Technical Specification

Transport and Main Roads Specification MRTS259 Transportable Generator

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Queensland Government

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1 Introduction

This Technical Specification defines the minimum technical requirements 240 V, 50 Hz, 0.8 lagging power factor, Single phase, and prime rated transportable electric generators (to be called generators from hereon) with soundproof enclosures. The primary purposes of these generators are to supply power to traffic signals during utility power outage and use as standalone, short term power sources to "Truck Inspection Bays" where utility power is not available. This Technical Specification also covers the testing requirements and specifications of other accessories to be provided with the generators. Technical requirements of generators for fixed installations and long term operations are not within the scope of this Specification.

This is a new Technical Specification.

This Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements*, MRTS201 *General Equipment Requirements* and other Technical Specification as appropriate.

2 Definition of terms

The terms defined in Clause 2 of MRTS201 *General Equipment Requirements*, MRTS210 *Provision of Mains Power* and MRTS228 *Electrical Switchboards* apply to this Specification.

Table 2 - Definitions

Term	Definition
AVR	Automatic Voltage Regulation
CSA	Cross-Sectional Area
gG	fuses with full range breaking capacity for general applications
HRC	High Rupture Capacity
MSB	Main Switchboard
MSL	Mean Sea Level

3 Reference documents

The requirements of the reference documents listed in Table 3 below apply to this Specification. Where there are inconsistencies between this Specification and reference documents, the order of precedence will be:

- this Specification
- Australian Standards
- International Standards.

Table 3 – Reference documents

Document	Description
AS/NZS CISPR 14.1	Limits and methods of measurement of radio disturbance characteristics of electrical motor-operated and thermal appliances for household and similar purposes electric tools and similar electric apparatus
AS 1940	The Storage and Handling of Flammable and Combustible Liquids
AS/NZS 2276.1	Cables for Traffic Signals Installations.
AS 2578	Traffic Signal Controllers
AS 2790	Electricity generating sets - Transportable (Up to 25 kW)
AS/NZS 3000	Wiring Rules
AS/NZS 3010	Electrical Installations - Generating Sets
AS/NZS 3100:2009	Approval and test specification - General requirements for electrical equipment
AS/NZS 3112:2011	Approval and test specification - Plugs and socket-outlets
AS 4594	Internal Combustion Engines -Performance
AS/NZS 5000.1	Electrical Cables -Polymeric Insulated
AS 60529	Degrees of Protection Provided by Enclosures
MRTS201	*General Equipment Requirements*
MRTS210	*Provision of Mains Power*
MRTS228	*Electrical Switchboards*

3.1 Acts and Regulations

All works undertaken and equipment supplied shall be in accordance with the following legislations:

- *Workplace Health and Safety Act* and Regulations
- *Environmental Protection Act*, and Regulations
- *Queensland Electrical Safety Act 2002* and Regulations
- *Fuel Quality Standards Act 2000*.

4 Quality system requirements

The quality system requirements defined in MRTS201 *General Equipment Requirements* apply to this Specification in addition to project specific requirements as defined by the principals' representative.

Table 4 – Hold Points and Witness Points

Clause	Hold Point	Witness Point
7.2	1. Datasheet on protective device. Full load current and p.u. impedance of generator	
12	2. Records of Tests and Inspections	
12.2		Short circuit test on load; RPEQ certification

5 Functional requirements

The generator is to be used to supply power to traffic signals during power outages and as a standalone power source for “Truck Inspection Bays” where utility power supply is not available. The generator shall be able to supply power within the specified parameters under varying load conditions and environmental conditions at least for seven days continuously without degrading performance (excluding refuelling). The generator shall be able to operate with 10% overload capacity for one hour during every 12 hour period. The generator should be able to provide sufficient short circuit current for the operation of protective devices within the times specified in AS/NZS 3000.

The generator is to be self-contained, enabling connection to existing power distribution system/equipment without any changes or adjustments that require specialised tools.

6 Operational requirements

The design and construction of the generator shall meet the operational and performance requirements described in the following sections. Additional operational requirements defined in MRTS201 also apply to work under this standard.

7 Electrical requirements

7.1 General

The generator shall operate within the following performance parameters at 40°C ambient temperature, relative humidity of 90% at 500 m MSL (Mean Sea Level).

Table 7.1 – Generator parameters

Parameter	Rating
Type of generator	: Prime rated
Loading	: 100% step loading with speed droop of 5%
Earth pin of socket outlet /extension leads	: 15A
No of phases	: 1
Voltage	: 240V
Voltage regulation	: +/- 5%
Frequency	: 50Hz
Frequency regulation	: +/- 2%
Power factor	: 0.8 lagging
Deviation dactor for voltage waveform	: 5%
Harmonic distortion	: 7 %
Over loading	: 10% for one hour during every 12 hour period
Noise level	: 65 dBA @ 7m

The 15A requirement for the generator socket outlet ensures compatibility with the 15A inlet plug of a traffic signal controller.

7.2 Short circuit performance

The generator shall provide sufficient current to automatically disconnect a protective device within 0.4 seconds to protect against short circuit currents when the Fault Loop Impedance is within values which are in accordance with the principles Table 8.1 of AS 3000.

The protective device shall comply with the requirements of clause 2.4.3 of AS/NZS 3000:2007 and can be installed in any of the following methods:

a) integral to the generator

b) integral to the load's supply inlet (e.g. Traffic signal controller or main switchboard), or

c) independent over-current protection unit, or protective junction box, which connects the generator to the load.

The generator supplier shall provide datasheet containing information on the protective device used, the p.u. impedance and full load current and Prospective Short Circuit Current (PSSC) of the generator, or shall do so by measurement, to enable calculation of and Fault Loop impedance prior to installation. **Hold Point 1**

7.2.1 Overcurrent protection unit (terminal box)

Where a protective device integral to the generator, or integral to the MSB of the load is not available, and independent overcurrent protection unit, or terminal box, connecting the generator to a changeover device installed at the MSB of the load, shall be provided. The unit shall disconnect supply to the load within 400ms in the event of a short circuit fault. In addition, the unit shall:

- connect to the MSB changeover device in accordance with the principles outlined in Clause 2.5.4 of AS 3010:2005
- have a 15A inlet plug to AS/NZS 3112:2011, to connect to the generator
- have a 15A switched outlet socket to AS/NZS 3112:2011 with a flexible cord integral to the unit. The active wire in the cord shall be overcurrent protected and the neutral is not switched. Earthing and bonding requirements shall be in accordance with Clause 2.5.6 of AS 3010:2005
- provide means for resetting the unit once the overcurrent device has operated
- provide indicators showing the status of the unit
- if using overcurrent relays, provide means for setting the time/current thresholds and hysteresis
- be rated to IP56 or better in accordance with AS 60529
- be suitable to accommodate lugged or clamped termination of the active and neutral XLPE/PVC, non-armoured, 2core, stranded copper conductor cables of appropriate CSA that comply with AS/NZS 5000.1 and AS/NZS 2276.1
- be of class II (double-insulated) construction in accordance with AS/NZS 3100:2009.

7.3 Earthing and bonding

The prime mover, base plate, generator housing and all other conductive parts shall be electrically bonded to form generator bonding system (see Clause 2.5.6.1 of AS/NZS 3010:2005). A separate terminal connected to the generator bonding system shall be provided in the output terminal box in order to facilitate connection to the earth bar of MEN switchboard.

The neutral shall not be earthed when the generator is connected to a MEN switchboard. (Refer Clause 2.5.6.2.2 of AS/NZS 3010). Consequently, generators with RCD protection shall not be used when the generator is connected to an MEN switchboard.

8 Physical and mechanical requirements

8.1 Engine

The generator engine shall be an internal combustion type, complying with the requirements of AS 4594. The engine shall meet all the performance requirements of the generator set under the specified operating conditions and shall be suitable to operate with fuels listed in *Fuel Quality Standard Act 2000*. The Time Between Overhauls (TBO) should be more than 4000 hours for prime rated applications.

The prime mover and generator should be direct coupled, and both shall be mounted on a common base plate. Anti-vibration mounting shall be provided between generator set and base plate.

8.1.1 Cooling

A forced air or closed loop water cooling system shall be provided that ensure continuous operation of the generator in a range of ambient temperature and humidity prescribed in Figure 1.1 of AS 2578- Part 1.

For closed loop water cooling systems an engine driven pump and fan are preferable.

8.1.2 Air intake

The engine air intake system shall include dry type air filters.

8.1.3 Exhaust

Exhaust gas system shall be of mild steel and all connections shall be flanged using heat resistant gaskets containing no asbestos and with outlet preventing ingress of dust or storm water into the cooling system.

A silencer shall be provided to reduce noise to the specified levels.

All exhaust pipe surfaces shall be insulated. Insulation shall be suitably rated mineral wood or fibreglass and shall be fixed with corrosion resistant self-tapping screws.

8.1.4 Lubrication

The lubricating oil system shall be self-priming and splash type by means of an engine driven integral pump. The pump shall have on the suction side a coarse strainer and on the delivery side a duplex ‘full flow’ fine filter complete with changeover cock incorporating pressure by-passes to facilitate oil flow to the engine should the filter become blocked. The lubrication system capacity shall be sufficient to enable to run continuously for 12 hours at any load without replenishment.

A manual oil level indicator shall be provided.

8.1.5 Starting

The generator shall be started either electrically via an “ON” switch, or via a recoil starter (pull start).

For electrically started generators a 12V starter motor shall be used. The equipment shall include an adequately rated lead/acid battery together with an automatic mains energised battery charger. The charger shall have a continuous output rating sufficient to recharge the battery from 1.8 V/cell to a fully charged condition in a period of eight hours. A charging indicator or charging parameter indication should be provided in the control panel.

The battery shall be capable of providing at least six starting cycles within a period of five minutes and shall not affect the correct operation of the control system during the start of the engine.

Where a recoil starter is used, it shall be equipped with a compression release mechanism.

8.1.6 Governor

The governor of the engine shall be mechanical/electronic type and be capable of fine governing of speed to Class A1 of AS 4594.

8.1.7 Fuel system and storage

The fuel tank shall be integral within the generator unit and without refuelling shall provide for at least four hours continuous running at full load capacity. The fuel tank shall be complete with fill, vent, drain, overflow line, and level indication. A low level switch shall be provided for indication at control panel. A fuel water separator shall be provided in case the fuel is diesel.

To allow for additional fuel capacity, it is desirable that the generator has provision for auxiliary plug-in fuel tanks.

A manual shut-off valve and filter shall be provided in the supply line to the engine. The fuel system shall incorporate facilities to overcome fuel starvation due to high ambient temperatures.

8.2 Generator

8.2.1 General

The generator shall be single phase, two wire, brushless, self-exciting and self-regulating type. The degree of protection for the generator and exciter shall be not less than IP 23 in accordance with AS 60529. Cooling of the generator shall be by a radial-flow fan. Generator bearings shall be of the ball or roller type, and prepacked with sufficient grease for operating over long periods without replenishment.

The generator windings shall be air cooled, with Class F insulation (NEMA classification) and shall be varnish impregnated to suit the specified environment conditions and heated to compensate for condensation propensity.

Generators shall be equipped with a protection system to protect a motor from winding failure and prevent starting of the generator in the event of high winding temperature. The protection system may include current sensitive devices or temperature sensitive devices.

Excessive winding temperature causes permanent winding damage, and can cause complete winding insulation breakdown and failure causing down-time. Therefore a good monitoring system is essential to minimize costs which can be incurred.

8.2.2 Excitation

The exciter shall be brushless and self-excited type with rotating silicon rectifiers, static voltage regulator and compounding equipment. The voltage regulator shall maintain its setting for long periods without adjustment.

The excitation system shall generate a sufficient current to automatically disconnect a protective device within 0.4 seconds in the event of a short circuit, when the Fault Loop Impedance of the installation is in accordance with the principles of Table 8.1 of AS 3000.

The exciter shall have Class F insulation with Class B temperature rise and be of the enclosed ventilated type having the same degree of protection as the generator enclosure.

A solid state type automatic voltage regulator (AVR) shall be provided with following minimum facilities:

- under frequency roll off
- over frequency roll off
- excitation over current protection.

8.3 Enclosure

The relevant clauses of enclosures as defined in MRTS 201 is applicable to this standard as specified by the Principal's representative. Additional requirements are listed below.

All moving parts that may cause injury to persons shall be protected by barriers to prevent unintentional personal contact with such parts. The protection shall be provided by guards, enclosures, railings or fences.

The combined generator and engine unit shall be integrally coupled and enclosed in a mobile acoustic and fire proof casing suitable for outdoor operation. Protection rating of the generator integral with enclosure shall be at least IP44 in accordance with AS 60529.

The enclosure shall be provided with the following facilities:

- lifting points/pad Mounting
- lockable covers with safety guards allowing adequate access for inspection and maintenance, and screening to prevent entry of vermin
- secure cable access into the enclosure
- sufficient ventilation to prevent accumulation of dangerous gases and creation of hot spots.

9 Environmental requirements

The generator shall deliver power with the above listed parameters under environmental conditions listed in MRTS201.

9.1 Noise level

The noise level of the complete generator set in a soundproof enclosure including inlet air and exhaust shall not exceed 65dBA at seven meters.

9.2 Radio frequency interference

The electromagnetic interference produced by the mobile generator unit shall not exceed the limits prescribed in AS/NZS CISPR 14.1.

10 Telecommunications requirements

The telecommunications requirements defined in MRTS201 apply to work provided under this specification.

Where required by the Principal, the generator shall provide means for wirelessly communicating alarm signals to a designated recipient. This may be via a handheld device or a fixed station. The alarm signals required include those listed in Section 11.2, and generator mislocation as defined in Section 11.3.

11 Instrumentation and control requirements

11.1 Automatic shutdown

Automatic shutdown of the generator and lockout of the starting system shall result from any of the following:

- low lubricating oil pressure
- high cooling water temperature
- over crank
- engine over speed
- high stator temperature.

11.2 Control panel

Where applicable, [1]the generator control panel shall consist of following:

- visual and audible fault indication and alarm accept/reset
- voltmeter
- ammeter
- frequency meter
- hour run counter

[1] The relevance of any of the listed features depends on the generator type. For example, some generators do not use batteries and therefore not require “battery charge indicator”

- engine 'start' and 'stop' push button and lock switch
- 'emergency stop' push button
- mains operated battery charger of the constant potential type with MCCB, ammeter
- run indicator lamp
- fault indicator lamp
- audible alarm
- lamp test push buttons, alarm accept and reset buttons
- battery charge indicator.
- lubrication oil pressure indicator
- cooling water temperature indicator
- fuel level in integral fuel tank low.

A microprocessor control panel with Alpha-numerical character digital display is an acceptable alternative to hardwired equipment. The microprocessor control panel shall incorporate all the above mentioned facilities. The microprocessor control panel shall be able to connect to a standard personal computer to download data and information from the module and to programme the Module.

11.3 Global positioning system (GPS)

Where required by the Principal, the generator shall be fitted with an on-board tamper proof GPS receiver. The on board GPS receiver shall monitor the location in three dimensions (Latitude, Longitude and Altitude) of the generator and also synchronise the generator's internal clock. The generator control unit shall provide an alarm if the generator is moved beyond a 30m radius of its installed position. This may be achieved using a virtual perimeter or "geo-fence".

This option for electronically tagging the generator may act as an additional anti-vandal or anti-theft feature in addition to similar measures that may be implemented/required by the districts.

12 Testing and inspection

No less than seven days' notice of all test plans including routine tests (12.1), and short circuit performance test (12.2) shall be given to the Principal's representative/s in order that they may be present if they desire. Duplicate copies of the Supplier's records of all previous tests and type test certificates shall be available to the Principal's representative. **Hold Point 2 2**

12.1 Routine tests

Each item of equipment shall be subjected to and satisfactorily withstand the routine tests specified in Australian Standard AS 4594.

The generator unit shall be tested at full load complete with the exciter, AVR, and operating with the fuel specified. The test program shall include at least the following, in accordance with the requirements of AS 4594:

- temperature rise

- alternator and exciter temperature rises
- vibration test of generator at rated speed and load
- response checks of AVR and frequency control with sudden load change
- noise level measurement
- over-speed shut-down function test
- measurement of net fuel usage at 50%, 75% and 100% of generator rated output
- capability of starting equipment
- exhaust emissions
- waveform deviation
- routine testing of all circuit breakers and control equipment
- complete functional testing of all emergency shutdown equipment including indication, alarms, controls, etc.

12.2 Testing and commissioning

The mobile generator set shall be sufficiently tested on-site prior to commissioning to ensure that design, materials and installation standards comply with MRTS201.

A short circuit current shall flow when the generator active and neutral terminals are bolted (short circuited). The resultant short circuit current shall be sufficient to cause the protective device or terminal box to disconnect the load within 0.4 seconds, in accordance with AS/NZS 3000 requirements. The test report shall include a test plan and a results sheet to include the generator type, rating (kVA), details of protective device tested, details of the circuit tested including the EFLI of the circuit, disconnection time, fault current and point of fault in the circuit (see Appendix A). The test results shall be certified by an electrical RPEQ and presented to the Principal for approval **Witness Point 1**.

13 Warranty

The warranty period for the generator set shall be minimum of one year or 1500 operating hours whichever may be reached first from ex-factory / supply date. The supplier should complete any warranty defects within 14 days of notice. The warranty shall include both spare parts and labour.

14 Training

The training requirements defined in MRTS201 are applicable to this Specification.

15 Documentation

The documentation requirements defined in MRTS201 are applicable to this Specification.

16 Maintenance

The maintenance requirements defined in MRTS201 are applicable to this Specification.

Appendix A: Test Sheet

Characteristic	Description/Value
Generator Characteristics	
Generator make/model	
Generator type (conventional/inverter)	
Rated AC output (kVA)	
Power factor	
AC output (W)	
Rated voltage (V)	
Rated frequency (Hz)	
In-built AC protection type (fuse, breaker, relay etc.)	
In-built protection rating (A)	
Prospective short circuit current at generator terminals	
Dry weight (kg)	
Secondary protective device characteristics	
Secondary protective device type (if any)	
Secondary protection rating (A)	
Time delay (ms) (for time-current relays)	
Load characteristics	
Load description	
Max demand (A)	
max EFLI (Ω)	
Test settings and results	
Description of measuring instrument	
EFLI at location of induced fault (Ω)	
Type of fault (A-N, A-PE)	
Fault clearance time (ms)	
Fault current (A RMS)	
Certification	
Certifying Engineer	
Signature	
RPEQ #	