

2. AIR QUALITY

2.1 Introduction

In this section, the methodology, equipment, monitoring locations, criteria and protocols for the monitoring and audit of air quality impacts during the construction are explained. Dust is expected to be the key pollutant.

The impact of fugitive dust on ambient air pollution depends on the quantity, as well as the drift potential, of the dust particles injected into the atmosphere. Large dust particles will settle out near the source. Particles that are 30 - 100 μm in diameter are likely to settle within a distance of 100 m from the source depending on atmospheric turbulence. The main dust impact will arise from the fine particles of a diameter less than 30 μm , measured as TSP, dispersed over great distances. TSP levels shall, therefore, be monitored to evaluate the dust impact during construction. The objectives of TSP monitoring shall be:

- to identify the extent of construction dust impacts on sensitive receivers;
- to determine the effectiveness of mitigation measures in controlling construction activities;
- to recommend further mitigation measures if found to be necessary; and
- to comply with AL Levels for air quality as defined in this Manual.

2.2 Air Quality Parameters

Monitoring and audit of the TSP levels shall be carried out by the ET to ensure that any deteriorating air quality can be readily be detected and timely actions taken.

1-hour and 24-hour TSP levels shall be measured to indicate the impact of construction dust on air quality. The TSP levels shall be measured by following the standard high volume sampling method as set out in 'Title 40 of the Code of Federal Regulations, Chapter 1 (Part 50), Appendix B'. Upon approval of the ER, 1-hour TSP levels can be measured by direct reading methods, which are capable of producing comparable results to those by the high volume sampling method, to indicate short event impacts.

All relevant data including temperature, pressure, weather conditions, elapsed-time meter reading for the start and finish of the sampler, identification and weight of the filter paper, and other special phenomena and work progress of the concerned site shall be recorded in detail. A sample data sheet is shown in *Annex A*.

2.3 Monitoring Equipment

High volume samplers (HVS) complying with the following specification shall be used for carrying out the 1-hr and 24-hr TSP monitoring:

- a) m^3/min (20-60 SCFM) adjustable flow range;
- b) equipped with a timing/control device with ± 5 minutes accuracy for 24 hours operation;
- c) installed with elapsed-time meter with ± 2 minutes accuracy for 24 hours operation;
- d) capable of providing a minimum exposed area of 406 cm^2 (63 in^2);
- e) flow control accuracy: $\pm 2.5\%$ deviation over 24-hr sampling period;
- f) equipped with a shelter to protect the filter and sampler;
- g) incorporated with an electronic mass flow rate controller or other equivalent devices;
- h) equipped with a flow recorder for continuous monitoring;
- i) provided with a peaked roof inlet;
- j) incorporated with a manometer;
- k) able to hold and seal the filter paper to the sampler housing in a horizontal position; and
- l) easy to change the filter; and capable of operating continuously for 24-hr period.

The ET Leader will be responsible for ensuring provision of the monitoring equipment. He shall ensure that sufficient HVSs, with appropriate calibration kits, are available for carrying out the baseline monitoring, regular impact monitoring and ad hoc monitoring. The HVSs shall be equipped with an electronic mass flow controller and be calibrated against a traceable standard at regular intervals. All the equipment, calibration kit, filter papers, etc. shall be clearly labelled.

Initial calibration of dust monitoring equipment shall be conducted upon installation and thereafter at bi-monthly intervals. The transfer standard shall be traceable to the internationally recognised primary standard and be calibrated annually. The calibration data shall be properly documented for future reference by concerned parties, such as the IC(E). All the data shall be converted into standard temperature and pressure conditions.

The flow-rate of the sampler before and after the sampling exercise with the filter in position shall be verified as constant and be recorded in the data sheet as mentioned in *Annex A*.

If the ET Leader proposes to use a direct reading dust meter to measure 1-hr TSP levels, he shall submit sufficient information to the IC(E) to prove that the instrument is capable of achieving a comparable result to the HVS and may be used for the 1-hr sampling. The instrument shall also be calibrated regularly, and the 1-hr sampling shall be determined periodically by HVS to check the validity and accuracy of the results.

In exceptional situations, the ET Leader may adopt alternative methods to obtain representative wind data after gaining approval from the ER and agreement from IC(E).

2.4 Laboratory Measurement / Analysis

A clean laboratory shall be available to analyse the collected dust samples. This shall have constant temperature and humidity control and be equipped with all necessary measuring and conditioning instruments including for equipment calibration and maintenance. The laboratory shall be accredited by HOKLAS or other internationally accredited body.

If a site laboratory is set up or a non-HOKLAS accredited laboratory is hired for carrying out the laboratory analysis, the laboratory equipment shall be approved by the ER in consultation with the IC(E). Measurement performed by the laboratory shall be demonstrated to the satisfaction of the ER and the IC(E). The IC(E) shall conduct regular audits of the measurements performed by the laboratory to ensure the accuracy of results. The ET Leader shall provide the ER with one copy of the 'Title 40 of the Code of Federal Regulations, Chapter 1 (Part 50), Appendix B' for his reference.

Filter paper of size 8"x 10" shall be labelled before sampling. It shall be a clean filter paper with no pin holes, and shall be conditioned in a humidity controlled chamber for over 24-hr and be pre-weighed before use.

After sampling, the filter paper loaded with dust shall be kept in a clean and tightly sealed plastic bag. The filter paper shall then be returned to the laboratory for reconditioning in the humidity controlled chamber followed by accurate weighing by an electronic balance with a readout down to 0.1 mg. The balance shall be regularly calibrated against a traceable standard.

All the collected samples shall be kept in good condition for 6 months prior to disposal.

2.5 Monitoring Locations

The dust monitoring locations are shown on *Figure 2.1-4* and summarised in *Table 2.1*. The status and locations of dust sensitive receivers may change after issuing this Manual. If this happens, the ET Leader shall propose updated monitoring locations and seek approval from the ER and agreement from the IC(E).

Table 2.1 Dust Monitoring Stations

Dust Monitoring Stations	
AM1	Tso Wan Village
AM2	Hong Kong Garden
AM3	Tai Lam Chung Tsuen
AM4	So Kwun Wat Sun Tsuen
AM5	Scattered Houses at So Kwun Wat
AM6	Scattered House to the West of Poseidon Court

Where alternative monitoring locations are proposed, the following criteria, shall be followed as far as practicable:

- a) at the site boundary or such locations close to the major dust emission source;
- b) close to the sensitive receivers; and
- c) take into account the prevailing meteorological conditions.

The ET Leader shall agree with the ER in consultation with the IC(E) the position of the HVS for installation of the monitoring equipment. When positioning the samplers, the following points shall be addressed:

- a) a horizontal platform shall be provided with appropriate support to secure the samplers against gusty winds;
- b) no two samplers shall be placed less than 2 metre apart;
- c) the distance between the sampler and an obstacle, such as a building, must be at least twice the height that the obstacle protrudes above the sampler;
- d) a minimum of 2 metres of separation from walls, parapets and penthouses is required for rooftop samplers;
- e) a minimum of 2 metre separation is required from any supporting structure, measured horizontally;
- f) no furnace or incinerator flue shall be nearby;
- g) airflow around the sampler shall be unrestricted;
- h) the sampler shall be more than 20 metres from the dripline;
- i) any wire fence and gate, to protect the sampler, shall not cause any obstruction during monitoring;
- j) permission must be obtained to set up the samplers and to obtain access to the monitoring stations; and
- k) a secured supply of electricity is required to operate the samplers.

2.6 Baseline Monitoring

The ET Leader shall carry out baseline monitoring at all of the designated monitoring locations for at least 14 consecutive days prior to the commencement of construction to obtain daily 24-hr TSP samples. 1-hr sampling shall also be carried out at least 3 times per day while the highest dust impact is expected. Before commencing the baseline monitoring, the ET leader shall inform the IC(E) of the baseline monitoring programme such that the IC(E) can conduct on-site audits to ensure accuracy of the results.

During the baseline monitoring, there shall not be any construction or dust generating activities in the vicinity of the monitoring stations.

In case the baseline monitoring cannot be carried out at the designated monitoring locations during the baseline monitoring period, the ET Leader shall carry out the monitoring at alternative locations which can effectively represent the baseline conditions at the impact monitoring locations. The alternative baseline monitoring locations shall be approved by the ER and agreed with the IC(E).

In exceptional cases, when insufficient baseline monitoring data or questionable results are obtained, the ET Leader shall liaise with the IC(E) and EPD to agree on an appropriate set of data to be used as a baseline reference. This shall be submitted to ER for approval.

Ambient conditions may vary seasonally and shall be reviewed at three monthly intervals. If the ET Leader considers that the ambient conditions have changed and a repeat of the baseline monitoring is required, the monitoring shall be at times when the contractor's activities are not generating dust, at least in the proximity of the monitoring stations. Should change in ambient conditions be determined, the baseline levels and, in turn, the air quality criteria shall be revised. The revised baseline levels and air quality criteria shall be agreed with the IC(E) and EPD.

2.7 Impact Monitoring

The ET Leader shall carry out impact monitoring during the course of the Works. For regular impact monitoring the sampling frequency of at least once every six-days shall be strictly observed at all the monitoring stations for 24-hr TSP monitoring. For 1-hr TSP monitoring the sampling frequency of at least three times every six-days shall be undertaken when the highest dust impact occurs. Before commencing the baseline monitoring the ET leader shall inform the IC(E) of the impact monitoring programme such that the IC(E) can conduct an on-site audit to ensure accuracy of the impact monitoring results.

The specific time to start and stop the 24-hr TSP monitoring shall be clearly defined for each location and be strictly followed by the operator.

In case of non-compliance with the air quality criteria a more frequent monitoring exercise, as specified in the Action Plan in *Section 2.8*, shall be conducted within 24 hours of obtaining the result. This additional monitoring shall be continued until the excessive dust emission or the deterioration in air quality is rectified.

2.8 Event and Action Plan for Air Quality

The baseline monitoring results form the basis for determining the air quality criteria for impact monitoring. The ET Leader shall compare the impact monitoring results with the air quality criteria set for 24-hour TSP and 1-hour TSP. *Table 2.2* shows the air quality criteria, namely the Action and Limit (AL) Levels to be used. Should non-compliance of the air quality criteria occur the actions set out in the Action Plan in *Table 2.3* shall be undertaken.

Table 2.2 Action and Limit Levels for Air Quality

Parameters	Action	Limit (µg/m ³)
24 Hour TSP Level in µg/m ³	For baseline level ≤ 200 µg/m ³ , Action level = (Baseline level * 1.3 + Limit level)/2; For baseline level > 200 µg/m ³ , Action level = Limit Level	260
1 Hour TSP Level in µg/m ³	For baseline level ≤ 384 µg/m ³ , Action level = (Baseline level * 1.3 + Limit level)/2 For baseline level > 384 µg/m ³ , Action level = Limit Level	500

Table 2.3 Event/Action Plan for Air Quality

EVENT	ACTION			ER	CONTRACTOR
	ET Leader	IC(E)			
1. Exceedance for one sample	<ol style="list-style-type: none"> 1. Identify source 2. Inform IC(E) and ER 3. Repeat measurement to confirm finding 4. Increase monitoring frequency to daily 	<ol style="list-style-type: none"> 1. Check monitoring data submitted by ET 2. Check contractor's working method 	1. Notify contractor	<ol style="list-style-type: none"> 1. Rectify any unacceptable practice 2. Amend working methods if appropriate 	
2. Exceedance for two or more consecutive samples	<ol style="list-style-type: none"> 1. Identify source 2. Inform IC(E) and ER 3. Repeat measurements to confirm findings 4. Increase monitoring frequency to daily 5. Discuss with IC(E) and contractor on remedial actions required 6. If exceedance continues, arrange meeting with IC(E) and ER 7. If exceedance stops, cease additional monitoring 	<ol style="list-style-type: none"> 1. Checking monitoring data submitted by ET 2. Check contractor's working method 3. Discuss with ET and contractor on possible remedial measures 4. Advise the ER on the effectiveness of the proposed remedial measures 5. Supervisor implementation of remedial measures 	<ol style="list-style-type: none"> 1. Confirm receipt of notification of failure in writing 2. Notify contractor 3. Ensure remedial measures properly implemented 	<ol style="list-style-type: none"> 1. Submit proposals for remedial actions to IC(E) within 3 working days of notification 2. Implement the agreed proposals 3. Amend proposal if appropriate 	

EVENT	ACTION		IC(E)	ER	CONTRACTOR
	ET	Leader			
1. Exceedance for one sample	1. Identify source 2. Inform ER and EPD 3. Repeat measurement to confirm finding 4. Increase monitoring frequency to daily 5. Assess effectiveness of contractor's remedial actions and keep IC(E), EPD and ER informed of the results		<ol style="list-style-type: none"> 1. Checking monitoring data submitted by ET 2. Check contractor's working method 3. Discuss with ET and contractor on possible remedial measures 4. Advise the ER on the effectiveness of the proposed remedial measures 5. Supervisor implementation of remedial measures 	<ol style="list-style-type: none"> 1. Confirm receipt of notification of failure in writing 2. Notify contractor 3. Ensure remedial measures properly implemented 	<ol style="list-style-type: none"> 1. Take immediate action to avoid further exceedance 2. Submit proposals for remedial actions to IC(E) within 3 working days of notification 3. Implement the agreed proposals 4. Amend proposal if appropriate
2. Exceedance for two or more consecutive samples	<ol style="list-style-type: none"> 1. Notify IC(E), ER, contractor and EPD 2. Identify source 3. Repeat measurement to confirm findings 4. Increase monitoring frequency to daily 5. Carry out analysis of contractor's working procedures to determine possible mitigation to be implemented 6. Arrange meeting with IC(E) and ER to discuss the remedial actions to be taken 7. Assess effectiveness of contractor's remedial actions and keep IC(E), EPD and ER informed of the results 8. If exceedance stops, cease additional monitoring 		<ol style="list-style-type: none"> 1. Discuss amongst ER, ET, and contractor on the potential remedial actions 2. Review contractor's remedial actions whenever necessary to assure their effectiveness and advise the ER accordingly 3. Supervise the implementation of remedial measures 	<ol style="list-style-type: none"> 1. Confirm receipt of notification of failure in writing 2. Notify contractor 3. In consultation with the IC(E), agree with the contractor on the remedial measures to be implemented 4. Ensure remedial measures properly implemented 5. If exceedance continues, consider what portion of the work is responsible and instruct the contractor to stop that portion of work until the exceedance is abated 	<ol style="list-style-type: none"> 1. Take immediate action to avoid further exceedance 2. Submit proposals for remedial actions to IC(E) within 3 working days of notification 3. Implement the agreed proposals 4. Resubmit proposals if problem still not under control 5. Stop the relevant portion of works as determined by the ER until the exceedance is abated

2.9 Dust Mitigation Measures

The EIA report has recommended dust control and mitigation measures. The contractors shall be responsible for the design and implementation of these measures.

The dust control measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* shall be incorporated in the contract specifications. These shall be during construction implemented in order to reduce dust impact to within the acceptable criteria of $500\mu\text{g}\text{m}^{-3}$. Typical control measures are:

- where breaking of rock/concrete is required, watering shall be implemented to suppress dust generation, water spray shall be used during the handling of excavated material at the site and at active tunnel construction works, excavation and fill sites where dust is likely to be created;
- the height from which excavated materials are dropped shall be controlled to the minimum practical to limit fugitive dust generation from unloading;
- all dusty materials shall be sprayed with water immediately prior to any loading, unloading or transfer operation so as to keep them wet;
- any stockpiles of aggregate or spoil shall be covered and water applied;
- vehicles travelling on haul roads shall be limited to a speed of 20 km/h;
- every vehicle shall be washed to remove any dusty materials from its body and wheels before leaving a construction site;
- loads on vehicles shall be covered entirely by clean impervious sheeting to ensure that dusty materials do not escape; and
- the working area of any excavation shall be sprayed with water before, during and immediately after any operation so as to maintain the entire surface wet.

The following control measures are recommended during blasting of works:

- the areas within 30 m of the blasting area shall be wetted with water prior to blasting;
- blasting shall not be carried out when the strong wind signal or tropical cyclone warning signal No. 3 or higher is hoisted unless with the prior permission of the Commissioner of Miners;
- wire mesh, gunny sacks and sandbags should be used on top of the blast area at each shot to prevent flying rock and dust;
- blast area surfaces shall be watered to increase moisture content; and

- dust filters should be fitted to tunnel construction ventilation systems.

According to the EPD's *Best Practicable Means Requirements for Cement Works (Concrete Batching Plant)*, the following mitigation measures are required for concrete batching plants:

- the loading, unloading, handling, or transfer or storage of cement, pulverised fuel ash or other equally dusty materials shall be carried in a enclosed system;
- all dust-laden air or waste gas shall be properly extracted and vented to a fabric filtering system;
- cement, pulverised fuel ash or other equally dusty materials shall be stored in a storage silo fitted with audible high level alarms to warn of over-filling. The high-level alarm indicators shall be interlocked with the material filling line;
- vents of all silos and weighing scales shall be fitted with fabric filtering system;
and
- before each delivery the seating of pressure relief valves of all silos shall be checked, and the valves reseated if necessary.

If the above measures are not sufficient to restore the air quality to acceptable levels, the contractor shall liaise with the ET Leader to devise further mitigation measures. These shall be proposed to the ER for approval and subsequently implement by the contractor.