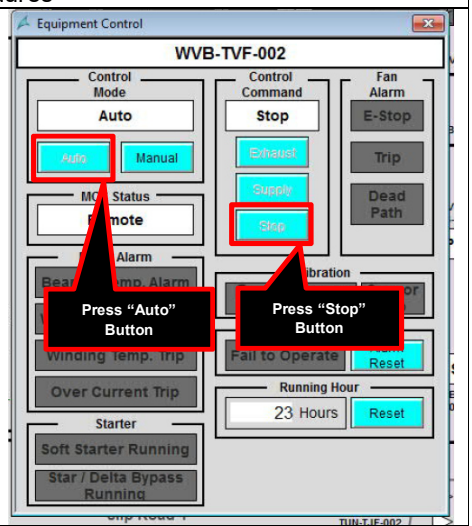
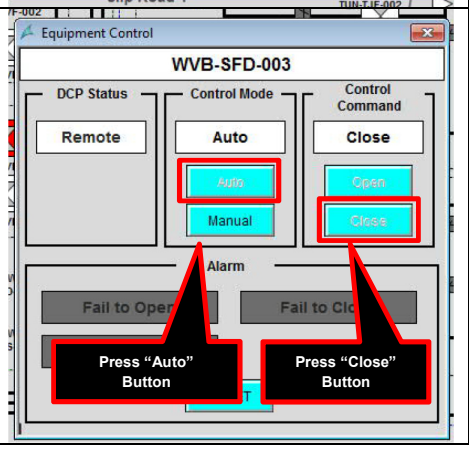
f	Press "Auto" button in Mode Table Section Page to resume the system in “Auto” Mode on CCMS Workstation at ADB Control Room	
g	Tunnel Ventilation System TVS will be resumed in “Auto” Mode on CCMS Workstation at ADB Control Room.	

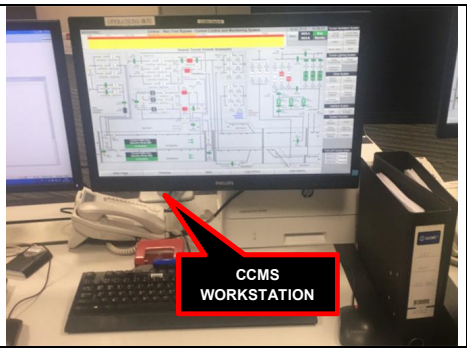
APPENDIX 6 – TVF OPERATION INSTRUCTION

Case 6 : Activate and Deactivate Individual Equipment by CCMS Workstation at ADB Control Room

1	Activate and Deactivate Individual Equipment Procedures	
a	Auto / Manual control of individual equipment Tunnel Ventilation System operate in CCMS Workstation at ADB Control Room.	
b	Tunnel operators can switch individual equipment from “Auto” to “Manual” on CCMS GUI. Individual single stage TVF • Press "Manual" button in Control Mode Section • Press “Exhaust”, “Supply” or “Stop” in Control Command Section. Operator need to manually open all building damper and OHVD in tunnel to create a clean path for the request TVF except associated Damper.	
c	Individual two stage TVF, more interlock during Fan A and Fan B have bi-directional operation. If Fan A or B is running “Exhaust”, another TVF can’t control to run “Supply” direction, the interlock function protect the TVFs always running the same direction Either Fan A or Fan B command to run “Exhaust” or “Supply”.	

d	Individual damper • Press "Manual" button in Control Mode Section • Press “Open” or “Close” in Control Command Section.	

1	Resume Auto Mode on Individual Equipment Procedures	
a	Tunnel operator can switch individual equipment from “Manual” to “Auto” on CCMS GUI. Individual single stage TVF • Press “Stop” in Control Command Section • Press "Auto" button in Control Mode Section Individual two stage TVF If Fan B is commanded to “Stop” when Fan A & B both running, the associated damper will keep open during Fan A still running, and the Fan B will stop after minimum runtime counter passed.	
b	Individual damper • Press “Stop” in Control Command Section • Press "Auto" button in Control Mode Section	

c	Tunnel Ventilation System TVS will be resumed in "Auto" Mode in Individual Equipment on CCMS Workstation at ADB Control Room.	

Appendix 13
Control Philosophy of TVF for In-tunnel Air Quality

the associated APS system and dampers will return to fail-safe position. Other healthy DPRUs at other ventilation buildings will continue to control the tunnel ventilation equipments according to the mode table. After the failed DRPU resumes back to normal, it will continue the auto control mode according to the mode table to start fans, dampers and APS system.

APS system will be stopped when TVS "emergency mode" is activated or tunnel high temperature alarm is received from LHDS or the related TVF is failed. In case of receiving tunnel high temperature alarm from LHDS, the APS system serving the relevant tunnel bound will be stopped. The tunnel ventilation fans and associated dampers are required to stop first before the associated APS system can be stopped.

Operating Mode Table for Normal / Congestion Operation (Uni-Directional Traffic)

Note: AQMS Sensor ID and location refer to Appendix Drawing.

Normal / Congestion Operation (Uni-Directional Traffic)				
Tunnel Section (Mode)	**Level Up Condition [Relationship AQMS Sensor ID]**	**Level Down Condition [Relationship AQMS Sensor ID]**	**Ventilation Level**	**Relationship Tunnel Ventilation Fan**
Westbound Tunnel West portal	Tunnel air velocity >0 (m/s) towards portal [WB-TAV-01]	Tunnel air velocity >1 (m/s) towards tunnel [WB-TAV-01]	0 1 2	WVB-TVF-004,005
Eastbound Tunnel between CH 2885 and CH 3770	CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) [EB-VS-03, EB-CO-03, EB-NO2-03, EB-VS-04, EB-CO-04, EB-NO2-04]	CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [EB-VS-03, EB-CO-03, EB-NO2-03, EB-VS-04, EB-CO-04, EB-NO2-04]	0 1 2	MVB-TVF-004,005,006

Normal / Congestion Operation (Uni-Directional Traffic)				
Tunnel Section (Mode)	**Level Up Condition [Relationship AQMS Sensor ID]**	**Level Down Condition [Relationship AQMS Sensor ID]**	**Ventilation Level**	**Relationship Tunnel Ventilation Fan**
Westbound Tunnel between CH 2885 and CH 3770	CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) [WB-VS-03, WB-CO-03, WB-NO2-03, WB-VS-04, WB-CO-04, WB-NO2-04]	CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [WB-VS-03, WB-CO-03, WB-NO2-03, WB-VS-04, WB-CO-04, WB-NO2-04]	0 1 2	MVB-TVF-001,002,003
Slip road 1 tunnel	Tunnel air velocity >0 m/s towards portal [SR1-TAV-01]	Tunnel air velocity >1 m/s towards tunnel [SR1-TAV-01]	0 1 1a 2 2a	MVB-TVF-011,012,013
Westbound tunnel between CH 1480 and CH 2885	CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) (Switch to same ventilation level with suffix "a") [WB-VS-01, WB-CO-01, WB-NO2-01, WB-VS-02, WB-CO-02, WB-NO2-02]	CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) (Switch to same ventilation level without suffix "a") [WB-VS-01, WB-CO-01, WB-NO2-01, WB-VS-02, WB-CO-02, WB-NO2-02]		
Slip road 3 tunnel	Tunnel air velocity >0 (m/s) towards portal [SR3-TAV-01]	Tunnel air velocity >1 (m/s) towards tunnel [SR3-TAV-01]	0 1 1a 2 2a 3	MVB-TVF-007,008,009,010

Normal / Congestion Operation (Uni-Directional Traffic)				
Tunnel Section (Mode)	**Level Up Condition [Relationship AQMS Sensor ID]**	**Level Down Condition [Relationship AQMS Sensor ID]**	**Ventilation Level**	**Relationship Tunnel Ventilation Fan**
Eastbound tunnel between CH 1480 and CH 2885	CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) (Switch to same ventilation level with suffix "a") [EB-VS-01, EB-CO-01, EB-NO2-01, EB-VS-02, EB-CO-02, EB-NO2-02]	CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) (Switch to same ventilation level without suffix "a") [EB-VS-01, EB-CO-01, EB-NO2-01, EB-VS-02, EB-CO-02, EB-NO2-02]	3a	
Eastbound tunnel at eastern portal	Tunnel air velocity >0 (m/s) towards portal [EB-TAV-08]	Tunnel air velocity >1 (m/s) towards tunnel [EB-TAV-08]	0 1 2 3 4 5	EVB-TVF-004,005,006,007,008,009
Westbound tunnel between CH 3770 and CH 5150, slip road 8 tunnel	CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) [WB-VS-05, WB-CO-05, WB-NO2-05, WB-VS-06, WB-CO-06, WB-NO2-06, WB-VS-07, WB-CO-07, WB-NO2-07, WB-VS-08, WB-CO-08, WB-NO2-08, SR8-VS-01, SR8-CO-01, SR8-NO2-01]	CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [WB-VS-05, WB-CO-05, WB-NO2-05, WB-VS-06, WB-CO-06, WB-NO2-06, WB-VS-07, WB-CO-07, WB-NO2-07, WB-VS-08, WB-CO-08, WB-NO2-08, SR8-VS-01, SR8-CO-01, SR8-NO2-01]	0 1 2	EVB-TVF-001,002,003

Normal / Congestion Operation (Uni-Directional Traffic)				
Tunnel Section (Mode)	**Level Up Condition [Relationship AQMS Sensor ID]**	**Level Down Condition [Relationship AQMS Sensor ID]**	**Ventilation Level**	**Relationship Tunnel Ventilation Fan**
Maintenance Mode of MVB for Eastbound (for the following APS under maintenance: - MVB-APS-003)	The following Level Up Condition are used for controlling WVB TVFs and Dampers): CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) EB-VS-01, EB-CO-01, EB-NO2-01, EB-VS-02, EB-CO-02, EB-NO2-02]	The following Level Down Condition are used for controlling WVB TVFs and Dampers): CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [EB-VS-01, EB-CO-01, EB-NO2-01, EB-VS-02, EB-CO-02, EB-NO2-02]	-	MVB-TVF-012,013 WVB-TVF-001,002,003
Maintenance Mode of MVB for Eastbound (for the following APS under maintenance: - MVB-APS-004)	The following Level Up Condition are used for controlling WVB TVFs and Dampers): CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) EB-VS-01, EB-CO-01, EB-NO2-01, EB-VS-02, EB-CO-02, EB-NO2-02]	The following Level Down Condition are used for controlling WVB TVFs and Dampers): CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [EB-VS-01, EB-CO-01, EB-NO2-01, EB-VS-02, EB-CO-02, EB-NO2-02]	-	MVB-TVF-012,013 WVB-TVF-001,002,003
Maintenance Mode of MVB for Westbound (for the following APS under maintenance: - MVB-APS-001)	The following Level Up Condition are used for controlling WVB TVFs and Dampers): CO > 80 (ppm), OR NO2 > 0.8 (ppm),	The following Level Down Condition are used for controlling WVB TVFs and Dampers): CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m)	-	MVB-TVF-009,010 WVB-TVF-001,002,003

Normal / Congestion Operation (Uni-Directional Traffic)				
Tunnel Section (Mode)	**Level Up Condition [Relationship AQMS Sensor ID]**	**Level Down Condition [Relationship AQMS Sensor ID]**	**Ventilation Level**	**Relationship Tunnel Ventilation Fan**
	OR Visibility > 0.004 (1/m) [WB-VS-01, WB-CO-01, WB-NO2-01, WB-VS-02, WB-CO-02, WB-NO2-02]	[WB-VS-01, WB-CO-01, WB-NO2-01, WB-VS-02, WB-CO-02, WB-NO2-02]		
Maintenance Mode of MVB for Westbound (for the following APS under maintenance: - MVB-APS-002)	The following Level Up Condition are used for controlling WVB TVFs and Dampers): CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) [WB-VS-01, WB-CO-01, WB-NO2-01, WB-VS-02, WB-CO-02, WB-NO2-02]	The following Level Down Condition are used for controlling WVB TVFs and Dampers): CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [WB-VS-01, WB-CO-01, WB-NO2-01, WB-VS-02, WB-CO-02, WB-NO2-02]	-	MVB-TVF-009,010 WVB-TVF-001,002,003
MVB-APS-002 Bypass Mode of MVB	The following Level Up Condition are used for controlling WVB TVFs and Dampers): CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) [WB-VS-01, WB-CO-01, WB-NO2-01, WB-VS-02, WB-CO-02,	The following Level Down Condition are used for controlling WVB TVFs and Dampers): CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [WB-VS-01, WB-CO-01, WB-NO2-01, WB-VS-02, WB-CO-02, WB-NO2-02]	-	MVB-TVF-001,002,003

Normal / Congestion Operation (Uni-Directional Traffic)				
Tunnel Section (Mode)	**Level Up Condition [Relationship AQMS Sensor ID]**	**Level Down Condition [Relationship AQMS Sensor ID]**	**Ventilation Level**	**Relationship Tunnel Ventilation Fan**
	WB-NO2-02]			
MVB-APS-004 Bypass Mode of MVB	The following Level Up Condition are used for controlling WVB TVFs and Dampers): CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) EB-VS-01, EB-CO-01, EB-NO2-01, EB-VS-02, EB-CO-02, EB-NO2-02]	The following Level Down Condition are used for controlling WVB TVFs and Dampers): CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [EB-VS-01, EB-CO-01, EB-NO2-01, EB-VS-02, EB-CO-02, EB-NO2-02]	-	MVB-TVF-001,002,003

Operating Mode Table for Normal / Congestion Operation (Bi-Directional Traffic)

Note: AQMS Sensor ID and location refer to Appendix Drawing.

Normal / Congestion Operation (Bi-Directional Traffic)				
Tunnel Section (Mode)	**Level Up Condition [Relationship AQMS Sensor ID]**	**Level Down Condition [Relationship AQMS Sensor ID]**	**Ventilation Level**	**Relationship Tunnel Ventilation Fan**
Eastbound tunnel west portal	Tunnel air velocity >0 (m/s) towards portal [EB-TAV-01]	Tunnel air velocity >1 (m/s) towards tunnel [EB-TAV-01]	0 1 2	WVB-TVF-004,005
Westbound tunnel west portal	Tunnel air velocity >0 (m/s) towards portal [WB-TAV-01]	Tunnel air velocity >1 (m/s) towards tunnel [WB-TAV-01]	0 1 2	WVB-TVF-004,005
Eastbound tunnel between CH 2885 and CH 3770	CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) [EB-VS-03, EB-CO-03, EB-NO2-03, EB-VS-04, EB-CO-04, EB-NO2-04]	CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [EB-VS-03, EB-CO-03, EB-NO2-03, EB-VS-04, EB-CO-04, EB-NO2-04]	0 1 2	MVB-TVF-004,005,006
Westbound tunnel between CH 2885 and CH 3770	CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) [WB-VS-03, WB-CO-03, WB-NO2-03, WB-VS-04, WB-CO-04, WB-NO2-04]	CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [WB-VS-03, WB-CO-03, WB-NO2-03, WB-VS-04, WB-CO-04, WB-NO2-04]	0 1 2	MVB-TVF-001,002,003
Slip road 1 tunnel	Tunnel air velocity >0 (m/s) towards portal [SR1-TAV-01]	Tunnel air velocity >1 (m/s) towards tunnel [SR1-TAV-01]	0 1 2	MVB-TVF-011,012,013
Westbound tunnel between CH 1480 and CH 2885	CO > 80 (ppm), OR NO2 > 0.8 (ppm) [WB-CO-01, WB-NO2-01, WB-CO-02, WB-NO2-02]	CO < 40 (ppm), AND NO2 < 0.4 (ppm) [WB-CO-01, WB-NO2-01, WB-CO-02, WB-NO2-02]	0 1	MVB-TVF-012,013

Normal / Congestion Operation (Bi-Directional Traffic)				
Tunnel Section (Mode)	**Level Up Condition [Relationship AQMS Sensor ID]**	**Level Down Condition [Relationship AQMS Sensor ID]**	**Ventilation Level**	**Relationship Tunnel Ventilation Fan**
Slip road 3 tunnel	Tunnel air velocity >0 (m/s) towards portal [SR3-TAV-01]	Tunnel air velocity >1 (m/s) towards tunnel [SR3-TAV-01]	0 1 2 3	MVB-TVF-007,008,009,010
Eastbound tunnel between CH 1480 and CH 2885	CO > 80(ppm), OR NO2 > 0.8 (ppm) [EB-CO-01, EB-NO2-01, EB-CO-02, EB-NO2-02]	CO < 40(ppm), AND NO2 < 0.4 (ppm) [EB-CO-01, EB-NO2-01, EB-CO-02, EB-NO2-02]	0 1	MVB-TVF-009,010
Eastbound tunnel between CH 3770 and CH 5150	CO > 80(ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) [EB-VS-05, EB-CO-05, EB-NO2-05, EB-VS-06, EB-CO-06, EB-NO2-06, EB-VS-07, EB-CO-07, EB-NO2-07]	CO < 40(ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [EB-VS-05, EB-CO-05, EB-NO2-05, EB-VS-06, EB-CO-06, EB-NO2-06, EB-VS-07, EB-CO-07, EB-NO2-07]	0 1 2	EVB-TVF-004B,005B,006B
Eastbound Tunnel at Eastern Portal	Tunnel air velocity >0 (m/s) towards portal [EB-TAV-08]	Tunnel air velocity >1 (m/s) towards tunnel [EB-TAV-08]	0 1 2	EVB-TVF-007A,008A,009A
Westbound Tunnel between CH 3770 and CH 5150, Slip Road 8 Tunnel	CO > 80(ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) [WB-VS-05, WB-CO-05, WB-NO2-05, WB-VS-06, WB-CO-06, WB-NO2-06, WB-VS-07, WB-CO-07, WB-NO2-07, WB-VS-08,	CO < 40(ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [WB-VS-05, WB-CO-05, WB-NO2-05, WB-VS-06, WB-CO-06, WB-NO2-06, WB-VS-07, WB-CO-07, WB-NO2-07, WB-VS-08, WB-CO-08, WB-NO2-08,	0 1 2	EVB-TVF-001,002,003

Normal / Congestion Operation (Bi-Directional Traffic)				
Tunnel Section (Mode)	**Level Up Condition [Relationship AQMS Sensor ID]**	**Level Down Condition [Relationship AQMS Sensor ID]**	**Ventilation Level**	**Relationship Tunnel Ventilation Fan**
	WB-CO-08, WB-NO2-08, SR8-VS-01, SR8-CO-01, SR8-NO2-01]	SR8-VS-01, SR8-CO-01, SR8-NO2-01]		
Westbound Tunnel at Eastern Portal	Tunnel air velocity >0 (m/s) towards portal [WB-TAV-09]	Tunnel air velocity >1 (m/s) towards tunnel [WB-TAV-09]	0 1 2	EVB-TVF-007A,008A,009A
Maintenance Mode of MVB for Eastbound (for the following APS under maintenance: - MVB-APS-001, MVB-APS-002 & MVB-APS-003)	The following Level Up Condition are used for controlling WVB TVFs and Dampers): CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) EB-VS-01, EB-CO-01, EB-NO2-01, EB-VS-02, EB-CO-02, EB-NO2-02]	The following Level Down Condition are used for controlling WVB TVFs and Dampers): CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [EB-VS-01, EB-CO-01, EB-NO2-01, EB-VS-02, EB-CO-02, EB-NO2-02]	-	MVB-TVF-004,005,006 MVB-TVF-012,013
Maintenance Mode of MVB for Eastbound (for the following APS under maintenance: - MVB-APS-004)	The following Level Up Condition are used for controlling WVB TVFs and Dampers): CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) EB-VS-01, EB-CO-01, EB-NO2-01, EB-VS-02, EB-CO-02, EB-NO2-02]	The following Level Down Condition are used for controlling WVB TVFs and Dampers): CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [EB-VS-01, EB-CO-01, EB-NO2-01, EB-VS-02, EB-CO-02, EB-NO2-02]	-	MVB-TVF-009,010
Maintenance Mode of MVB for Westbound (for the	The following Level Up Condition are used for controlling WVB TVFs and	The following Level Down Condition are used for controlling WVB TVFs and Dampers):	-	MVB-TVF-001,002,003 MVB-TVF-009,010

Normal / Congestion Operation (Bi-Directional Traffic)				
Tunnel Section (Mode)	**Level Up Condition [Relationship AQMS Sensor ID]**	**Level Down Condition [Relationship AQMS Sensor ID]**	**Ventilation Level**	**Relationship Tunnel Ventilation Fan**
following APS under maintenance: - MVB-APS-001, MVB-APS-003 & MVB-APS-004)	Dampers): CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) [WB-VS-01, WB-CO-01, WB-NO2-01, WB-VS-02, WB-CO-02, WB-NO2-02]	CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [WB-VS-01, WB-CO-01, WB-NO2-01, WB-VS-02, WB-CO-02, WB-NO2-02]		
Maintenance Mode of MVB for Westbound (for the following APS under maintenance: - MVB-APS-002)	The following Level Up Condition are used for controlling WVB TVFs and Dampers): CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) [WB-VS-01, WB-CO-01, WB-NO2-01, WB-VS-02, WB-CO-02, WB-NO2-02]	The following Level Down Condition are used for controlling WVB TVFs and Dampers): CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [WB-VS-01, WB-CO-01, WB-NO2-01, WB-VS-02, WB-CO-02, WB-NO2-02]	-	MVB-TVF-001,002,003 MVB-TVF-009,010
MVB-APS-002 Bypass Mode of MVB	The following Level Up Condition are used for controlling WVB TVFs and Dampers): CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) [WB-VS-01, WB-CO-01, WB-NO2-01, WB-VS-02, WB-CO-02, WB-NO2-02]	The following Level Down Condition are used for controlling WVB TVFs and Dampers): CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [WB-VS-01, WB-CO-01, WB-NO2-01, WB-VS-02, WB-CO-02, WB-NO2-02]	-	MVB-TVF-001,002,003

Normal / Congestion Operation (Bi-Directional Traffic)				
Tunnel Section (Mode)	**Level Up Condition [Relationship AQMS Sensor ID]**	**Level Down Condition [Relationship AQMS Sensor ID]**	**Ventilation Level**	**Relationship Tunnel Ventilation Fan**
MVB-APS-004 Bypass Mode of MVB	The following Level Up Condition are used for controlling WVB TVFs and Dampers): CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m) EB-VS-01, EB-CO-01, EB-NO2-01, EB-VS-02, EB-CO-02, EB-NO2-02]	The following Level Down Condition are used for controlling WVB TVFs and Dampers): CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m) [EB-VS-01, EB-CO-01, EB-NO2-01, EB-VS-02, EB-CO-02, EB-NO2-02]	-	MVB-TVF-009,010

The requirement for fulfilling the "Level Up Condition" of ventilation level is either one measured reading of mentioned AQMS sensors is above the setpoint. The following is the level up example:

Level up setpoints	Related AQMS Sensor	Example 1: EB-VS-01 is 0.005 (1/m) Example 2: EB-CO-02 is 85 (ppm)
CO > 80 (ppm), OR NO2 > 0.8 (ppm), OR Visibility > 0.004 (1/m)	EB-VS-01, EB-CO-01, EB-NO2-01, EB-VS-02, EB-CO-02, EB-NO2-02]	

The requirement for fulfilling the "Level Down Condition" of ventilation level are both measured reading of mentioned AQMS sensors are below the setpoints. The following is the level up example:

Level down setpoints	Related AQMS Sensor	Example: EB-VS-01 is 0.001 (1/m) EB-CO-01 is 35 (ppm) EB-NO2-01 is 0.3 (ppm) EB-VS-02 is 0.001 (1/m) EB-CO-02 is 38 (ppm) EB-NO2-02 is 0.2 (ppm)
CO < 40 (ppm), AND NO2 < 0.4 (ppm), AND Visibility < 0.002 (1/m)	EB-VS-01, EB-CO-01, EB-NO2-01, EB-VS-02, EB-CO-02, EB-NO2-02]	

With the mode with ventilation level including suffix "a", the switching level up and level down sequence will be shown in Appendix D – Mode Table with suffix "a" combination.

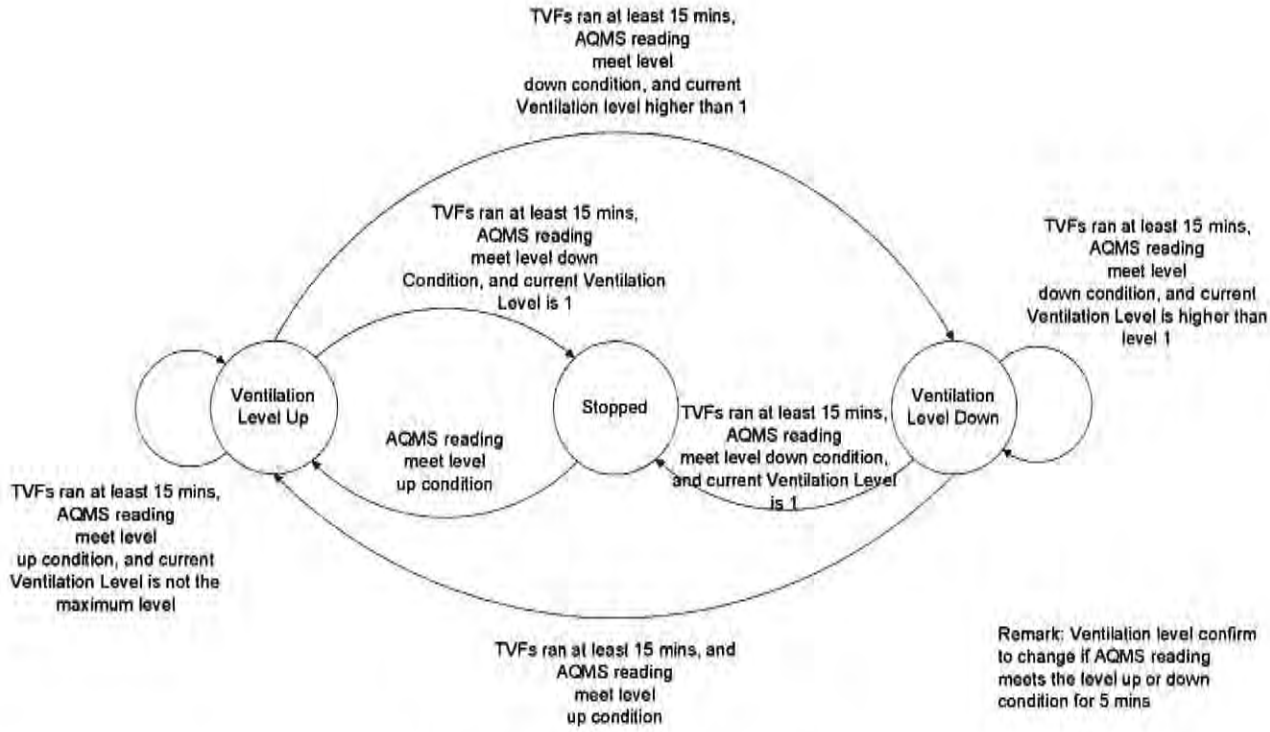


Diagram for Normal/Congestion Mode

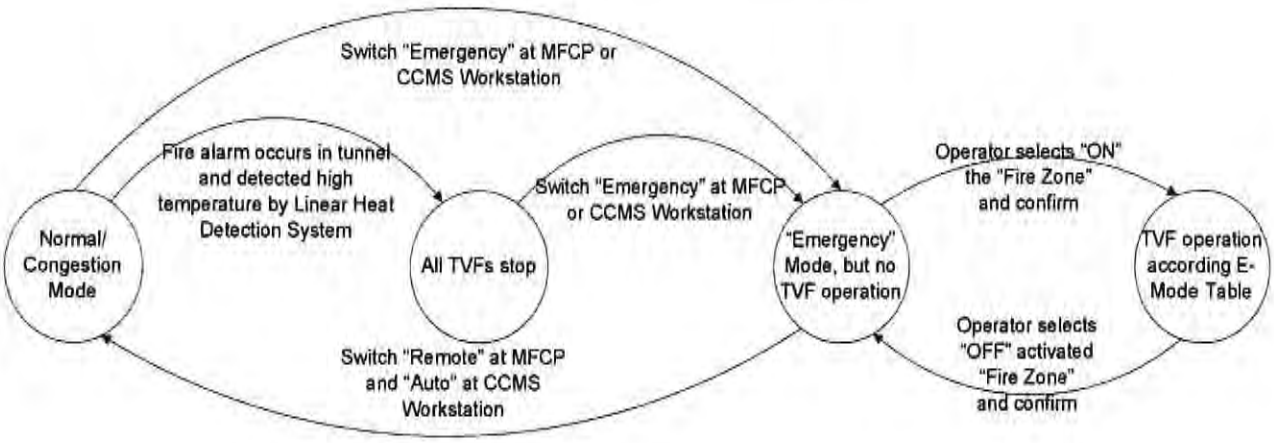


Diagram for Emergency Mode

Appendix 14
Maintenance Checklist for AQMS

SICK
Sensor Intelligence.

7th August 2019

Leighton Contractors (Asia) Limited
Room 1308, Kodak House,
321 Java Road,
Hong Kong

Dear Mr. Tommy Hon,

Recommended Maintenance Procedures for AQMS

Air Quality Monitoring System (AQMS) monitors NO_2, CO, visibility, temperature and air velocity in tunnel to help providing good tunnel environment to tunnel users. The AQMS in Central - Wan Chai Bypass consists of three sensors:

- VICOTEC321 (NO_2, visibility, temperature)
- VICOTEC412 (CO)
- VM400 (Air velocity)

For a fully functional AQMS, we strongly recommend the operators to maintain the sensors at a regular basis.

Enclosed please find a periodic maintenance checklist with detailed procedures attached.

If you have any questions, please feel free to contact me.

Sincerely,

Yannick

Ying Li
Project Management Officer
Ying.Li@sick.com.hk
+852 2153 6318

Periodic Maintenance Checklist for AQMS system in CWB
CWB 隧道 AQMS 系統日常維護表

VICOTEC321 (NO2, visibility, temperature)

Daily reading monitoring 每日恆常監測		OK	Remarks
1.	Is NO2 reading plausible? For example: NO2 讀數是否正常/合理? 不正常情況例如： • Reading is negative • 讀數是負數 • Reading is frozen for more than 5 minutes (monitor when the device seems abnormal) • 懷疑裝置有問題時，留意讀數是否連續 5 分鐘不曾變更 • Reading does not go down after ventilation • 抽風系統啟動後，讀數仍未回落		To be checked on CCMS screen in Control Room. 讀數於控制室 CCMS 屏幕進行每日恆常監測。 Report when fault occurs. 如有異常請上報。
2.	Is visibility reading plausible? For example: VIS 讀數是否正常/合理? 不正常情況例如： • Reading is negative • 讀數是負數 • Reading is frozen for more than 5 minutes (monitor when the device seems abnormal) • 懷疑裝置有問題時，留意讀數是否連續 5 分鐘不曾變更 • Reading does not go down after ventilation • 抽風系統啟動後，讀數仍未回落		To be checked on CCMS screen in Control Room. 讀數於控制室 CCMS 屏幕進行每日恆常監測。 Report when fault occurs. 如有異常請上報。
3.	Is temperature reading plausible? For example: 溫度讀數是否正常/合理？不正常情況例如： • Reading ≤ 0°C • 讀數少於 0°C • Reading is not consistent with other temperature readings at vicinity • 跟附近其他測溫讀數比較，是否一致 • Reading is significantly different from actual tunnel condition • 讀數跟隧道內應有溫度存有明顯差異		To be checked on CCMS screen in Control Room. 讀數於控制室 CCMS 屏幕進行每日恆常監測。 Report when fault occurs. 如有異常請上報。
Quarterly routine site inspection 每季常規檢查			
1.	Visual check of sensor tube blockage. 檢查防塵筒內有沒有異物 • Check if there is any obstacles (e.g. insects) in sensor tubes (sender/receiver unit and reflector unit) • 檢查有否異物，例如昆蟲 • Remove obstacles (if any) • 如有，請移除		Or when necessary. 或有需要時。
2.	Cleaning of lens (if necessary). 如有需要，請清潔保護鏡		Or when necessary.

	• No direct looking into the light beam • 不要直視光源 • Detailed procedures are shown in Appendix A – Section (1) • 步驟見附錄 A		或有需要時。
Yearly routine site inspection 每年常規檢查			
1.	Replace activated charcoal bag in sender/receiver unit. 更換活性碳(包裝) PN 5323946 • Detailed procedures are shown in Appendix A – Section (2) • 步驟見附錄 A		
2.	Replace the drying agent cartridge in reflector unit. 更換乾燥劑 PN 2012785 • Detailed procedures are shown in Appendix A – Section (2) • 步驟見附錄 A		
3.	Conduct NO2 and visibility span test. 用專用濾鏡進行 NO2 及 VIS 測試 • Detailed procedures are shown in Appendix A – Section (3) • 步驟見附錄 A		
Before and after tunnel cleaning 清洗隧道前後			
1.	Before tunnel cleaning, cover the sender/receiver unit and reflector unit with the yellow lid provided. 在清洗隧道前，防塵筒上請裝上黃色蓋 • Cover the tube front to avoid water going into the tube • 裝上黃色蓋作防水之用		
2.	After tunnel cleaning, remove the yellow lids from tube fronts. 清洗完畢後請移除黃色蓋		

VICOTEC412 (CO)

Daily reading monitoring 每日恆常監測		Yes/No	Remarks
1.	Is CO reading plausible? For example: CO 讀數是否正常/合理? 不正常情況例如： • Reading is negative • 讀數是負數 • Reading is frozen for more than 5 minutes (monitor when the device seems abnormal) • 懷疑裝置有問題時，留意讀數是否連續 5 分鐘不曾變更 • Reading does not go down after ventilation • 抽風系統啟動後，讀數仍未回落		To be checked on CCMS screen in Control Room. 讀數於控制室 CCMS 屏幕進行每日恆常監測。 Report when fault occurs. 如有異常請上報。
Quarterly routine site inspection 每季常規檢查			
1.	Visual check of sensor tube blockage. 檢查防塵筒內有沒有異物 • Check if there is any obstacles (e.g. insects) in sensor tubes (sender unit and receiver unit) • 檢查有否異物，例如昆蟲 • Remove obstacles (if any) • 如有，請移除		Or when necessary. 或有需要時。
2.	Cleaning of lens (if necessary). 如有需要，請清潔保護鏡 • No direct looking into the light beam • 不要直視光源 • Detailed procedures are shown in Appendix B – Section (1) • 步驟見附錄 B		Or when necessary. 或有需要時。
Yearly routine site inspection 每年常規檢查			
1.	Conduct CO span test. 用專用濾鏡進行 CO 測試 • Detailed procedures are shown in Appendix B – Section (2) • 步驟見附錄 B		
Before and after tunnel cleaning 清洗隧道前後			
1.	Before tunnel cleaning, cover the sender unit and receiver unit with the yellow lid provided. 在清洗隧道前，防塵筒上請裝上黃色蓋 • Covering the tube front to avoid water going into the tube • 裝上黃色蓋作防水之用		
2.	After tunnel cleaning, remove the yellow covers from tube front. 清洗完畢後請移除黃色蓋		

VM400 (Air velocity)

Daily reading monitoring 每日恆常監測		Yes/No	Remarks
1.	Is airflow reading plausible? For example: 風速讀數是否正常/合理? 不正常情況例如： • Reading is frozen for more than 5 minutes (monitor when the device seems abnormal) • 懷疑裝置有問題時，留意讀數是否連續 5 分鐘不曾變更 • Reading is significantly different from actual tunnel condition • 讀數和隧道內情況有明顯差異		To be checked on CCMS screen in Control Room. 讀數於控制室 CCMS 屏幕進行每日恆常監測。 Report when fault occurs. 如有異常請上報。
Half-yearly routine site inspection 每半年常規檢查			
1.	Visual check of the completeness of device housing. 檢查裝置完整性 • Broken / incomplete housing could affect the functionality of sensor • 損壞 / 不完整的裝置會影響性能		Or when necessary. 或有需要時。
2.	Visual check of airflow path blockage. 檢查裝置內有沒有異物 • Remove obstacles in airflow path (if any) • 如有，請移除		Or when necessary. 或有需要時。
After tunnel cleaning 清洗隧道後			
1.	Visual check of device housing. 檢查裝置內有沒有水滴 • Ultrasonic transducers are sensitive to water presence, therefore no water droplets shall be found inside the device housing • 水滴會影響超聲波傳感器的運作，如有水滴，請清潔裝置		

Appendix 15
Record for Manual Adjustment of Ventilation Level in Case of Abnormal AQMS Sensor Readings

Record reference no. _____

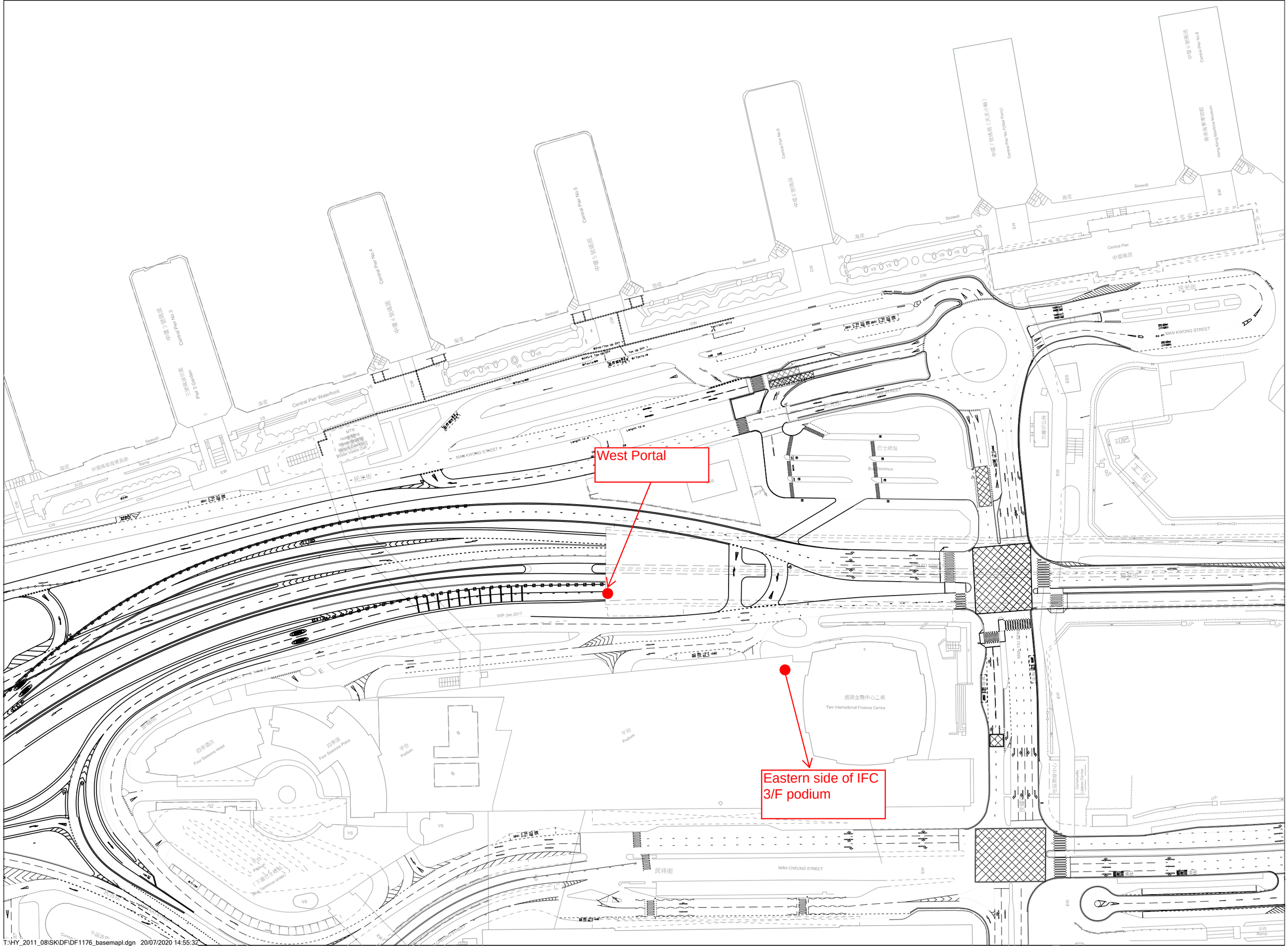
Record for manual adjustment of ventilation level in case of abnormal AQMS sensor readings

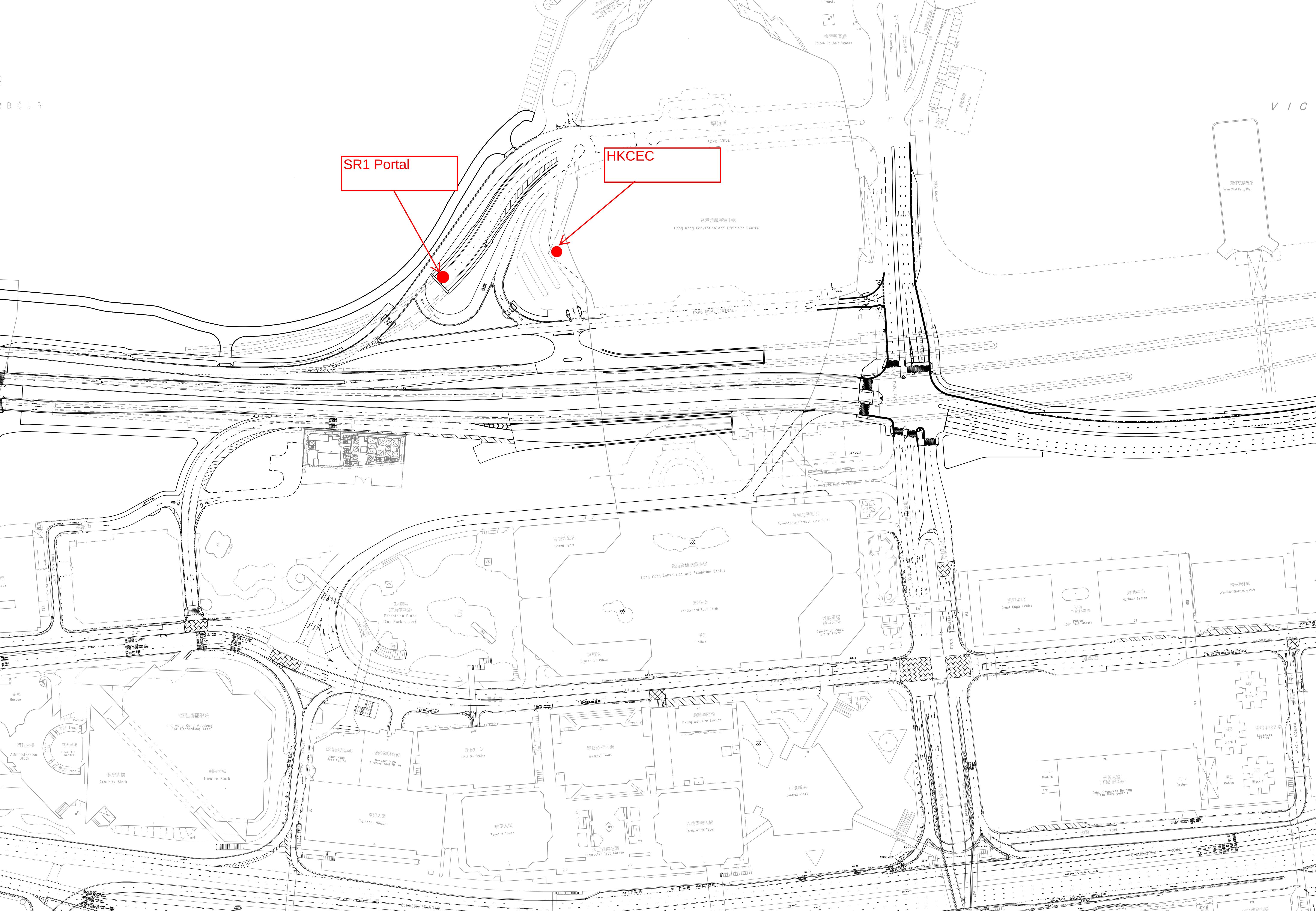
Date	:		
Concerned AQMS sensor(s)	:		
Description of abnormality	:		
Details of action taken	:		
Time	:	(Switching to Manual Mode)	(Resumption to Auto Mode)
The operating APS and TVFs at the concerned ventilation building	:	(Before switching to Manual Mode)	(After resumption to Auto Mode)
Ventilation level	:	(Before switching to Manual Mode)	(After resumption to Auto Mode)
Were the readings of neighbouring sensor(s) in compliance with the maximum concentration limits as stated in Practice Note on Control of Air Pollution in Vehicle Tunnels during the Manual Mode? *	:		
Was traffic flow data referred to for the switching of Manual Mode (in case of inaccurate neighbouring sensor(s))? *	:		

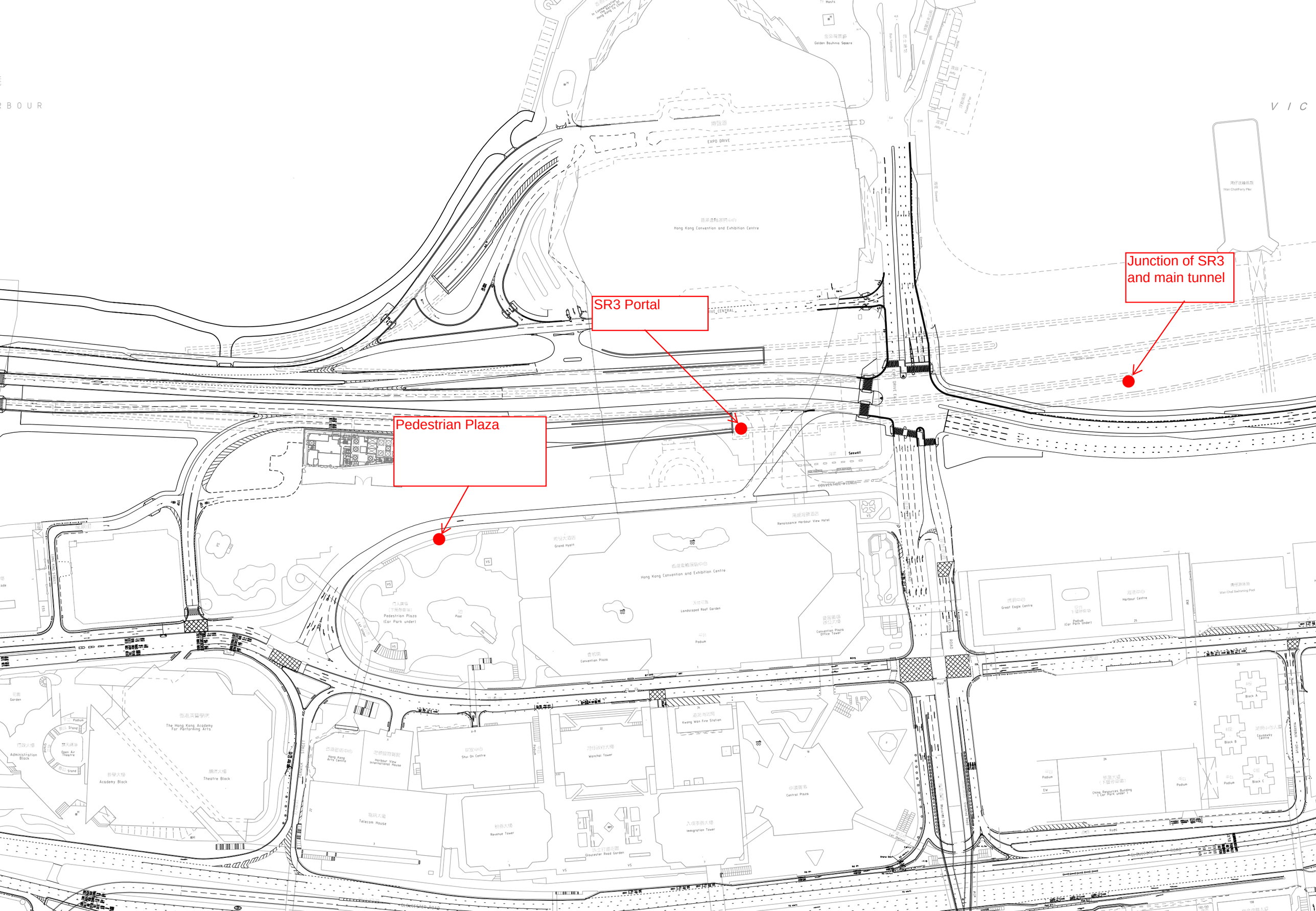
* ET / IEC may request for supplementation of relevant data for verification

Name: _____ Position: _____ Signature: _____

Appendix 16
Layout of Additional Air Quality Monitoring Stations


West Portal
Eastern side of IFC 3/F podium
Central Pier No.3
Central Pier No.4
Central Pier No.5
Central Pier No.6
Central Pier No.7(Star Ferry)
Central Pier No.8
Hong Kong Maritime Museum
Central Pier
Central Pier Waterfront
Pier 3 Garden
Seawall
Ramp
MAN KWONG STREET
MAN CHEUNG STREET
Length 10 m
Four Seasons Hotel
Four Seasons Place
Two International Finance Centre
Bus Terminus
Podium
Community Liaison Centre
WIP Jan 2017
T:\HY_2011_08\SK\DF\DF1176_basemapl.dgn 20/07/2020 14:55:32


SR1 Portal
HKCEC


SR3 Portal
Junction of SR3 and main tunnel
Pedestrian Plaza
EXPO DRIVE
HARBOUR ROAD
GLOUCESTER ROAD
CONVENTION AVENUE
Hong Kong Convention and Exhibition Centre
Grand Hyatt
Renaissance Harbour View Hotel
Pedestrian Plaza (Car Park under)
Pool
Landscaped Roof Garden
Convention Plaza
Convention Plaza Office Tower
Podium
Great Eagle Centre
Harbour Centre
Wan Chai Swimming Pool
Causeway Centre
China Resources Building (Car Park under)
Central Plaza
Immigration Tower
Revenue Tower
Telecom House
Shui On Centre
Wanchai Tower
Kwong Wan Fire Station
Gloucester Road Garden
Hong Kong Arts Centre
Harbour View International House
The Hong Kong Academy For Performing Arts
Academy Block
Theatre Block
Administration Block
Open Air Theatre
Garden
Golden Bauhinia Square
Wan Chai Ferry Pier
Sea wall

East Portal

Causeway Bay Community Centre

ISLAND EASTERN CORRIDOR LINK EASTBOUND

ISLAND EASTERN CORRIDOR LINK WESTBOUND

LANDSCAPE DECK

Elevated Road

CUT LINE A-A

CUT LINE B-B

ADMINISTRATION BUILDING

EXISTING OPEN CHANNEL TO BE DEMOLISHED

BOX-CULVERT U1

Seawall

GOVERNMENT SUPPLIES DEPARTMENT

EX-GOVERNMENT SUPPLIES DEPARTMENT DEPOT

THE ELECTRIC CENTRE

Block 11

Block 12

Block 13

Block 14

Fu Lee Loy Mansion 27-9

King Wah House 7-5

Victor Court 18

Wang Fai Mansion 12-2

AIA Tower 183

Electric Road Municipal Services Building 229

Rest Garden

Car Park

KING WAH ROAD

WANG ON ROAD

ELECTRIC ROAD

FOOK YUM ROAD

OIL STREET

Harbour Grand Hong Kong

Harbour Heights

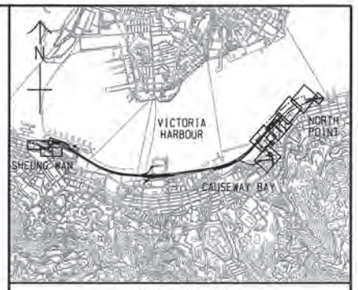
Nam Fung Court

Home Affairs Department Causeway Bay Community Centre

Commercial Complex Under Podium

Podium

Seawall



KEY PLAN
SCALE A1 1 : 50000
A3 1 : 100000

NOTES:
1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH DRAWINGS NO. 60095653/IEC/1001 AND 1003 TO 1006.
2. FOR NOTES AND LEGEND REFER TO DRAWING. NO. 60095653/IEC/1001.

REV. 修訂	DESCRIPTION 內容摘要	DES. 設計	CHECKED 核對	DATE 日期
A	WORKING DRAWING	ALCF	BCC	DEC 10
-	TENDER DRAWING	ALCF	BCC	MAY 10

Highways Department 路政署
Major Works Project Management Office

CENTRAL - WAN CHAI BYPASS AND IEC LINK

PWP ITEM NO. 工務計劃項目編號 579 TH

CENTRAL - WAN CHAI BYPASS - TUNNEL (NORTH POINT SECTION) AND ISLAND EASTERN CORRIDOR LINK

GENERAL LAYOUT

SHEET 2 OF 6

AECOM

DRG.NO. 圖紙編號 60095653/IEC/1002A

DESIGNED BY 設計	CONTRACT NO. 合約編號	P. Dir. APPROVED 批准人
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