

TRANSPORT FOR NSW (TfNSW)

TfNSW SPECIFICATION D&C TS913

MOTORWAY SYSTEMS – PLANT MANAGEMENT AND CONTROL SYSTEM

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MOTORWAY SYSTEMS - PLANT MANAGEMENT AND CONTROL SYSTEM

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FOREWORD

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REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification TfNSW D&C TS913 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.

TfNSW SPECIFICATION D&C TS913

MOTORWAY SYSTEMS – PLANT MANAGEMENT AND CONTROL SYSTEM

1 GENERAL

1.1 SCOPE

This Specification sets out the requirements for the Plant Management and Control System (PMCS) which provides monitoring, control, recording and reporting of all mechanical and electrical plant associated with the ventilation, fire safety, electrical, lighting and environmental monitoring required for the safe and effective operation of Motorway tunnels.

The requirements in this Specification are applicable only to tunnels or tunnels within Motorways, approach roadways and entry and exit ramps.

1.2 RELATED SPECIFICATIONS

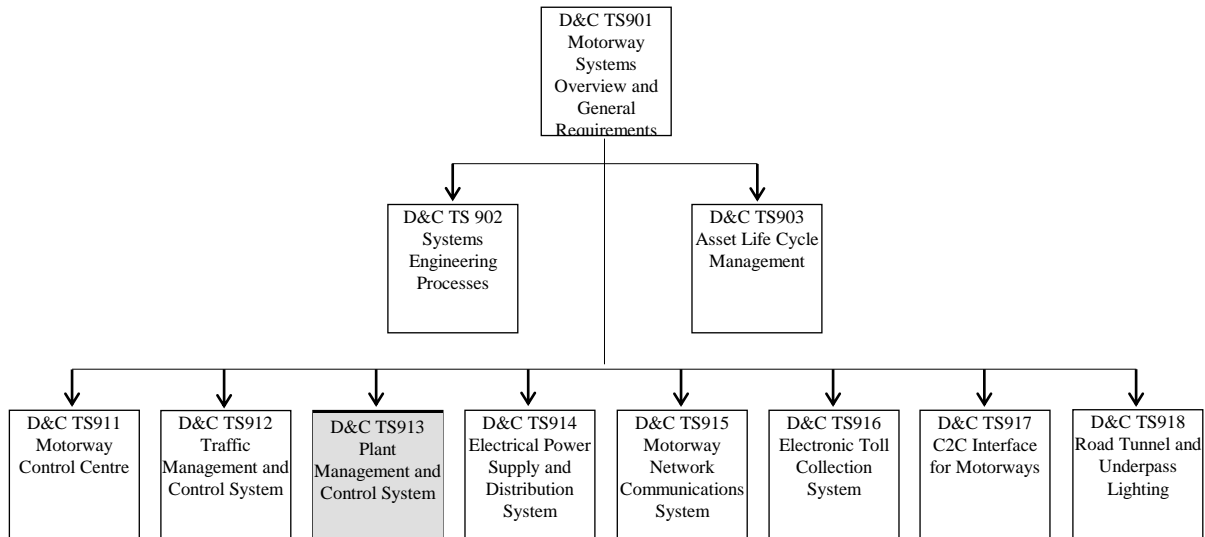
This Specification is a Level 2 document which forms part of the suite of TfNSW specification documents for the Motorway Systems (see figure below). Other documents within the suite are:

Level 1

- D&C TS901 “Motorway Systems Overview and General Requirements”;

Level 2

- D&C TS902 “Systems Engineering Processes”;
- D&C TS911 “Motorway Systems - Motorway Control Centre”;
- D&C TS912 “Motorway Systems - Traffic Management and Control System”;
- D&C TS914 “Motorway Systems - Electrical Power Supply and Distribution”;
- D&C TS915 “Motorway Systems - Motorway Network Communications System”;
- D&C TS916 “Motorway Systems - Electronic Toll Collection System”;
- D&C TS917 “Motorway Systems - C2C Interface for Motorways”;
- D&C TS918 “Motorway Systems - Road Tunnel and Underpass Lighting”.



1.3 STRUCTURE OF THE SPECIFICATION

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

1.3.1 (Not Used)

1.3.2 (Not Used)

1.3.3 Schedules of HOLD POINTS and Identified Records

The schedule in Annexure TS913/C lists the **HOLD POINTS** that must be observed. Refer to Specification TfNSW D&C Q6 for the definition of **HOLD POINTS**.

The records listed in Annexure TS913/C are **Identified Records** for the purposes of TfNSW D&C Q6 Annexure Q/E.

1.3.4 Planning Documents

The **PROJECT QUALITY PLAN** must include each of the documents and requirements listed in Annexure TS913/D and must be implemented.

1.3.5 (Not Used)

1.3.6 Referenced Documents

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 2350). For convenience, the full titles are given in Annexure TS913/M.

1.4 DEFINITIONS AND ACRONYMS

1.4.1 Definitions

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

The term “Motorway operator” means the person(s) undertaking the operation of the Motorway using the OMCS.

The following definition applies to this Specification:

Tunnel An underground or covered roadway, which is continuously enclosed for a length of at least 120 m measured along the road alignment.

1.4.2 Acronyms

The following acronyms apply to this Specification:

CB	Circuit breaker
CCTV	Closed circuit television
DB	Distribution board
DRS	Disaster Recovery Site
HV	High voltage
I/O	Inputs/Outputs
IMS	Incident Management System
LV	Low voltage
METS	Motorist Emergency Telephone System
MCC	Motorway Control Centre
MNCS	Motorway Network Communications System
OMCS	Operations Management and Control System
PA	Public Address
PLC	Programmable Logic Controllers
PMCS	Plant Management and Control System
RCU	Remote Control Unit
TfNSW	Transport for NSW
SWTC	Project Deed Scope of Works and Technical Criteria
TMC	Transport Management Centre
TMCS	Traffic Management and Control System
UPS	Uninterruptible Power Supply
VCP	Ventilation Control Plan
WTP	Water Treatment Plant

2 PLANT MANAGEMENT AND CONTROL SYSTEM

2.1 GENERAL

- (a) The Contractor is responsible for the design, procurement and installation of the Plant Management and Control System (PMCS), to the requirements stated in Clauses 2 to 6.

2.1.1 PMCS Overview

- (a) The PMCS must provide automatic monitoring and control of tunnel functions, systems and network, including:
 - (i) PMCS communication network;
 - (ii) tunnel ventilation;
 - (iii) pressurisation;
 - (iv) air quality monitoring;
 - (v) fire safety;
 - (vi) tunnel emergency equipment;
 - (vii) drainage and water treatment;
 - (viii) electrical power supply;
 - (ix) lighting in tunnel and egress passages;
 - (x) egress signage, including directional and exit signs;
 - (xi) Public Address (PA) System.
- (b) The actual PMCS requirements for each project will depend on the tunnel length and location and will be specified in the Project Deed Scope of Works and Technical Criteria (SWTC).
- (c) The (sub)contractor(s) for each design packages corresponding to each PMCS function will provide supplementary information particular to the PMCS function to inform the PMCS design.

2.1.2 Integration With Other Systems

- (a) The PMCS must integrate with:
 - (i) Traffic Management and Control System (TMCS) as part of the OMCS, to allow coordination of tunnel plant operation with traffic management.
 - (ii) Fire Safety System installed for the Motorway, to allow the PMCS to implement pre-determined responses for fire incidents and other specific circumstances.
 - (iii) PA system.

2.1.3 PMCS Functions and Capabilities

- (a) The PMCS must:
 - (i) process information received from instrumentation associated with the tunnel and determine the appropriate mode of operation for all plant and equipment;
 - (ii) control equipment accurately, reliably and efficiently to ensure that the specified performance requirements and safety criteria are met, whilst avoiding unnecessary use of equipment and consequent wastage of energy;
 - (iii) display real-time status, alarms and faults of all plant and equipment;
 - (iv) record all equipment/device alarms, faults and states, including date/time stamp information, control source (e.g. manual-operator, automatic-system, etc) and command parameters (e.g. set-points, mode changes, etc);

- (v) allow the Motorway operator to extract/export all recorded data to open (non-proprietary), industry standard formats.

2.1.4 Incident Response Plans

- (a) The PMCS must incorporate Incident Response Plans which have been developed and designed in consultation with, and meeting the requirements of TfNSW, other relevant stakeholders and authorities.

2.1.5 Automatic and Manual Control

- (a) Under normal operation, the PMCS must automatically monitor and control all plant and equipment. A facility must be provided to allow for manual override by the Motorway operator during emergencies or shutdowns for maintenance.
- (b) All automated systems must be supported by secondary or manual systems to allow the tunnel services to be safely operated in a mode involving a higher level of Motorway operator control in the event of system failure.

2.1.6 Network Time Synchronisation

- (a) The PMCS, including all systems and equipment/devices, must be synchronised with the Transport Management Centre (TMC) Network Time servers using Network Time Protocol via the Motorway Network Communications System (MNCS).

2.2 SYSTEM RELIABILITY

2.2.1 Compliance with Reliability Requirements for OMCS

- (a) The PMCS must comply with the same reliability requirements as those specified for the OMCS in Specification TfNSW D&C TS911.

2.2.2 Other Requirements

- (a) In addition, the PMCS must:
 - (i) not be exposed to unauthorised interruptions;
 - (ii) be easily maintained and operated;
 - (iii) have the ability to undertake self-diagnostics.

2.3 SAFETY

2.3.1 Safety Controls and Interlocks

- (a) All necessary safety controls and safety interlocks for failsafe operation must be provided to override operational controls.
- (b) This is to ensure protection against personal injury and damage to plant under all conditions of operation (including starting, running, and stopping) as well as for any foreseeable abnormal conditions of individual component failure and/or service interruption.

2.3.2 Automatic Checking

- (a) A means of automatic checking of equipment conditions prior to starting equipment must be provided. This includes detection of:
 - (i) any equipment failures;
 - (ii) any condition inhibiting proper operation;
 - (iii) any alarm initiation.

2.3.3 Safety In Design

- (a) The PMCS must include redundancy for personnel and critical equipment protection as determined by a Safety In Design process.

2.3.4 Protection Against Inadvertent Electrical Contact

- (a) Within each PMCS cabinet, protection must be provided to prevent inadvertent contact with dangerous voltages.

2.4 PMCS DESIGN

2.4.1 General

- (a) Design development of the PMCS must be in accordance with the requirements of TfNSW D&C TS901 and TfNSW D&C TS911.
- (b) Failure of the PMCS hardware, software or data network must not adversely impact the operation of the TMCS.

2.4.2 No Single Point of Failure

- (a) Design of the PMCS must be such that no single point of failure can cause major disruption to system operation or performance.
- (b) Servers must be duplicated and interlinked, with automated transfer to the standby server in the event of failure. Redundant network connections must be provided (refer Clause 3.3).

2.4.3 “Hold Last State”

- (a) Design of the PMCS must be such that any failure in the instrumentation or control system will cause all associated plant and equipment to go into, or remain in, a defined state. The ability to “hold last state”, during communication loss or programming downloads, can prevent loss of control or a lengthy recovery period.

2.4.4 Standalone Operation of Controller and Field Device

- (a) Each controller and field device must be designed, configured, installed and programmed to provide for standalone operation with minimal performance degradation due to failure of other system components to which it is connected, or with which it communicates.

2.4.5 Independent Carriageway Operation

- (a) The PMCS equipment for each tunnel carriageway must be able to operate independently, such that there is no impact on the operation of the PMCS in the other tunnel carriageway when:
 - (i) a PMCS equipment fault occurs in one tunnel carriageway;
 - (ii) a maintenance activity is being performed on PMCS equipment in one tunnel carriageway.

3 EQUIPMENT AND SOFTWARE

3.1 GENERAL

3.1.1 PMCS Components

- (a) The PMCS consist of:
 - (i) centralised equipment, located within the Motorway Control Centre (MCC) and Disaster Recovery Site (DRS), where control requirements and monitored data is coordinated;
 - (ii) distributed roadside and equipment cabinets, monitoring and controlling system elements within the tunnel and associated facilities;
 - (iii) high availability links between elements of the PMCS;
 - (iv) high availability links between the PMCS and other systems.

3.1.2 Allowance for Future Changes

- (a) Design and selection of the PMCS equipment must be such that the hardware can be easily re-configured or expanded due to future changes in system requirements, to provide flexibility.

3.1.3 Use of Proven Technology

- (a) The PMCS must utilise proven technology consisting of Programmable Logic Controllers (PLC), Remote Control Unit (RCU) and Supervisory Control and Data Acquisition (SCADA) equipment with industry standard interface protocols such as Ethernet/IP and Modbus.
- (b) The protocols used must be industry open standard, available “off the shelf” products.

3.1.4 PMCS Operator Interface

- (a) In addition to the PMCS operator interface (integrated as part of the OMCS user interface) provided via the OMCS Operator Workstations, a PMCS operator interface must also be provided via the OMCS Engineering Workstations (refer TfNSW D&C TS911) which allows for full operation of the PMCS consistent with the monitoring, control, display and reporting that are provided via the OMCS user interface.

3.2 PLANT MANAGEMENT DEVICES

3.2.1 Redundancy

- (a) Plant management devices, including PLC and RCU, and equipment must meet the following requirements:
 - (i) The failure of any one controller must not disrupt communication on the network.
 - (ii) The controllers must have a redundant configuration. Any disruption to the functioning of the primary controller must result in an automatic changeover to a secondary controller with minimal or no impact to communications network or field devices.
 - (iii) PLC/RCU must operate independently of the network functionality in a peer to peer arrangement.

3.2.2 Automatic Resumption of Operation

- (a) Upon restoration of normal power after a power failure, controllers must automatically resume full operation without requirement for manual intervention.

3.2.3 Modular and Expandable

- (a) PLC/RCU must be modular and expandable.
- (b) PLC/RCU must have 30% spare analogue and digital inputs and outputs in addition to the designed capacity required to achieve the functional intent.

3.2.4 Field Cabinets

- (a) All PLC/RCU must be located within dedicated field cabinets. Such field cabinets may house both PMCS and TMCS equipment. Apart from the physical cabinet and the incoming power supply cables, the PMCS and TMCS equipment must be completely independent.
- (b) Each field cabinet must be sized to accommodate a 20% increase in the overall number of points.
- (c) All field cabinets must have door monitoring via the PMCS to alert Motorway operators when a cabinet door has been opened as stated in Clause 4.6.

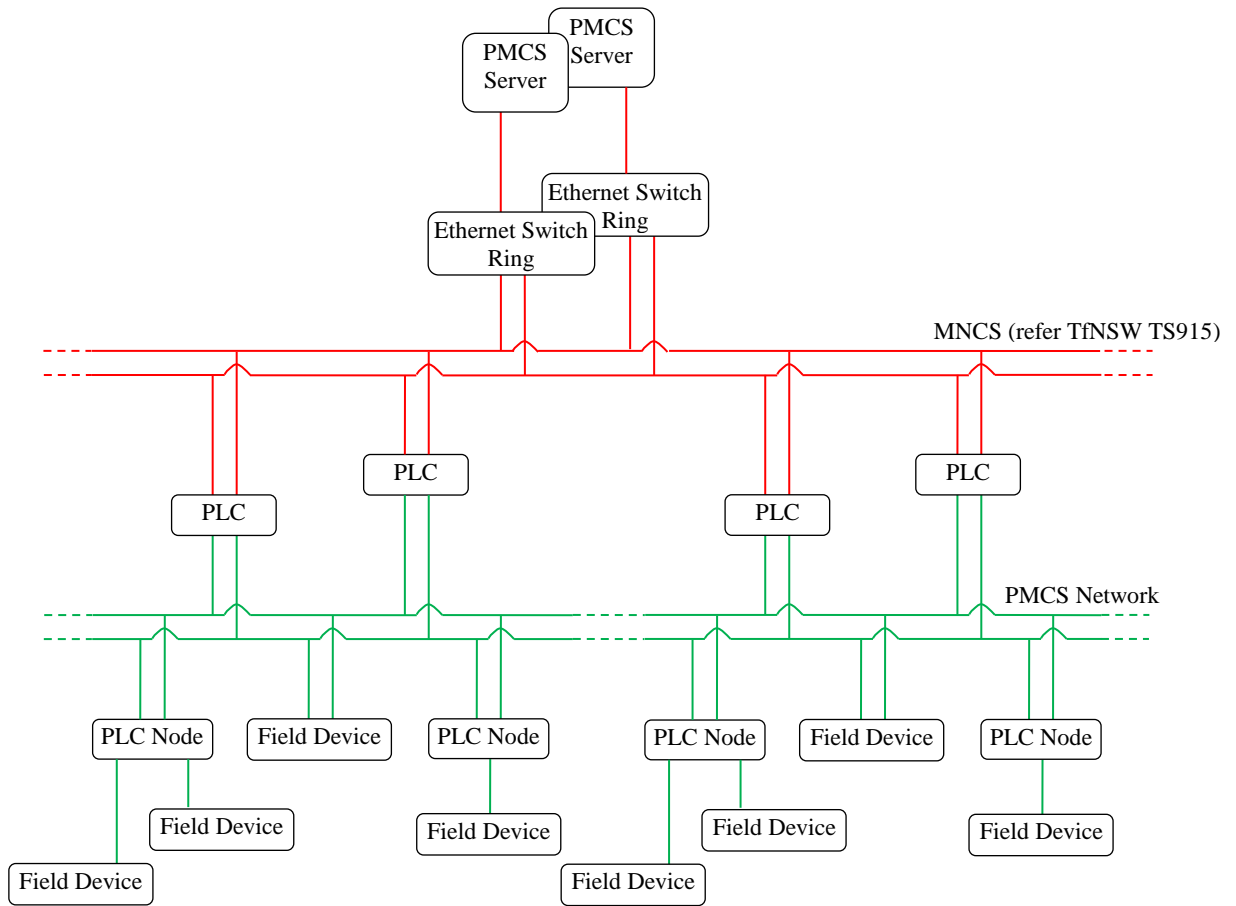
3.3 PMCS NETWORK

3.3.1 General

- (a) The PMCS network will interface with the OMCS through the MNCS. The MNCS requirements are stated in Specification TfNSW D&C TS915.
- (b) PLC/RCU which are not directly connected to the MNCS will form part of the PMCS network.

3.3.2 Network Architecture

- (a) A typical configuration of a PMCS network and the interface to the MNCS is shown in Figure TS913.1.



Notes:

- (1) Two number of servers, Ethernet switch rings and PLC are shown, to provide redundancy.
- (2) The PMCS network provides the connection between the PLC (or RCU) and the PLC nodes, or directly with field device.

Figure TS913.1 - PMCS Network Architecture

- (b) The PMCS network communication must have redundancy between the PLC (or RCU) and the PLC nodes or field device.
- (c) The network connections between the PLC (or RCU) and the PLC nodes, and between each individual PLC, must be monitored and represented on the PMCS.

3.3.3 Hold Point

HOLD POINT

Process Held:	Procurement and installation of PMCS network equipment.
Submission Details:	Complete design documentation in accordance with D&C TS901 in relation to PMCS network.
Release of Hold Point:	The Nominated Authority will consider the submitted documents prior to authorising the release of the Hold Point.

3.4 ENVIRONMENTAL REQUIREMENTS**3.4.1 General**

- (a) All PMCS equipment must be designed to operate in a Motorway tunnel environment.

3.4.2 Operating Conditions

- (a) Where installed in a tunnel environment, design or selection of all PMCS equipment must be such that they are suitable for operation under the conditions stated in Table TS913.1.

Table TS913.1 – Tunnel Operating Environmental Conditions

Parameter	Conditions
Carbon monoxide (CO)	As specified in Conditions of Approval
Nitrogen dioxide (NO ₂)	As specified in Conditions of Approval
Particulates (PM10)	1.4 mg/m ³ (upper limit)
Temperature range (dry bulb)	–10°C to 50°C: operation within specification –10°C to 60°C: operation without malfunction or damage
Relative humidity	10% to 95%

- (b) Where equipment rooms or egress passages are continuously pressurised with air from outside the tunnel, or where the room can be environmentally controlled, then PMCS equipment located inside those rooms or passages will need only to meet the requirements of the anticipated environmental conditions rather than those stated in Table TS913.1.

3.4.3 Water Seepage and Air Movement Buffering

- (a) For a drained tunnel, seepage water must be diverted away from PMCS equipment.
- (b) PMCS equipment, including support structures, cabinets and cabling, must be protected from water ingress and constant buffering of air movement caused by traffic and tunnel ventilation system.

3.4.4 IP Rating

- (a) All PMCS equipment must have the appropriate IP ratings as specified in the SWTC, other TfNSW specifications or applicable Australian Standards.

3.4.5 Radio Frequency Interference

- (a) Selection of PMCS equipment must be such that:
- (i) interference to radio equipment nearby does not exceed the limits set out in the ACMA-mandated Electromagnetic Compatibility (EMC) standards (“the List”). Suppression devices must be provided where necessary.
 - (ii) operation of the PMCS/equipment will not be affected by radio frequency interference at the limits set out in the List.
 - (iii) operation of the PMCS/equipment does not interfere with operating frequency bands used elsewhere within the tunnel.

4 TUNNEL SERVICES

4.1 GENERAL

4.1.1 Condition Monitoring Devices

- (a) The PMCS must provide (where not provided as part of the equipment) and/or interface to (where provided as part of the equipment) condition monitoring facilities for all tunnel and tunnel related plant and equipment.

4.1.2 Balancing Run Hours

- (a) Where the PMCS configuration requires redundant (standby) equipment, the PMCS must cycle the duty operation of the equipment to balance the number of run hours between the equipment.

4.2 TUNNEL VENTILATION

4.2.1 General

- (a) The PMCS must be able to monitor and automatically control all tunnel ventilation functions to continuously, reliably and efficiently provide a safe environment for tunnel users and external communities, during normal operation as well as during emergency operation, in accordance with the Ventilation Control Plans (VCP) (refer Clause 4.2.4).
- (b) The PMCS must allow for manual control of the tunnel ventilation system by the Motorway operator when required.

4.2.2 Data Logging

- (a) The PMCS must provide data logging and retrieval facilities of all time domain functions of the tunnel ventilation. These facilities must be reliable, robust, vandal proof and conveniently located for maintenance purposes.

4.2.3 Tunnel Ventilation Operational Modes

- (a) The PMCS must facilitate the following tunnel ventilation operational modes:
 - (i) **normal operation** for the management and control of emission concentrations in-tunnel, under all traffic scenarios, including fluid free flow traffic, breakdown and congestion;
 - (ii) **emergency operation** for the management and control of smoke in the event of a fire, for the safe egress of occupants and access to emergency services.
- (b)
 - (i) **Normal Operation**
During normal operation, the PMCS must automatically operate and adjust the flow of air within the tunnel and at the ventilation outlets to maintain in-tunnel and in-stack air quality within the allowable limits specified in the Conditions of Approval.
 - (ii) **Emergency Operation**
During emergency operation, the PMCS must allow the Motorway operators to initiate VCP. If required by Fire and Life Safety Strategy, the PMCS must also provide a means of automatically initiating VCP (for example, if there has been no response from the Motorway operator to the emergency event).

4.2.4 Ventilation Control Plans

- (a) VCP will be developed by others to ensure compliance with the air quality requirements stated in the Conditions of Approval.
- (b) The VCP will be developed in conjunction with the Fire and Life Safety Strategy to provide a tenable environment for the safe egress of tunnel users and safe access for emergency services, during an incident.
- (c) The VCP developed must be implemented in the PMCS.

4.2.5 Key Inputs

- (a) To efficiently control tunnel ventilation, the PMCS may utilise the following key inputs to automatically determine the most appropriate level of ventilation required at any given time and for any given traffic scenario:
 - (i) time of day;
 - (ii) traffic speed and density via input from the TMCS;
 - (iii) incident detection via input from the TMCS;
 - (iv) Air Quality Monitoring System;
 - (v) Fire Safety System.

4.3 PRESSURISATION

- (a) The PMCS must monitor and control the pressurisation of escape passages, service galleries, ancillary and plant rooms based on the fire location information fed from the Fire Safety System.

4.4 AIR QUALITY MONITORING

4.4.1 General

- (a) The PMCS must monitor air quality conditions within the tunnel and within the Ventilation Station Outlets.

4.4.2 Data Logging

- (a) The PMCS must be able to record data and produce reports to verify that the performance of the tunnel ventilation meets the requirements of the Conditions of Approval.
- (b) The PMCS must use this data for developing reports, trending of data and for future evaluation or performance assessments of tunnel systems.

4.4.3 In-Tunnel Monitoring

- (a) The PMCS must accurately, reliably and continuously record and display real-time concentrations of:
 - (i) carbon monoxide (CO);
 - (ii) nitric oxide (NO);

- (iii) nitrogen dioxide (NO₂);
 - (iv) any other pollutant required to be measured in the Conditions of Approval.
- (b) The PMCS must accurately, reliably and continuously record and display visibility measurements as required in the Conditions of Approval.

4.4.4 In-Stack Monitoring

- (a) The PMCS must accurately, reliably and continuously record and display, for each VSO, real-time concentrations of:
- (i) carbon monoxide (CO);
 - (ii) nitric oxide (NO);
 - (iii) nitrogen dioxide (NO₂);
 - (iv) particulate matter (PM10 and PM2.5);
 - (v) volatile organic compounds;
 - (vi) air velocity;
 - (vii) air temperature (dry bulb and wet bulb);
 - (viii) relative humidity.

4.5 FIRE SAFETY

4.5.1 General

- (a) Through integration with the PMCS, the PMCS must monitor and control the Fire Safety System, comprising all fire alarm, detection and protection systems in the Motorway, including:
- (i) linear heat sensors;
 - (ii) smoke detectors;
 - (iii) control equipment (e.g. main fire indicator panel, sub-fire indicator panel, remote transponder unit, etc);
 - (iv) deluge valves;
 - (v) sprinkler system;
 - (vi) fire (fighting) water pumps;
 - (vii) water storage tank levels;
 - (viii) drainage pit - foam suppression system;
 - (ix) drainage pit - hydrocarbon level monitoring.

4.5.2 Data Logging

- (a) The PMCS must display and log all Fire Safety System alarms, faults and device states.
- (b) The PMCS must log all use of this Fire Safety System, including date/timestamp information, deluge zones used and source of the control (e.g. Motorway operator, or other system such as OMCS Incident Management System (IMS)).

4.5.3 Heat Sensors and Smoke Detectors

- (a) The status of fire detection devices (e.g. linear heat sensors and smoke detectors) will be processed by the Fire Safety System to produce fire state signals.
- (b) The Fire Safety System will send fire state signals to the PMCS to notify the PMCS of the fire event.
- (c) In response, the PMCS must alert by either visual or audible alarm the Motorway operators and create an incident in the OMCS IMS for the Motorway operators to respond to.

4.5.4 Deluge Control

- (a) The PMCS must have the ability to send commands to the Fire Safety System to operate individual deluge valves.
- (b) However, this form of deluge control is subsidiary to the Fire Safety System deluge control, and must not override the Fire Safety System control; i.e. if the Fire Safety System is operating a deluge zone, the PMCS cannot close the valve and stop the operation. Similarly, the PMCS cannot operate a deluge valve that has been isolated at the Fire Safety System.

4.5.5 Tunnel Ventilation

- (a) The Fire Safety System will send fire data to the PMCS to change tunnel ventilation operation. In response, the PMCS must:
 - (i) override the current ventilation mode and initiate the relevant ventilation fire mode operation, for the location of the detected fire;
 - (ii) bypass any equipment lockouts, such as thermal overloads and “starts per hour” inhibits for any of the supply, exhaust or jet fans.

4.5.6 Pressurisation

- (a) The Fire Safety System will send fire data to the PMCS to initiate pressurisation. In response, the PMCS must:
 - (i) pressurise the egress passages to prevent smoke from entering the passages and non-incident tunnel;
 - (ii) bypass any equipment lockouts such as thermal overloads and “starts per hour” inhibits for the egress ventilation fans.

4.5.7 Drainage

- (a) The Fire Safety System will send fire data to the PMCS to operate the drainage system. In response, the PMCS must operate drainage pumps and valves to empty the drainage sumps, in preparation for the incoming deluge water.
- (b) Where necessary, the Fire Safety System will operate the foam suppression system.

4.6 EMERGENCY EGRESS DOORS AND EQUIPMENT CABINETS

- (a) The PMCS must monitor all emergency equipment cabinets, and alert the Motorway operator when the cabinet door is open, including automatic switching of CCTV display to the camera monitoring the cabinet door.

- (b) The PMCS must monitor all emergency egress doors, and alert the Motorway operator when the egress door is open, including automatic switching of CCTV display to the camera monitoring the egress door.

4.7 DRAINAGE AND WATER TREATMENT SYSTEM

4.7.1 Data Logging

- (a) The PMCS must record and display information related to the operation of the drainage system, including:
 - (i) start and stop times for operation;
 - (ii) power consumption;
 - (iii) equipment faults.

4.7.2 Automatic Operation

- (a) Drainage system pumps and associated control gear must be designed to operate automatically by the PMCS.

4.7.3 Water Levels

- (a) The PMCS must monitor the water levels within the sump pits and operate the necessary pump(s) to transfer the water to either a water treatment system, suitable dispersal location or storage pond, depending on the specific project requirements.

4.7.4 Water Quality

- (a) The PMCS must monitor the water quality within sumps.
- (b) If the pH or hydrocarbon levels of the collected water are outside of the range of permitted levels specified in the Conditions of Approval, the PMCS must operate valves to isolate the sump and contain the polluted water.
- (c) Valves in the drainage system may also be operated to divert water into dedicated isolation compartments, if required.

4.7.5 Water Treatment Plant

- (a) The PMCS must receive status and alarm information from the Water Treatment Plant (WTP) such as high level, low level, dosing system failure and filter failure, in order to notify the Motorway operators of the status of any problems that may require attention.
- (b) The PMCS must provide data on the operation of the drainage system pumps to the WTP.

4.8 ELECTRICAL POWER SUPPLY AND DISTRIBUTION

- (a) Electrical power supply and distribution functions that are to be monitored, controlled and recorded by the PMCS are specified in Specification TfNSW D&C TS914.

4.8.1 High Voltage (HV) System

4.8.1.1 General

- (a) The PMCS must monitor various components of the HV system to ensure that the supply meets the varied demands of the system.

4.8.1.2 HV Metering

- (a) The PMCS must incorporate HV metering management to inform the Motorway operator of the electrical supply characteristics at various points. This is used by Motorway operators to assist in the control of circuit breakers.

4.8.1.3 HV Circuit Breaker

- (a) The PMCS must monitor and allow Motorway operators to remotely control the HV circuit breakers and associated equipment. The PMCS must provide indication, displays, detailed status and fault analysis facility for maintenance purposes.

4.8.1.4 HV Transformer and Isolator

- (a) The PMCS must monitor HV transformers and isolators. Control of the HV transformers and isolators via the PMCS is not required.

4.8.2 Low Voltage (LV) System

4.8.2.1 General

- (a) The PMCS must monitor the essential (backed up by Uninterruptible Power Supply (UPS)) and non-essential LV distribution boards.

4.8.2.2 LV Distribution Boards and Circuit Breakers

- (a) LV supplies must be monitored and controlled by the PMCS.
- (b) Air circuit breakers (ACB) must be monitored and controlled through the PMCS.
- (c) The supplies to the ACB must be monitored by the PMCS to ensure that a standby supply is available. The PMCS must raise an alarm if a standby supply is not available.
- (d) LV distribution boards (DB), circuit breakers (CB) and isolators must be monitored by the PMCS.
- (e) Each LV DB must be monitored by the PMCS to:
 - (i) ensure that supply voltage is present at the DB;
 - (ii) keep the Motorway operator informed of the CB/isolator/device status.
- (f) Control of the LV isolators or CB by the PMCS is not required.

4.8.2.3 LV Energy Consumption

- (a) The PMCS must monitor and record the energy consumption of the following systems:
 - (i) tunnel ventilation;
 - (ii) lighting (carriageways including entry/exit ramps).
- (b) The PMCS must generate energy consumption reports that are configurable by the Motorway operator in terms of date, time and tunnel segment.

4.8.3 Uninterruptible Power Supply and Battery System

- (a) The PMCS must monitor the following aspects of the UPS:
 - (i) incoming voltage;
 - (ii) outgoing voltage;
 - (iii) individual battery voltage/health;
 - (iv) UPS operation mode;
 - (v) UPS health alarm.
- (b) The PMCS must monitor the battery charger system.
- (c) The PMCS is not required to control the UPS system and battery chargers.

4.8.4 Emergency Generators

- (a) The PMCS must provide comprehensive monitoring and alarm information for emergency generators (where installed). As a minimum, this must include:
 - (i) fuel level;
 - (ii) running;
 - (iii) failure to start;
 - (iv) amp load;
 - (v) engine temperature;
 - (vi) lubricating oil level;
 - (vii) all generator fault conditions.

4.9 LIGHTING

4.9.1 General

- (a) The PMCS must monitor and have the ability to control all lighting systems, including tunnel lighting, feature lighting, and emergency lighting (e.g. directional exit signs in the tunnel carriageways, the emergency exit lights in the tunnel carriageways and the egress passages, emergency lighting of the tunnel carriageways).

4.9.2 Control of Lighting Levels

- (a) The PMCS must adjust the stages of tunnel and feature lighting in the various zones in accordance with the outside conditions as reported through sensors (e.g. photometers).

4.9.3 “Time of Day” Clock System

- (a) The PMCS must provide an alternative backup “time of day” clock system for use with tunnel and feature lighting based on seasonal and latitudinal variations of lighting in case of sensor failure.

4.10 BUILDING SERVICES

- (a) The PMCS must monitor the following building services, and provide notification to the Motorway operator of status/events and fault/alarm conditions:
 - (i) air conditioning and ventilation systems, including equipment room temperature and humidity;
 - (ii) security and access control, including equipment rooms door open alarms;
 - (iii) door activation to secure areas, plant rooms, equipment rooms, substations, etc;
 - (iv) general lighting;
 - (v) emergency exit lighting;
 - (vi) electrical power, including emergency generator (where present), UPS and backup battery alarms;
 - (vii) hydraulic services;
 - (viii) Fire Safety System, including smoke detector alarms and sprinkler activation;
 - (ix) lift services.

4.11 CCTV SWITCHING

4.11.1 General

- (a) The CCTV system for Motorway and building monitoring will be supplied as part of the TMCS. The requirements of the CCTV system are stated in Specification TfNSW D&C TS912.

4.11.2 Automatic Switching

- (a) In the event of any of the following inputs received by the PMCS, the PMCS must automatically, via the OMCS/TMCS, switch the CCTV screen to display the CCTV camera(s) near the relevant location or incident:
 - (i) input from the Fire Safety System;
 - (ii) door activation: emergency egress passages;
 - (iii) door activation: equipment rooms, plant rooms, electrical rooms etc.;
 - (iv) door activation: PMCS/TMCS equipment cabinets;
 - (v) door activation: emergency equipment cabinets;
 - (vi) light activation: equipment rooms, plant rooms, electrical rooms etc.

4.12 PUBLIC ADDRESS SYSTEM

4.12.1 General

- (a) The PMCS must allow Motorway operators to perform public announcements via the PA system to zone(s) selected by the Motorway operators.
- (b) The PMCS must be integrated with the PA system to ensure any public announcements performed remain intelligible under all Motorway conditions (including ventilation systems operating).

4.12.2 PA System Zones

- (a) PA system zones must be defined/sized appropriately to meet operational requirements and to avoid public announcements being performed to areas in which the public announcement is not required/applicable.
- (b) The PMCS must provide logical groupings of PA system zones to assist the Motorway operators with performing public announcements over larger sections of the Motorway.

4.12.3 Monitoring

- (a) The PMCS must include an in-tunnel monitoring system to allow the Motorway operators to monitor public announcements in order to confirm the correct operation of the PA system.

4.12.4 Logging

- (a) The PMCS must display and log all PA system alarms, faults and device states.
- (b) The PMCS must log all use of the PA system, including date/timestamp information, zones used and source of the control (e.g. Motorway operator or other system such as OMCS IMS, Fire Safety System etc).

4.13 HOLD POINT

HOLD POINT

Process Held:	Procurement and installation of PMCS hardware and software.
Submission Details:	Complete design documentation in accordance with TfNSW D&C TS901 in relation to all PMCS tunnel services.
Release of Hold Point:	The Nominated Authority will consider the submitted documents prior to authorising the release of the Hold Point.

5 PMCS INTERFACE REQUIREMENTS

5.1 GENERAL

- (a) This Clause provides examples of the interface requirements of the PMCS. This is not an exhaustive list, and must be used as a guide only. This is not intended to be a complete list of all input/output (I/O) monitoring and control points for the PMCS.

5.2 FIRE SAFETY SYSTEM INTERFACE

- (a) Raw data must be passed from the Fire Safety System to the PMCS.
- (b) Processed command data must be passed from the PMCS to the Fire Safety System.

5.3 FIELD DEVICES “STATUS ONLY” INTERFACES

- (a) The following list is an example of “status only” interfaces, between field devices and the PMCS that may be required.

In-tunnel air monitoring	HV metering	UPS
In-stack air monitoring	HV transformer feeder CB	Battery charger
Pit level sensor	HV transformer	Substation temperature
Hydrocarbon sensor	HV isolator	Substation door
pH sensor	LV switchboard monitoring	Egress passage door
Water Treatment Plant	LV DB and CB monitoring	Emergency equipment cabinet door
	Building monitoring	Portal light sensor

- (b) Raw data must be passed from each of the devices listed above to the PMCS, typically as an I/O. No data must be transferred from the PMCS to these devices.

5.4 FIELD DEVICES CONTROL AND STATUS INTERFACES

- (a) The following list is an example of plant devices with control and status interfaces that may be required.

Supply fan	Motorised valve	Egress passage light
Supply fan damper	Sump pit pump	Strobe light
Jet fan	HV motorised isolator	Directional exit sign
Egress ventilation fan	HV feeder CB	Substation air conditioning
Exhaust fan	HV CB	Modulating damper
Exhaust fan damper	HV bus tie CB	Substation vent fan
External air monitoring	LV incomer	Substation damper
Pit ventilation fan	Tunnel lights	CCTV
Ground water pump	Exit light	

- (b) Raw data must be passed from each of these devices listed above to the PMCS. The PMCS in turn generates command data and passes it onto these devices. This exchange of raw data and command data is typically through discrete I/O.

5.5 TMCS INTERFACE

- (a) The PMCS must exchange data with the TMCS as part of an integrated OMCS.

6 PMCS TESTING AND COMMISSIONING

6.1 GENERAL

- (a) The PMCS comprises several subsystems that must be tested both individually and when integrated with the OMCS.
- (b) The testing and commissioning of the PMCS must satisfy the requirements of the overall OMCS integration and testing detailed in TfNSW D&C TS911 Clause 9.
- (c) The testing and commissioning of the PMCS must also adhere to the process, methodologies and documentation requirements specified in TfNSW D&C TS901 Clause 5 and TfNSW D&C TS911 Clause 9.

6.2 HOLD POINT

HOLD POINT

Process Held: Commencement of testing.

Submission Details: Complete test documentation (including Test Plans and Test Specifications) in accordance with TfNSW D&C TS901 Clause 5 and TfNSW D&C TS911 Clause 9.

Release of Hold Point: The Nominated Authority will consider the submitted documents prior to authorising the release of the Hold Point.

ANNEXURES TS913/A TO TS913/B – (NOT USED)**ANNEXURE TS913/C – SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS**

Refer to Clause 1.3.3.

C1 SCHEDULE OF HOLD POINTS

Clause	Description
3.3.3	Procurement and installation of PMCS network equipment.
4.13	Procurement and installation of PMCS hardware and software.
6.2	Commencement of testing.

C2 SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of TfNSW D&C Q6 Annexure Q/E.

Clause	Description of Identified Record
	Systems Engineering Management Plan, System Requirements Specification, Design Documentation, Equipment Documentation, Test Plans, Test Specifications, and Work-As-Executed Documentation for PMCS complying with TfNSW D&C TS901 Clause 5 and TfNSW D&C TS911 Clause 9.
6	Test documentation, including test reports, for all PMCS installation, testing and commissioning activities carried out.

ANNEXURE TS913/D – PLANNING DOCUMENTS

Refer to Clause 1.3.4.

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
	Systems Engineering Management Plan, Design/Development Plan(s) and Test Plan(s) developed in accordance with TfNSW D&C TS901 and TfNSW D&C TS902.

ANNEXURES TS913/E TO TS913/L – (NOT USED)

ANNEXURE TS913/M – REFERENCED DOCUMENTS

Refer to Clause 1.3.6.

TfNSW Specifications

- TfNSW D&C Q6 Quality Management System (Type 6)
- TfNSW D&C TS901 Motorway Systems Overview and General Requirements
- TfNSW D&C TS902 Systems Engineering Processes
- TfNSW D&C TS911 Motorway Systems - Motorway Control Centre
- TfNSW D&C TS912 Motorway Systems - Traffic Management and Control System
- TfNSW D&C TS914 Motorway Systems - Electrical Power Supply and Distribution System
- TfNSW D&C TS915 Motorway Systems - Motorway Network Communications System
- TfNSW D&C TS916 Motorway Systems - Electronic Toll Collection System
- TfNSW D&C TS917 Motorway Systems - C2C Interface Requirements for Motorways
- TfNSW D&C TS918 Motorway Systems - Road Tunnel and Underpass Lighting

Australian Communications and Media Authority (ACMA) Documents

ACMA-mandated Electromagnetic Compatibility (EMC) standards