

Master Specification

Part TUN-ME-DC4

Tunnel Equipment Cabinets

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TUN-ME-DC4 Tunnel Equipment Cabinets

1 General

- a) This Master Specification Part sets out the requirements for the design, supply and installation of Tunnel equipment cabinets and associated equipment, including:
 - i) the documentation requirements, as set out in section 2;
 - ii) the Tunnel equipment cabinet requirements, as set out in section 3;
 - iii) the control and monitoring requirements, as set out in section 4;
 - iv) the Design Life requirements, as set out in section 5;
 - v) the maintainability requirements, as set out in section 6;
 - vi) the testing and acceptance requirements, as set out in section 7;
 - vii) the warranty requirements, as set out in section 8;
 - viii) the Hold Point requirements, as set out in section 9; and
 - ix) the verification and testing requirements, as set out in section 10.
- b) References to “Tunnel equipment cabinets” in this Master Specification Part includes the cabinets and enclosures located within Tunnels to house ITS equipment and supporting electrical and communications equipment, including:
 - i) data communication network equipment;
 - ii) plant monitoring and control system (PMCS) equipment (other than when this equipment is housed in low voltage (LV) switchboards, motor control centres or distribution boards) including:
 - A. remote I/O and Programmable Logic Controllers (PLC); and
 - B. remote device and instrumentation marshalling equipment;
 - iii) radio rebroadcast (RRB) equipment;
 - iv) public address (PA) equipment;
 - v) speed enforcement equipment;
 - vi) over-height vehicle (OHV) enforcement equipment;
 - vii) dangerous goods vehicle (DGV) enforcement system equipment;
 - viii) in-Tunnel wayfinding and positioning system equipment;
 - ix) Tunnel lighting control equipment;
 - x) backup power supplies;
 - xi) video surveillance equipment;
 - xii) automatic incident detection equipment; and
 - xiii) electronic sign equipment.
- c) References to “marshalling cabinets” within this Master Specification Part includes equipment cabinets used as marshalling points, including special purpose cabinets that are required to be installed within the Tunnel environment to facilitate direct connection to instrumentation equipment.

- d) This Master Specification Part does not apply to equipment cabinets located outside of Tunnels. RD-ITS-S3 “ITS Enclosures” applies to equipment cabinets which are located “at grade” (i.e. open road, not in Tunnels).
- e) The Tunnel equipment cabinets must comply with the Reference Documents, including:
 - i) AS 1319 Safety signs for the occupational environment;
 - ii) AS/NZS 1580.457.1 Paints and related materials - Methods of test, Method 457.1: Resistance to natural weathering;
 - iii) AS 1627 Metal finishing - Preparation and pretreatment of surfaces;
 - iv) AS 2700 Colour standards for general purposes;
 - v) AS 3990 Mechanical equipment - Steelwork;
 - vi) AS 4100 Steel structures;
 - vii) AS 60529 Degrees of protection provided by enclosures (IP Code);
 - viii) AS/CA S009 Installation requirements for customer cabling (Wiring Rules);
 - ix) AS/NZS 1664 Aluminium structures;
 - x) AS/NZS 1170 Structural design actions;
 - xi) AS/NZS 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules);
 - xii) AS/NZS 3085.1 Telecommunications installations - Administration of communications cabling systems, Part 1: Basic requirements;
 - xiii) AS/NZS ISO 9001 Quality management systems - Requirements; and
 - xiv) ISO 16890-1 Air filters for general ventilation - Part 1: Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM).

2 Documentation

2.1 Design Documentation

In addition to the requirements of PC-EDM1 “Design Management”, the Design Documentation must include:

- a) all relevant design documentation and information required by RD-ITS-D1 “Design of Intelligent Transport Systems (ITS)” (as it relates to the Tunnel equipment cabinets);
- b) for each type of Tunnel equipment cabinet:
 - i) manufacturers specifications;
 - ii) Design Drawings showing the generic equipment layout; and
 - iii) cabinet Design Drawings;
- c) for each Tunnel equipment cabinet, Design Drawings detailing:
 - i) the layout and mounting arrangement of equipment housed within the Tunnel equipment cabinet;
 - ii) cable management, cable and connection paths;
 - iii) power single line diagram;
 - iv) communications interconnection diagram; and
 - v) cabinet asset identification labelling;

- d) specifications for equipment associated with the Tunnel equipment cabinets, including:
 - i) cables;
 - ii) cable management;
 - iii) terminals and fittings; and
 - iv) security mechanisms, including locking mechanisms, door monitoring (if specified in the Contract Documents), keys (including both mechanical and electronic locking, where relevant); and
- e) a Tunnel equipment cabinet cable labelling scheme which complies with the requirements of PC-CN2 "Asset Handover".

2.2 Construction Documentation

In addition to the requirements of PC-CN3 "Construction Management", the Construction Documentation must include:

- a) drawings, manufacturer's specifications, and diagrams of each type of Tunnel equipment cabinet supplied by the Contractor, including equipment layout and wiring;
- b) a Tunnel equipment cabinet cable labelling scheme which complies with the requirements of PC-CN2 "Asset Handover"; and
- c) where cooling systems are included in Tunnel equipment cabinets supplied by the Contractor, the Testing and Commissioning Management Plan as required by PC-CN1 "Testing and Commissioning", and results of the testing for the cooling system.

2.3 Quality Management Records

In addition to the requirements of PC-QA1 "Quality Management Requirements" or PC-QA2 "Quality Management Requirements for Major Projects" (as applicable), the Quality Management Records must include:

- a) Shop Drawings for each type of Tunnel equipment cabinet; and
- b) As-Built Records for each Tunnel equipment cabinet detailing:
 - i) equipment layouts;
 - ii) wiring schematics;
 - iii) cable schedules; and
 - iv) bill of materials for each Tunnel equipment cabinet including installed equipment.

3 Tunnel equipment cabinet requirements

3.1 General

- a) Equipment cabinets housing general electrical equipment (e.g. ITS, PMCS and communications equipment) must comply with the requirements of section 3.1 to section 3.11.
- b) Marshalling cabinets must comply with the requirements of section 3.1 to section 3.11 with the exception of:
 - i) section 3.3a)iii);
 - ii) section 3.4 where the marshalling cabinets are not ground mounted;
 - iii) section 3.6b);
 - iv) section 3.6g);
 - v) section 3.6j); and

- vi) section 3.7c)vi).
- c) All Tunnel equipment cabinets must be designed, constructed, supplied and installed to:
 - i) achieve the required Design Life;
 - ii) meet Safety in Design requirements;
 - iii) provide a suitable environment for the reliable operation of the housed equipment including (as required):
 - A. temperature control;
 - B. humidity control;
 - C. dust, particulate and moisture ingress protection; and
 - D. management of vibration likely to be experienced in a Tunnel environment;
 - iv) prevent the entry of vermin; and
 - v) for the duration of the Design Life as a minimum, comply with all requirements of the Contract Documents for the environmental conditions expected to be encountered in the specified application, including potential exposure to:
 - A. high humidity;
 - B. corrosive groundwater;
 - C. atmospherically borne corrosive agents; and
 - D. atmospherically borne pollutant particles, including those which may be electrically conductive.
- d) The Tunnel equipment cabinet equipment and associated cable layout design:
 - i) as far as practical, must have the same general layout for each type of Tunnel equipment cabinet;
 - ii) must facilitate maintenance of equipment installed in the Tunnel equipment cabinet including:
 - A. convenient access to equipment including equipment displays; and
 - B. quick removal and replacement of equipment without the need for specialist tools; and
 - iii) must detail a practical and reliable cable termination and management strategy.
- e) All cables installed in Tunnel equipment cabinets must be LSZH.

3.2 Tunnel equipment cabinet locations

All Tunnel equipment cabinets must be installed in plant rooms or equipment rooms within the Tunnel.

3.3 Tunnel equipment cabinet dimensions

- a) The Tunnel equipment cabinets must:
 - i) have sufficient interior space to:
 - A. allow housed equipment, including cabling, to be installed, inspected, operated, maintained, removed or replaced without disassembly of the Tunnel equipment cabinet or the housed equipment;
 - B. install all necessary cable management and cable containment systems required by the Reference Documents;

- C. segregate communication cabling and electrical cabling as required by the Reference Documents; and
 - D. ensure that specified manufacturer cable bend radii requirements are not impinged upon for all cabling;
 - ii) provide sufficient cable management to ensure that all cables are adequately supported and are not subject to stress or cannot detach from their associated terminals or plugs or sockets in normal operation or whilst undertaking maintenance activities;
 - iii) provide for a clear buffer space of at least 80 mm between all housed equipment and equipment mounting arrangements and the Tunnel equipment cabinet walls, any access covers and access doors;
 - iv) provide sufficient space to ensure that cable access, management and termination can be undertaken neatly, efficiently and without impairment; and
 - v) provide sufficient volume or non-forced convection ventilation to ensure that housed equipment remains within specified operational temperature ranges at all times and under all load conditions.
- b) Each type of Tunnel equipment cabinet must have standardised dimensions (i.e. to minimise the number of different sized or dimensioned cabinets for each cabinet use type).
 - c) The Tunnel equipment cabinets must:
 - i) be based around 19 inch rack units where the housed equipment uses this mounting format; or
 - ii) adopt accepted industry standards where the housed equipment does not use the mounting format required by section 3.3c)i).

3.4 Cable gland plates and glanding

- a) The Tunnel equipment cabinets must:
 - i) utilise a “bottom entry and exit” cabling configuration to prevent water and condensation ingress from above; and
 - ii) have a gasketed non-ferrous gland plate installed within the Tunnel equipment cabinet base compartment to prevent dust, dirt and vermin ingress via the cable containment system.
- b) The gland plates installed pursuant to section 3.4a)ii) must have layouts which satisfy the following requirements:
 - i) the gland plates must be logically designed to efficiently manage cable access; and
 - ii) the gland plates must be punched off-site during the manufacturing process to meet the specific requirements of the Tunnel equipment cabinet into which the gland plate is to be installed.
- c) The gland plates must satisfy the following requirements:
 - i) the gland plates must be cross bonded to the Tunnel equipment cabinet’s earthing system;
 - ii) all glands must be chromium plated brass; and
 - iii) any unused holes in the gland plate must:
 - A. be plugged with metallic gasketed blanks; and
 - B. not be plugged with nylon or plastic blanks.
- d) Where access is not readily available to both front and rear aspects of the Tunnel equipment cabinet gland plate (including where Tunnel equipment cabinets are installed back-to-wall), the Contractor must:

- i) provide a 120 mm (minimum) cable zone, clear of any obstacles, within the Tunnel equipment cabinet beneath the gland plate; and
- ii) provide sufficient space above the gland plate (a minimum of 2 RU clear space below cable management trunkings and similar equipment) as a cable marshalling zone.

3.5 Cable management requirements

- a) All Tunnel equipment cabinets must be provided with internal cable management to route cabling and cores neatly and securely from the point of Tunnel equipment cabinet entry (gland plate) to the points of termination (terminals).
- b) The Tunnel equipment cabinet cable management must:
 - i) support the segregation of cables and cable cores of differing voltages and applications, including LV, ELV, multi-pair copper and fibre optic cable in accordance with the Reference Documents;
 - ii) ensure all cables are adequately supported;
 - iii) accommodate the minimum bending radii of each cable and cable type;
 - iv) ensure the operation of Tunnel equipment cabinet doors does not stress or detach cables from their terminals, plugs or sockets;
 - v) ensure the removal of Tunnel equipment cabinet covers does not stress or detach cables from their terminals, plugs or sockets;
 - vi) ensure that cables are prevented from contact with sharp edges or any surfaces that may damage the cable; and
 - vii) comprise LSZH materials.
- c) The Contractor must not loosely coil cables in Tunnel equipment cabinets.
- d) The Contractor must avoid excessive cable density within Tunnel equipment cabinets.
- e) All cabling must be accommodated within the Tunnel equipment cabinet cable management and gland plate system when the Tunnel equipment cabinet is fully populated and wired as designed, with:
 - i) greater than 25% spare cable management system capacity remaining; and
 - ii) greater than 25% spare gland plate capacity remaining.
- f) The design and installation of fibre optic cabling within the Tunnel equipment cabinets must comply with RD-ITS-C3 "Telecommunications Cabling".
- g) The labelling of cabling within the Tunnel equipment cabinets must comply with RD-ITS-C3 "Telecommunications Cabling".
- h) All copper control I/O cabling cores, including spare cores, must be:
 - i) terminated into DIN rail mounted grouped, segregated and permanently labelled captive screw type terminals ("push in" (screwless) type terminals must not be used); and
 - ii) terminated and permanently labelled in accordance with the Design Documentation.
- i) All UTP cabling must be terminated using RJ45 plug or socket connectivity with male or female sides being permanently labelled as to their identity.
- j) In addition to the requirements of RD-ITS-C3 "Telecommunications Cabling", all cables must be permanently labelled as to the identification number:
 - i) immediately above the gland plate; and
 - ii) prior to entering internal Tunnel equipment cabinet cable management systems.

- k) All Tunnel equipment cabinets incorporating telecommunication cables (whether fibre optic or copper) must comply with the requirements of the AS/CA S009-2020 Installation requirements for customer cabling (Wiring Rules).

3.6 Tunnel equipment cabinet power distribution and management requirements

- a) 400v 3-phase supplies must not be utilised (nor broken out) within Tunnel equipment cabinets.
- b) LV and ELV supplies must utilise dedicated load centres installed within each Tunnel equipment cabinet fitted with load current rated isolators and over-current protection via MCB in accordance with AS/NZS 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules).
- c) LV and ELV circuits and equipment must be appropriately segregated and voltage presence warning labels provided in accordance with the requirements of AS/NZS 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules).
- d) All terminals installed within the Tunnel equipment cabinets (irrespective of voltage) must provide IP2X protection against direct contact.
- e) Plug-in 230v or ELV power packs must not be used for any equipment housed within Tunnel equipment cabinets.
- f) ELV supplies to all control and communications devices must be provided via redundantly configured (hard-wired) power supplies.
- g) "Raritan" multi-way IP (internet protocol) addressable socket outlets must be used within Tunnel equipment cabinets, noting that this does not include any PMCS or PLC equipment, or equipment that is necessary for the PMCS to operate correctly.
- h) Tunnel equipment cabinet earthing arrangements must comprise:
 - i) a dedicated earth bar with main earthing terminal and numbered terminals;
 - ii) cable screen earthing facilities (where cable screen earthing is required); and
 - iii) cross bonding to all Tunnel equipment cabinet covers and doors and extraneous metalwork in accordance with the requirements of AS/NZS 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules).
- i) Outer insulation and sheath of electrical cables must be colour coded to differentiate ELV from LV power cables.
- j) One single socket residual current device (RCD) protected general power outlet must be provided within each Tunnel equipment cabinet for maintenance purposes:
 - i) the outlet may be current limited to a minimum of 3 amps to minimise maximum demand requirements for the cabinet; and
 - ii) if the outlet is current limited, it must be appropriately labelled as a current limited outlet, stating the maximum current available.

3.7 Tunnel equipment cabinet doors and latches

- a) All Tunnel equipment cabinets must have access doors.
- b) Twin doors may be used to minimise spatial requirements for interior access.
- c) The Tunnel equipment cabinet doors must:
 - i) be hinged in the vertical plane using concealed hinges designed so that the doors cannot be demounted from the Tunnel equipment cabinet without the doors being in the open position;
 - ii) not exceed 900 mm in width and extend as far as practicable to the extremities of the Tunnel equipment cabinet shell;

- iii) be of the same material and finish as the Tunnel equipment cabinet shell itself;
 - iv) be mechanically secured when in the open position at 90° degrees and 140° degrees from their closed position via a captive non-sliding mechanism;
 - v) not interfere with the opening of adjacent Tunnel equipment cabinet doors when opened to 90° degrees; and
 - vi) feature an internal document storage pocket (A3 size minimum) with at least 2 equi-spaced finger slots from within the bottom of the pocket to 50 mm from its top to assist in the removal of contents from the pocket.
- d) Ethylene propylene diene monomer (EPDM) seals must be provided to all exterior doors of the Tunnel equipment cabinet, compressing against the folded edge of a fabricated self-draining channel around the door aperture and the door itself, ensuring the retention of the Tunnel equipment cabinet's nominated IP rating as measured in accordance with AS 60529 Degrees of protection provided by enclosures (IP Code) throughout its Design Life.
 - e) Doors and any exterior cover fixings must be of sufficient strength, stiffness and design to prevent unauthorised entry.
 - f) All Tunnel equipment cabinet access covers and doors must be lockable and installed flush with the Tunnel equipment cabinet when in the closed position.
 - g) All Tunnel equipment cabinets must be provided with non-electronic mechanical locks and multi-point door latching mechanisms.
 - h) The locks required by section 3.7g) must:
 - i) utilise a Euro Profile locking cylinder (DIN 18254), or equivalent, with restricted keying; or
 - ii) utilise a Lowe and Fletcher Barrel No. 380, Part No. A/CR32/01 WI3 lock or approved equivalent; or
 - iii) a ABUS 83/50 lock or equivalent, with restricted keying, for where padlocks are required.
 - i) At least 2 keys must be supplied with each Tunnel equipment cabinet for each Tunnel equipment cabinet lock.
 - j) The locking and unlocking of each Tunnel equipment cabinet door must be affected by single key operation.
 - k) The Tunnel equipment cabinet locking mechanism design must comply with the following:
 - i) the Tunnel equipment cabinet door lock must operate a 3-point latching mechanism with pins extending from the top, centre and bottom of the non-hinged side of the door; and
 - ii) the Tunnel equipment cabinet doors must house a flush mounting, ergonomic handle capable of accepting the locks required by this section 3.7.
 - l) Cover fixings (including screws, bolts and latches) must be captive with the cover when the cover is removed.
 - m) All locks and latches must be installed flush with the Tunnel equipment cabinet's outer skin.

3.8 Tunnel equipment cabinet environmental resilience

- a) For Tunnel equipment cabinets located in plant rooms or electrical equipment rooms, the Tunnel equipment cabinets must be designed to house equipment, allowing the equipment function normally, under the following conditions:
 - i) ambient temperatures up to 40°C; and
 - ii) ambient humidity up to 80%.

- b) For marshalling cabinets located outside of plant rooms or electrical equipment rooms, marshalling cabinets must protect housed equipment from the environment expected to be encountered in the proposed location including:
 - i) temperatures;
 - ii) humidity; and
 - iii) corrosives.
- c) Tunnel equipment cabinets, including marshalling cabinets, must achieve an ingress protection code rating in accordance with AS 60529 Degrees of protection provided by enclosures (IP Code) of:
 - i) IP42 or better when installed in a plant room or equipment room;
 - ii) IP66 when installed in areas that could be exposed to deluge, high-pressure water washing or external weather conditions; and
 - iii) IP65 or better when installed in any other Tunnel location.

3.9 Tunnel equipment cabinet surface finish and corrosion protection

- a) The exterior and interior of all Tunnel equipment cabinets must be free from burrs, protrusions, and sharp projections.
- b) Bends and folds must have an external bend radius not less than 3 mm.
- c) Zinc-alume electroplated mild steel Tunnel equipment cabinets must be used only in the controlled environment offered by plant rooms or equipment rooms as defined in TUN-FAC-DC1 "Requirements for Tunnel Facilities".
- d) Where the controlled, ambient, environment offered by plant rooms or equipment rooms is not available, fabricated 316 stainless steel Tunnel equipment cabinets must be used, including:
 - i) marshalling cabinets in Tunnel carriageways;
 - ii) ventilation stations and exhaust outlets;
 - iii) areas subject to deluge system action; and
 - iv) areas exposed to weather.
- e) Applied protective coatings must be applied in accordance with the coating manufacturer's specifications and be resistant to weathering and aging in accordance with AS/NZS 1580.457.1 Paints and related materials - Methods of test, Method 457.1: Resistance to natural weathering.
- f) The Tunnel equipment cabinets and any associated mounting structures or plinths must be finished in a ripple-free epoxy powder coat finish of minimum 100 micron thickness, excluding surface preparations or primers.
- g) The Tunnel equipment cabinets must be of a colour as defined in AS 2700 Colour standards for general purposes:
 - i) exterior colour: X15 orange;
 - ii) interior colour: X15 orange; and
 - iii) internal backplane plates, escutcheon plates and gland plates: white.

3.10 Labelling

- a) External asset identification labels must be supplied and affixed to all Tunnel equipment cabinets in accordance with the requirements of RD-ITS-C1 "Installation and Integration of ITS Equipment".

- b) Labels provided for Tunnel equipment cabinets for other purposes (i.e. other than external asset identification labels) must comply with the requirements of RD-ITS-S3 "ITS Enclosures".
- c) All Tunnel equipment cabinets must be labelled in accordance with PC-CN2 "Asset Handover", including an asset identification QR code. This QR code may be included as a part of the asset identification label required in 3.10a).

3.11 Tunnel equipment cabinet base mounting and external cable access facility

- a) All Tunnel equipment cabinets must have a minimum of 4 retaining stud holes provided internally within the base compartment bottom flange to enable the invisible fixing of the Tunnel equipment cabinet to the floor structure irrespective of floor material or structural design.
- b) The Tunnel equipment cabinet fixing system must allow on-site adjustment of vertical and horizontal alignment.
- c) Sufficient cable management (in the form of either an appropriately dimensioned pit or false floor structure) must be provided beneath each Tunnel equipment cabinet to allow direct cable access from below to the Tunnel equipment cabinet gland plate above.

4 Control and monitoring requirements

Unless otherwise specified in the Contract Documents, Tunnel equipment cabinets are not required to be monitored.

5 Design Life requirements

The Contractor must ensure that the Tunnel equipment cabinets have a Design Life in compliance with RD-ITS-D1 "Design of Intelligent Transport Systems (ITS)".

6 Maintainability

6.1 Access

- a) The design and layout of each Tunnel equipment cabinet must be capable of enabling full and safe access to the Tunnel equipment cabinet and the equipment housed within the Tunnel equipment cabinet by a single maintenance technician to allow:
 - i) removal and replacement of any of the equipment housed in the Tunnel equipment cabinet; and
 - ii) installation, testing or maintenance to be undertaken.
- b) The equipment housed within a Tunnel equipment cabinet must not be installed greater than 1800 mm above the standing surface upon which the Tunnel equipment cabinet is to be fixed, to support convenient maintenance access without the need for access aids.

6.2 Tunnel equipment cabinet internal lighting

Each Tunnel equipment cabinet must have internal lighting which complies with the enclosure lighting requirements specified in RD-ITS-S3 "ITS Enclosures".

6.3 Lifting and transportation points

- a) All Tunnel equipment cabinets must be provided with structurally secured lifting anchors rated to enable fitted-out Tunnel equipment cabinet handling without incurring damage or deformation.
- b) All lifting anchors and transportation anchors:

- i) must be capable of supporting the fitted-out Tunnel equipment cabinet (complete with all equipment housed within the Tunnel equipment cabinet);
 - ii) must be integral with the Tunnel equipment cabinet;
 - iii) must prevent moisture ingress to the Tunnel equipment cabinet so that the Tunnel equipment cabinet complies with the required IP rating; and
 - iv) do not include seals around the lifting anchors or transportation anchors.
- c) The lifting, transportation and off-loading requirements associated with Tunnel equipment cabinets which are to be installed within Tunnels where access may be restricted must consider any limitations imposed for such transport, offloading and installation.

7 Testing and acceptance

Testing and commissioning procedures and documentation must comply with the requirements of PC-CN1 "Testing and Commissioning".

8 Warranty

For the purposes of PC-CN3 "Construction Management", the Contractor must provide a manufacturer's warranty in accordance with the Contract Documents or RD-ITS-S1 "General Requirements for the Supply of ITS Equipment", whichever is the greater.

9 Hold Points

Table TUN-ME-DC4 9-1 details the review period or notification period, and type (documentation or construction quality) for each Hold Point referred to in this Master Specification Part.

Table TUN-ME-DC4 9-1 Hold Points

| Section reference | Hold Point | Documentation or construction quality | Review period or notification period |
|-------------------|--|---------------------------------------|--------------------------------------|
| 10a) | Approval of prototype sample of each Tunnel equipment cabinet type | Documentation | 20 Business Days review |

10 Verification requirements and records

- a) The Contractor must provide a prototype sample of each Tunnel equipment cabinet type it proposes to incorporate within the works for approval by the Principal, which will constitute a **Hold Point**. Mass production must not commence until the release of this Hold Point.
- b) The prototype must be made available for review within the boundaries of Adelaide metropolitan area, South Australia.