

TRANSPORT FOR NSW (TfNSW)
QA SPECIFICATION R165
IN-TUNNEL AIR QUALITY MONITORS

NOTICE

This document is a Transport for NSW QA Specification. It has been developed for use with roadworks and bridgeworks contracts let by Transport for NSW or by local councils in NSW. It is not suitable for any other purpose and must not be used for any other purpose or in any other context.

Copyright in this document belongs to Transport for NSW.

REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 1/Rev 0		First issue.	GM, CB	16.02.17
Ed 1/Rev 1	Global	References to “Roads and Maritime Services” or “RMS” changed to “Transport for NSW” or “TfNSW” respectively.	DCS	22.06.20
Ed 1/Rev 2	1.3 3.1.6 3.2.1 3.2.2 4.2.1 4.2.3 Annex M	Definitions and Acronyms updated. Requirement to fit lanyards to removable panels and covers added. Requirement for monitors to comply with AS/NZS 3580.18 added. Table 1 – air quality measurement requirements amended. “IP65 rating” for enclosures raised to “IP66 rating”. Requirement for cables to enter enclosures through bottom deleted. Clarification added that cable entry into enclosures must provide same IP rating as that of enclosures. Referenced documents updated.	EDCS	18.11.20

<p style="text-align: center;">GUIDE NOTES (Not Part of Contract Document)</p>

Submission at Tender Stage

Clause 2 of this Specification requires that details of the manufacturer's qualifications, quality system, and some technical information be submitted at the time of tender.

To ensure that tenderers are aware of this requirement, the Tender Documenter should highlight these requirements in the C12 "Request for Tenders" document.



IN-TUNNEL AIR QUALITY MONITORS

Copyright – Transport for NSW
IC-QA-R165

VERSION FOR: DATE:

CONTENTS

CLAUSE	PAGE
FOREWORD	ii
TfNSW Copyright and Use of this Document.....	ii
Revisions to Previous Version.....	ii
Project Specific Changes.....	ii
1 GENERAL	1
1.1 Scope	1
1.2 Structure of the Specification.....	1
1.3 Definitions and Acronyms	2
2 TENDER SUBMISSION AND MONITOR SELECTION.....	2
2.1 General	2
2.2 Manufacturer’s Qualifications	2
2.3 Manufacturer’s Quality System	3
2.4 Technical Information	3
3 DESIGN AND PERFORMANCE	4
3.1 Performance Requirements.....	4
3.2 Air Quality Measurements.....	5
3.3 Documentation Submission	6
4 MATERIALS AND COMPONENTS.....	7
4.1 General	7
4.2 Enclosures.....	7
5 MANUFACTURE AND FACTORY TESTING	8
5.1 General	8
5.2 Surface Corrosion Protection.....	8
5.3 Inspection and Factory Testing.....	8
5.4 Certification	8
6 TRANSPORT AND DELIVERY	9
6.1 General	9
6.2 Transport.....	9
7 INSTALLATION SUPERVISION AND SITE ACCEPTANCE TESTING	9
7.1 Attendance at Site During Installation and Commissioning.....	9
7.2 Installation and Commissioning Manual(s).....	10
8 POST-COMMISSIONING AND MAINTENANCE.....	10
8.1 Warranty.....	10
8.2 Defects Rectification.....	10
8.3 Routine Maintenance.....	10
8.4 Spare Parts and Consumables	11
8.5 Operation and Maintenance Manual(s)	11
8.6 Tools and Accessories	11
ANNEXURE R165/A – PROJECT SPECIFIC REQUIREMENTS.....	12
ANNEXURE R165/B – MEASUREMENT AND PAYMENT.....	13
B1 Measurement and Payment.....	13

ANNEXURE R165/C – SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS	14
C1 Schedule of Hold Points	14
C2 Schedule of Identified Records	14
ANNEXURE R165/D – PLANNING DOCUMENTS	15
ANNEXURE R165/F – DEFINITION OF EXTINCTION COEFFICIENT	17
ANNEXURES R165/G TO R165/L – (NOT USED)	17
ANNEXURE R165/M – REFERENCED DOCUMENTS	17
LAST PAGE OF THIS DOCUMENT IS	17

FOREWORD

TfNSW COPYRIGHT AND USE OF THIS DOCUMENT

Copyright in this document belongs to Transport for NSW.

When this document forms part of a contract

This document should be read with all the documents forming the Contract.

When this document does not form part of a contract

This copy is not a controlled document. Observe the Notice that appears on the first page of the copy controlled by TfNSW. A full copy of the latest version of the document is available on the TfNSW Internet website: <http://www.rms.nsw.gov.au/business-industry/partners-suppliers/specifications/index.html>

REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification TfNSW R165 Edition 1 Revision 1.

All revisions to the previous version (other than minor editorial and project specific changes) are indicated by a vertical line in the margin as shown here, except when it is a new edition and the text has been extensively rewritten.

PROJECT SPECIFIC CHANGES

Any project specific changes are indicated in the following manner:

- (a) Text which is additional to the base document and which is included in the Specification is shown in bold italics e.g. ***Additional Text***.
- (b) Text which has been deleted from the base document and which is not included in the Specification is shown struck out e.g. ~~Deleted Text~~.

TfNSW QA SPECIFICATION R165

IN-TUNNEL AIR QUALITY MONITORS

1 GENERAL

1.1 SCOPE

This Specification sets out the requirements for the supply of air quality monitors and related items such as mounting supports, for the measurement of in-tunnel air pollutants and visibility, including their design, manufacture, factory testing, documentation and delivery.

This Specification excludes requirements for installation of the air quality monitors, site acceptance testing and supply and installation of all cabling (power and communications) beyond the equipment terminal boxes.

1.2 STRUCTURE OF THE SPECIFICATION

This Specification includes a series of annexures that detail additional requirements.

1.2.1 Project Specific Requirements

Project specific details of work are shown in Annexure R165/A.

The types of air quality monitor and the number of each type required under the Contract is stated in Annexure R165/A.

1.2.2 Measurement and Payment

The method of measurement and payment is detailed in Annexure R165/B.

1.2.3 Schedules of HOLD POINTS and Identified Records

The schedules in Annexure R165/C list the **HOLD POINTS** that must be observed. Refer to Specification TfNSW Q for definition of **HOLD POINTS**.

The records listed in Annexure R165/C are **Identified Records** for the purposes of TfNSW Q Annexure Q/E.

1.2.4 Planning Documents

The PROJECT QUALITY PLAN must include each of the documents and requirements listed in Annexure R165/D and must be implemented.

1.2.5 Referenced Documents

Unless otherwise specified, the applicable issue of a referenced document, other than a TfNSW Specification, is the issue current at the date one week before the closing date for tenders, or where no issue is current at that date, the most recent issue.

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 1234). For convenience, the full titles are given in Annexure R165/M.

1.3 DEFINITIONS AND ACRONYMS

1.3.1 Definitions

The terms “you” and “your” mean “the Contractor” and “the Contractor’s” respectively.

1.3.2 Acronyms

CO	Carbon monoxide
I/O	Input/Output
ITP	Inspection and Test Plan
IP	Ingress protection
LV	Low voltage
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
NO	Nitric oxide
NO₂	Nitrogen dioxide
ppm	Parts per million
SAT	Site acceptance testing

2 TENDER SUBMISSION AND MONITOR SELECTION

2.1 GENERAL

Submit in your tender the following information under Clauses 2.2 to 2.4 for consideration by the Principal of the air quality monitors proposed.

The Principal will select the make and model for each type of air quality monitor required under the Contract using the tender submissions received. When assessing the proposed air quality monitors, the Principal will give preference to monitors that can be serviced locally.

2.2 MANUFACTURER’S QUALIFICATIONS

Submit documentation demonstrating that:

- (a) the monitor manufacturer has at least 10 years of recent experience in the manufacture of air quality monitors of the nature described in this Specification;
- (b) comparable air quality monitors have been in satisfactory operation for a minimum of five years in at least three projects.

2.3 MANUFACTURER'S QUALITY SYSTEM

2.3.1 Quality System Certification

The air quality monitor manufacturer must have a quality management system independently certified as fully complying with AS/NZS ISO 9001, by an organisation accredited by JAS-ANZ or an affiliated international certification organisation. Submit current documentation as proof of this certification.

2.3.2 Standards and Specifications

Where any of the standards or specifications used or proposed by the air quality monitor manufacturer for any material, manufacturing or testing method is different to what is specified in this Specification, submit details of such standard or specification with your tender, for assessment by the Principal.

2.4 TECHNICAL INFORMATION

Submit the following technical information:

- (a) General arrangement drawings showing all components of the proposed air quality monitoring system, including any mounting supports.
- (b) General information about the proposed air quality monitors, including its operating voltage, power quality requirements, power consumption and wiring details, Input/Output (I/O) provisions and controls, sensing technology, range, accuracy, resolution and sensitivity of measurements, estimated Mean Time Between Failure (MTBF) and Mean Time To Repair (MTTR).
- (c) Catalogue(s) of the proposed air quality monitors.
- (d) Details of material, manufacturing and testing standards for use in the design and manufacture of the monitors, where they are not referenced or are different from that which is specified in this Specification.
- (e) Proposed corrosion protection treatment regimes.
- (f) Sample copies of recent test reports showing compliance of the various monitor components and manufacturing procedures with their respective standards and respective Inspection and Test Plans (ITPs).
- (g) Recommended maintenance schedule/frequency.
- (h) Contact details and experience of proposed maintenance service provider who must have at least five years recent experience in maintaining monitors similar to those proposed.

3 DESIGN AND PERFORMANCE

3.1 PERFORMANCE REQUIREMENTS

3.1.1 Operating Conditions

The air quality monitors and their mounting supports must be suitable for operation in a tunnel environment, taking into consideration the following conditions under which they will be operating:

- (a) continuous operation in polluted air, including but not limited to, high concentrations of carbon monoxide, oxides of nitrogen, volatile organic compounds and particulate matter;
- (b) 24-hour operation;
- (c) water ingress from high pressure washing;
- (d) normal operating temperatures ranging from 0 to 55°C;
- (e) air velocities up to 11 m/s;
- (f) cold smoke, arising from fires occurring at a remote distance from the monitor;
- (g) subjected to electromagnetic interference (refer Clause 3.1.3);
- (h) attack by vermin and insects;
- (i) subjected to vandalism.

3.1.2 Low Voltage Power Supply

Monitors must be capable of continuous satisfactory operation when connected to the tunnel low voltage (LV) power supply stated in Annexure R165/A.

Obtain from the Principal other details of the LV supply system, including details of the LV system earthing arrangement, to ensure a compatible design.

Rate the monitors for its operating voltage, and fit the monitors with current surge protection which is neither a source of, or susceptible to, electromagnetic interference.

3.1.3 Electromagnetic Interference

In the selection of the monitoring equipment, make allowance for sources of electromagnetic interference within the tunnel which may affect the performance. Such sources may include equipment for radio rebroadcast, telecommunication rebroadcast and high voltage power cabling.

Obtain from the Principal details of potential sources of electromagnetic interference.

3.1.4 Control System Interface

As a minimum, each monitor must incorporate an electrically isolated 4 - 20 mA analogue output signal, for each measured parameter, suitable for connection to the remote I/O units of the tunnel control system;

In addition, each monitor must have an additional voltage free contact to provide a maintenance warning for lens contamination to the control system.

3.1.5 Self-diagnostic and Self-calibrating Capability

Monitors must have self-diagnostic and self-calibrating capabilities with automatic reporting of unit faults to the tunnel control system.

The monitor must automatically recalibrate its visibility level output to correct for lens contamination.

3.1.6 Accessibility for Maintenance

As access to the monitors for maintenance will be limited due to the operation of the road tunnel, the maintenance frequency must not be more than once every three months.

Supply monitors which are suitable for mounting at locations which can be accessed and serviced safely subsequent to their installation using standard access equipment (e.g. scissor lifts) readily available to maintenance personnel.

Fit removable panels and covers with lanyards to prevent them from falling after having been removed for access.

3.1.7 Monitor Mounting

Provide monitors complete with mounting supports or points to enable mounting in accordance with manufacturer's recommendations. Unless specified otherwise, monitors must be mounted on the tunnel walls.

3.1.8 Design Life

Design the monitors and their supports for the design life specified in Annexure R165/A.

3.1.9 Dimensions

Dimensions of monitors and their supports must be such that, when mounted, they do not encroach into the clearance envelope of the tunnel shown on the Drawings.

3.2 AIR QUALITY MEASUREMENTS

3.2.1 General

Where so specified in Annexure R165/A; supply tunnel air quality monitors capable of continuously and directly measuring:

- (a) concentration of carbon monoxide (CO);
- (b) concentration of nitric oxide (NO);
- (c) concentration of nitrogen dioxide (NO₂);
- (d) visibility.

Monitors must meet the requirements of AS/NZS 3580.18, unless specified otherwise.

Monitors must be able to continuously report in-tunnel air quality conditions to the tunnel control system, which will log the measurements reported to inform tunnel system operation.

3.2.2 Air Quality Measurement Requirements

Air quality monitors must comply with the requirements shown in Table R165.1 below for sensing technology, sensing range, lower detectable limit, accuracy and maximum resolution.

Table R165.1 – Air Quality Measurement Requirements

Monitor Type	Sensing Technology	Sensing Range	Lower Detectable Limit	Accuracy	Maximum Resolution
CO	Infrared absorption spectroscopy	0 to 250 ppm	2 ppm	±2 ppm	1 ppm
NO		0 to 30 ppm	1 ppm	±1 ppm	1 ppm
NO ₂	Differential optical absorption spectrometry	0 to 2.00 ppm	0.05 ppm	±0.05 ppm	0.05 ppm
Visibility ⁽¹⁾	Light transmission	0 to 0.015/m	0	±0.001/m	0.0005/m

Note:

⁽¹⁾ Expressed in terms of extinction coefficient k (refer Annexure R165/F for its definition).

You may propose to the Principal for approval alternative sensing technology to that shown in Table R165.1 which is suitable for the tunnel environment.

3.2.3 Response Time

The response time of the air quality monitors must not be greater 120 seconds for CO, NO and NO₂ pollutant levels, and not greater than 60 seconds for visibility levels.

3.3 DOCUMENTATION SUBMISSION

Prior to commencement of manufacture of the monitors for the Contract, submit the following information:

- (a) Completed air quality monitor equipment schedules as set out in Annexure R165/E.
- (b) General arrangement drawings showing the monitor system and mounting supports. The drawings must detail all spatial or geometric provisions required in the tunnel for reliable monitor operation.
- (c) Proposed standards or procedures for the design, manufacture and testing of monitors.
- (d) Certification that the design complies with this Specification and the relevant standards.
- (e) Nominated corrosion rate classifications in accordance with AS 4312, and corresponding nominated corrosion protection treatment schemes for the monitors and their supports. The nominated treatment must be based on the installation conditions and the corrosion rate classification specific to the monitor location.
- (f) ITP for manufacture of the monitors detailing inspection and testing methods and their applicable standard.
- (g) Evidence that the materials selected and the assembled monitors will meet the required design life with a reasonable level of maintenance.

- (h) Manufacturing and delivery programme.
- (i) Recommendations on suitable locations within the tunnel cross section for installing the monitors, to produce representative measurements of pollutant concentrations and to maximise their accuracy. These recommendations may be incorporated as part of the installation manual.
- (j) Installation and commissioning manual(s).
- (k) Operations and maintenance manual(s).

For items (j) and (k) above, a preliminary version containing only outline content is acceptable at this stage of the submission. The final manuals submitted must include the details specified in Clauses 7.2 and 8.5 respectively.

4 MATERIALS AND COMPONENTS

4.1 GENERAL

All components must be of low smoke and halogen free composition.

4.2 ENCLOSURES

4.2.1 General

Enclosures of all components of the air quality monitor system must be suitable for use in a tunnel environment with an IP66 rating to AS 60529.

All enclosures must be vermin and insect proof.

4.2.2 External Mounting Supports

Wall mounted enclosures must have external mounting supports. Drilling through the rear of the enclosure to provide holes for mounting purposes is not permitted.

4.2.3 Cable Entry

Cable entry into field mounted enclosures must provide the same IP rating as that of the enclosures.

Provide removable non-ferrous, metallic gland plates of at least 3 mm thickness and 20% spare useable area for future cables. Split gland plates are not permitted. Seal the gland plates to achieve the same IP rating as that of the enclosure.

4.2.4 Gaskets

Gaskets used for sealing must be made of temperature resistant synthetic rubber and resistant to the expected atmosphere in the road tunnel.

5 MANUFACTURE AND FACTORY TESTING

5.1 GENERAL

5.1.1 Hold Point

HOLD POINT

Process Held	Manufacture of each type of monitor and their supports.
Submission Details	At least 20 working days prior to commencement of fabrication, submit to the Principal the documentation detailed in Clause 3.3.
Release of Hold Point	The Principal will examine the submitted items prior to authorising the release of the Hold Point.

5.1.2 Standards and Procedures

Carry out manufacture of the monitors and related items in accordance with the agreed standards and/or procedures in Clause 3.3.

5.2 SURFACE CORROSION PROTECTION

5.2.1 General

Apply corrosion protection treatment to all monitor components, enclosures and mounting supports in accordance with your nominated treatment schemes submitted under Clause 3.3.

5.2.2 Prevent Galvanic Corrosion

Provide measures to prevent galvanic corrosion of monitors and their supports due to contact between dissimilar metals.

5.3 INSPECTION AND FACTORY TESTING

Carry out inspection and factory testing of the monitors in accordance with your submitted inspection and testing procedures in Clause 3.3 to verify that the monitors will perform as specified.

5.4 CERTIFICATION

Submit certificates of compliance of factory testing of the monitors. Attach current calibration certificates of all instrumentation and equipment used for testing the monitors.

6 TRANSPORT AND DELIVERY

6.1 GENERAL

6.1.1 Hold Point

HOLD POINT

Process Held	Dispatch of air quality monitors and mounting supports.
Submission Details	At least 10 working days prior to dispatch of the monitors and supports, submit to the Principal certification documents (refer Clause 5.4), installation and commissioning manual(s) (refer Clause 7.2), warranty (refer Clause 8.1), and operations and maintenance manual(s) (refer Clause 8.5).
Release of Hold Point	The Principal will examine the submitted items prior to authorising the release of the Hold Point.

6.1.2 Delivery Location

Deliver the air quality monitors, mounting supports and spares to the Site unless stated otherwise in Annexure R165/A.

6.2 TRANSPORT

6.2.1 General

Load and transport the air quality monitors and associated ancillary items in a manner that avoids any distortion or damage to the monitors, components and their protective coatings.

6.2.2 Labelling

Clearly label each item with the Contract number, description and quantity of the contents. Include details of the handling requirements.

6.2.3 Packing Protection

Use padding materials for packing of monitors and components suitable for the mode of transport to prevent damage to the items and their coatings during handling, storing and transport.

7 INSTALLATION SUPERVISION AND SITE ACCEPTANCE TESTING

Installation and commissioning of the monitors is not within the scope of this Specification.

7.1 ATTENDANCE AT SITE DURING INSTALLATION AND COMMISSIONING

Provide a representative of the air quality monitor manufacturer who will be in attendance at the Site to supervise the installation, site acceptance testing and commissioning of the monitors. Payment for this attendance will be made under Pay Item R165P3.

Provide the appropriate test gases or translucent screens required for testing each monitor.

7.2 INSTALLATION AND COMMISSIONING MANUAL(S)

7.2.1 Number of Copies

Provide three paper copies and an electronic copy of the installation and commissioning manual(s), written in the English language, for the monitors in accordance with Clause 3.3.

7.2.2 Contents

The manual(s) must include, but are not limited to, the following:

- (a) recommendations on suitable locations within the tunnel cross section for installing the monitors;
- (b) installation methodology;
- (c) site acceptance testing (SAT) procedures, to verify that the installed monitors will perform as required, including the interface with the control system;
- (d) commissioning procedures.

8 POST-COMMISSIONING AND MAINTENANCE

8.1 WARRANTY

Provide a written performance warranty from the manufacturer of the air quality monitor, for the warranty period stated in Annexure R165/A from the date of commissioning completion of the monitors.

The warranty must be in the name of the Principal and must cover the repair or replacement of parts to the same standard as that required under this Specification.

8.2 DEFECTS RECTIFICATION

Rectify any defects, including replacing as necessary any defective parts, during the warranty period at no cost to the Principal.

Attend to any notification of defect within 24 hours, and complete the required rectification work within the minimum time period agreed with the Principal.

8.3 ROUTINE MAINTENANCE

The maintenance service provider must carry out routine maintenance of the monitors in accordance with the submitted schedule in Clause 8.5, for the period stated in Annexure R165/A from the date of commissioning completion of the fans.

Payment for the routine maintenance including supply of spare parts and consumables will be made under Pay Item R165P2.

8.4 SPARE PARTS AND CONSUMABLES

Supply all parts and consumables required for defect rectification and routine maintenance over the warranty period and routine maintenance period.

All replacement parts used must be new and of the same make and model as the original.

8.5 OPERATION AND MAINTENANCE MANUAL(S)

8.5.1 Number of Copies

Provide three paper copies and an electronic copy of the operation and maintenance manual(s), written in the English language, for the monitors in a format approved by the Principal.

8.5.2 Contents

The manual(s) must include, but are not limited to, the following:

- (a) operational procedures;
- (b) routine maintenance/servicing procedures;
- (c) routine maintenance schedules, including information on calibration requirements and any consumables required;
- (d) all design parameters;
- (e) schedule of monitors and components models, serial numbers and suppliers;
- (f) designation, part numbers and commercial sources of spare parts;
- (g) storage and maintenance requirements for the monitors and ancillary components.
- (h) lead time for spare and replacement parts;
- (i) list of spare components supplied;

8.6 TOOLS AND ACCESSORIES

Provide two sets of all special tools and accessories required for installation, operation and maintenance of equipment provided.

ANNEXURE R165/A – PROJECT SPECIFIC REQUIREMENTS

Refer to Clause 1.2.1.

*NOTES TO TENDER DOCUMENTER: (Delete this boxed text after customising Annexure R165/A)**Complete the tables below by deleting whichever option is not applicable and filling in the required details. For advice on how to complete the tables, contact the Tunnel Technology Unit.**In the table below, the warranty period should normally be the same as the routine maintenance period.*

Clause	Description	Requirements
1.2.1	Quantity required:	
	Carbon monoxide (CO) ⁽¹⁾
	Nitric oxide (NO) ⁽¹⁾
	Nitrogen dioxide (NO ₂) ⁽¹⁾
	Visibility ⁽¹⁾
3.1.2	LV power supply (ph/V/Hz) / /
3.1.8	Design life years
6.1.2	Delivery location ⁽²⁾
8.1	Warranty period years ⁽³⁾
8.3	Routine maintenance period years ⁽³⁾

Notes:

- ⁽¹⁾ May be all housed within one single device or in separate devices.
⁽²⁾ Delivery location is the Site unless stated otherwise above.
⁽³⁾ From the date of commissioning completion.

ANNEXURE R165/B – MEASUREMENT AND PAYMENT

B1 MEASUREMENT AND PAYMENT

Refer to Clause 1.2.2.

Payment will be made for all costs associated with completing the work detailed in this Specification in accordance with the following Pay Items.

Where no specific pay items are provided for a particular item of work, the costs associated with that item of work are deemed to be included in the rates and prices generally for the Work Under the Contract.

Pay Item R165P1 - Supply of Air Quality Monitors

The unit of measurement is “each” air quality monitor supplied.

The rate covers the costs of all work and materials associated with the supply of air quality monitors and ancillary associated items, including their design, manufacture, factory testing and certification, and provision of manuals and any tools and accessories required for operation and maintenance.

Unless stated otherwise, the rate includes delivery to the Site or to a location stated in Annexure R165/A.

R165P1.1 Carbon Monoxide Monitors

R165P1.2 Nitrogen Dioxide Monitors

R165P1.3 Total Oxides of Nitrogen Monitors

R165P1.4 Visibility Monitors

Where separate sub-pay items are provided as above for measurement of each of the various pollutants and visibility, but the various sensor types can be housed within a single device type, then a single rate may be submitted for each device type.

Pay Item R165P2 - Routine Maintenance Including Supply of Spare Parts

This is a Lump Sum item.

The Lump Sum covers the costs of all work and materials associated with routine maintenance of the air quality monitors for the period specified in Annexure R165/A, including supply of all spare parts and consumables.

Pay Item R165P3 - Attendance by Monitor Manufacturer’s Representative at the Site (Provisional Quantity)

The unit of measurement is the “man-day”. The quantity is a Provisional quantity, and is measured as the number of days spent by the monitor manufacturer’s representative in attendance during installation, acceptance testing and commissioning of the air quality monitors. It includes any time required for travelling from the location where the representative is normally based, to the Site.

ANNEXURE R165/C – SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS

Refer to Clause 1.2.3.

C1 SCHEDULE OF HOLD POINTS

Clause	Description
5.1.1	Manufacture of monitors and related items
6.1.1	Dispatch of monitors and related items

C2 SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of TfNSW Q Annexure Q/E.

Clause	Description of Identified Record
2.4	Details of proposed fan system maintenance service provider
3.3	Drawings and other technical information of monitors
5.4	Monitor production testing certification
7.2	Installation and commissioning manual(s)
8.1	Warranty
8.5	Operation and maintenance manual(s)

ANNEXURE R165/D – PLANNING DOCUMENTS

Refer to Clause 1.2.4.

The following documents are a summary of documents that must be included in the PROJECT QUALITY PLAN. The requirements of this Specification and others included in the Contract must be reviewed to determine additional documentation requirements.

Clause	Description of Document
3.3	ITP for manufacture of monitors

ANNEXURE R165/E – EQUIPMENT SCHEDULES

Complete the schedule shown below with details of the axial fan proposed for the Contract and submit it in accordance with Clause 3.3 prior to commencement of manufacture of the fans.

Item	Monitor Types			
	Carbon Monoxide	Nitrogen Dioxide	Total Oxides of Nitrogen	Visibility
Make				
Model				
Sensing technology type				
Sensing range (ppm)				
Accuracy (ppm or k value)				
Resolution, max (ppm or k value)				
Self-diagnostic capability (Yes/No)				
Response time (seconds)				
Rated current (A)				
Rated voltage (V)				
Operating temperature range (°C)				
Air velocity range (m/s)				
IP rating				
Design life				
MTBF				
MTTR				

ANNEXURE R165/F – DEFINITION OF EXTINCTION COEFFICIENT

Extinction is defined as the loss of intensity relative to the source strength after travelling a certain distance through the tunnel air.

The extinction coefficient is calculated as follows:

$$k = -1/L \ln (E/E_0)$$

where k = extinction coefficient (m^{-1})

E_0 = light emitter (or source) intensity

E = light receptor intensity

L = distance between emitter and receptor (m)

ANNEXURES R165/G TO R165/L – (NOT USED)

ANNEXURE R165/M – REFERENCED DOCUMENTS

Refer to Clause 1.2.5.

TfNSW Specifications

TfNSW Q Quality Management System

Australian Standards

AS 4312 Atmospheric corrosivity zones in Australia

AS/NZS 3580.18 Methods for sampling and analysis of ambient air - Measurement of road tunnel air quality

AS/NZS ISO 9001 Quality management system - Requirements

AS 60529 Degrees of protection provided by enclosures (IP Code)