AS 7703:2020

Australian STANDARD®

Railway signalling – Power supplies

RISSB

RAIL INDUSTRY SAFETY AND STANDARDS BOARD

Train Control Systems Standard

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This Australian Standard® AS 7703 Railway signalling – Power supplies was prepared by a Rail Industry Safety and Standards Board (RISSB) Development Group consisting of representatives from the following organisations:

Rio Tinto	PTA WA	Metro Trains
Rail Assurance Consulting	Transport for NSW	Queensland Rail
Aurizon	Public Transport Victoria	Wabtec
Novaris	V/Line	Ansaldo STS
KiwiRail	JMD Railtech	

The Standard was approved by the Development Group and the Operations Standing Committee in Select SC approval date. On Select Board approval date the RISSB Board approved the Standard for release.

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Development of the Standard was undertaken in accordance with RISSB's accredited process. As part of the approval process, the Standing Committee verified that proper process was followed in developing the Standard

RISSB wishes to acknowledge the positive contribution of subject matter experts in the development of this Standard. Their efforts ranged from membership of the Development Group through to individuals providing comment on a draft of the Standard during the open review.

I commend this Standard to the Australasian rail industry as it represents industry good practice and has been developed through a rigorous process.

Deb Spring
Exec. Chair / CEO
Rail Industry Safety and Standards Board

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This Standard was prepared by the Rail Industry Safety and Standards Board (RISSB) Development Group AS 7703 Railway signalling – Power supplies. Membership of this Development Group consisted of representatives from the organisations listed on the inside cover of this document

Objective

The objective of this Standard is to provide an approach to the use of the electrical equipment throughout the system life cycle in achieving the functional signalling safety inherent with the hazards associated with the use of electricity. This standard specifically covers the signalling power supply and the manner in which it supports the other signalling equipment.

Compliance

There are two types of control contained within Australian Standards developed by RISSB:

1. Requirements.
2. Recommendations.

Requirements – it is mandatory to follow all requirements to claim full compliance with the Standard. Requirements are identified within the text by the term 'shall'.

Recommendations – do not mention or exclude other possibilities but do offer the one that is preferred. Recommendations are identified within the text by the term 'should'.

Recommendations recognise that there could be limitations to the universal application of the control, i.e. the identified control is not able to be applied or other controls are more appropriate or better.

For compliance purposes, where a recommended control is not applied as written in the standard it could be incumbent on the adopter of the standard to demonstrate their actual method of controlling the risk as part of their WHS or Rail Safety National Law obligations. Similarly, it could also be incumbent on an adopter of the standard to demonstrate their method of controlling the risk to contracting entities, or interfacing organisations where the risk may be shared.

Controls in RISSB standards address known railway hazards are addressed in Appendix A.

Contents

Appendix Contents

1 Scope and general

1.1 Scope

This Standard covers the use of the electrical equipment as part of signalling systems to achieve vital and non-vital functions. The signalling power supply is a critical aspect for safe operation of signal systems. This standard's scope includes the functional requirements of electrical equipment performing signals safety applications. The scope of this Standard covers the range of environmental conditions signals are likely to be exposed to when operating in Australasian rail networks. The scope also details standard requirements for electrical equipment that is used in signalling systems to aid standardisation of supply and interoperability of equipment across railway networks.

The standard also covers the use and safety throughout the system life cycle.

This includes:

(a) design;

(b) construction;

(c) test and commission;

(d) operation;

(e) maintenance;

(f) modification;

(g) decommission and disposal.

Because of the inherent hazards with electricity there are legislative requirements for its application. Reference is provided to these in Appendix F and G. The hazards associated with the electrical equipment and the railway signalling functions have been considered and documented to aid users in determining the SFAIRP application of this standard to a railway network or electrical signalling equipment.

1.2 Exclusions

Railway traction power supplies are excluded from this standard. Where the signalling power supply is derived from the railway traction power supply the standard only covers the transformer secondary circuits, protection circuits and all downstream equipment.

Railway traction return current circuits and associated equipment are excluded from this standard. This also includes the associated equipment for electrolysis protection.

On board signalling system power supplies are excluded from this standard.

1.3 Normative references

The following referenced documents are indispensable for the application of this Standard:

- AS/NZS 3000 Electrical installations
- AS 7702 Rail Equipment Type Approval
- IEC 60364-1 Low voltage Electrical installations – Part 1 - Fundamental principles, assessment of general characteristics, definitions.

1.4 Terms, definitions and abbreviations

1.4.1 Terms and definitions

For the purposes of this document, the terms and definitions given in RISSB Glossary: https://www.rissb.com.au/products/glossary/ and the following apply:

(a) ***alternating current (ac)***
is a type of electrical current, in which the direction of flow of electrons switches back and forth in a regular pattern or cycles. In Australasia this is typically 50 cycles per second and of a sine wave pattern

(b) ***direct current (dc)***
is electrical current that flows consistently in one direction

(c) ***high voltage***
> 1,000 volts RMS ac and > 1,500 volts dc

(d) ***IT (power system)***
a power system that has all live parts isolated from earth. Exposed conductive parts are directly connected to earth independent of the earthing of any point of the power system

(e) ***low voltage***
AC RMS voltage 50 volts to 1,000 volts and ripple free dc volts 120 to 1,500;

(f) ***SELV***
is a system of extra low voltage electrical circuit that is separated from other circuits. It is isolated from earth and from the protective earth conductors of other electrical circuits

1.4.2 Abbreviations

(a) ***ac***
alternating current

(b) ***dc***
direct current

(c) ***LV***
low voltage

(d) ***RIM***
rail infrastructure manager

(e) ***RMS***
Root Mean Square

(f) ***MEN***
Multiple Earth Neutral or defined as TN-C-S in IEC 60364

(g) ***OCPD***
over current protection device

(h) ***SPD***
surge protective device

2 Railway signalling system

2.1 Generic safety requirements

Electrical systems are inherently hazardous to people and other equipment. There are a range of issues to be addressed to achieve safety to the required levels.

AS/NZS 3000 nominates a number of voltage ranges. Related legislation and regulations detail specific requirements for working with the various voltage ranges. Extra low voltage circuits do not require specific licenses or training. However, circuits in the low voltage range and higher voltages have specific requirements for training and licensing. These requirements are state based and there can be specific state-based exemptions and conditions for working on railway signalling circuits.

AS 3000 allows for earthing systems other than MEN and as defined in IEC 60364. Railway signalling power systems are designed in conformance with IT system of earthing (unearthed) as detailed in IEC 60364 Low Voltage Electrical Installations.

There are training courses and Australian Qualification Framework (AQF) qualifications for working on low voltage and high voltage circuits. The Rail Safety Act nominates that AQF qualifications are the default requirements for the competency of people undertaking rail safety work.

There is also the risk that electrical energy can damage assets and equipment used as part of the signalling system. This can be from normal operation or an abnormal event or other failure of the equipment. The electrical circuit should be designed with protective devices to manage these events. Information on environmental considerations are found at Appendix B

The presence of an electrical hazard during operation of equipment is not necessarily obvious to the casual user. Signage regarding the potential hazard of the electrical equipment should be prominently displayed.

2.2 Electrical work legislative requirements

Because of the electrical hazards, there are legislated requirements for the design, installation, operation, maintenance and disposal of electrical equipment and systems. These legislative requirements may vary from state to state and shall be checked for the respective state in which the work is being undertaken or the assets are located.

These legislated requirements cover:

(a) qualifications and licences required to work on electrical systems

(b) standards and certifications required

(c) safety requirements

The RIM should have standards and procedures that are consistent with the legislated requirements.

2.3 Electrical work WHS requirements

The electricity that provides power for signalling systems is inherently hazardous. It may cause electrocution, death, burns to people and damage to equipment. There are WHS obligations directly relating to the use of electrical power. These shall be considered throughout the system life cycle for a signalling system. The Safety in Design approach allows for the identification of the electrical hazards and the implementation of controls to manage the hazards safe so far as is reasonably practical.

2.4 Signalling specific safety requirements

The signalling system uses electrical devices to provide the functional operation for the safety of railway operations. This includes items such as level crossing lights, signal lights, point motors and interlockings where a failure of the signalling electrical power supply will prevent the functional operation. This can lead to degraded modes of operation including manual working that are inherently less safe than the engineered systems. Consideration of these safety impacts should be included in the signalling design functional requirements to achieve fail-safe operation.

Signalling functions and circuits that have specific functional safety performance requirements also rely upon electrical power to maintain the logic function. This logic function can be based on a sequence of events or a set of conditions. The loss of electrical power can interrupt the retention of that status of the preceding operational events. The loss of electrical power can cause a sequence that is similar to but not equivalent to an acceptable event. For example:

(a) approach locking can be released by a track circuit occupancy which is similar to loss of power to the track circuit;

(b) the loss of electrical power can cause loss of route holding or locking functionality.

The signal power supply system is used to power logic switched circuits which can extend over multiple physical locations for the functional safety of the railway. The safety requirement and performance is achieved by having the circuits with logic switching in both the active and neutral path of the circuit. If an MEN system of earthing was in use one failure of the neutral switched path would effectively falsely activate the logic function. The use of the IT system of earthing (unearthed) ensures that the safety performance is achieved. There is one non-conformance with the IT system of earthing (unearthed). The IT standard requires that the continuous earth monitoring system disconnects power on the occurrence of a second earth fault. This is not applied as the total loss of signalling power would pose a greater overall risk than the electrical risk to an individual working on the signalling power electrical system. This latter risk is managed by system design, continuous earth monitoring, work practices, competency of staff with access to the system, scheduled maintenance plans and work practices for response to a first earth fault alarm and working while an earth fault persists.

2.5 Signalling power systems performance requirements

The signalling power system should be designed to meet a range of performance requirements. In rail network areas with high train frequency, the impact of electrical power failure is greater than for other areas with low frequency of trains. The performance requirements for a signalling system should consider the impact of loss of electrical power on the functional performance and on the degraded mode system safety.

The signalling power system performance contributes to the overall signalling system operation and availability. The requirements for the signal power system should be appropriate to meet the overall signalling system performance. Appropriate electrical back up performance should consider this and the mean time to repair the failure.

To determine the signalling system performance requirements a RIM should consider:

(a) fall back to manual operation or degraded mode and its safety hazards;

(b) hazards associated with repairing electrical power within an operating rail network;

(c) quiescent power load and dynamic power load when the power is restored;

(d) delays for systems to reboot or otherwise commence normal operation after power failure;

(e) an allowance for charging of standby batteries for full battery current plus standing load;

(f) change over to alternate back up power supplies and the impact of a momentary interruption to electrical power;

(g) the impact of manual entry of train information when restarting the system after a power failure.

This information and other nominated requirements should be detailed in the signals functional specification. Appendix D provides further information on signal equipment tests and data sheets.

2.6 Signal power systems overview

The signalling power system has the following main components.

(a) Primary power source that provides the electrical power for signalling functions. This may also be powering other functions on the railway.

(b) Secondary or back up power source that maintains signalling functionality in the event of a failure of the primary power source.

(c) Switching system to allow for change over to the secondary power source and back to the primary power source when it is again reliably available.

(d) Distribution system to allow for the electrical power to be available at multiple signalling equipment locations along the rail network.

(e) Transformation components to other voltages to allow for input or distribution at higher voltages and transformation to the operating voltage of the signalling equipment.

(f) Conditioning for power quality and power factor to ensure that the electrical power meets the interface requirements of the source network and of the signalling equipment.

(g) Protection against surges and lightning which can arise due to the nature of the electrical power and its distribution and the location of the equipment in the harsh railway environment by the use of SPDs.

(h) Protection against overload or faults caused by the signalling equipment being powered by the use of OCPDs and other devices.

(i) Protection against overload caused by an event that leads to damage to the signalling equipment such as a derailment, motor vehicle crash into signalling equipment, storm or other catastrophic action.

2.7 Signal power systems life cycle

The signalling power system can be expected to have changes over the system life cycle. These shall be evaluated in the design, operation and maintenance of the system. The RIM should also include provision for review of the above issues as part of the standard procedures for managing the design, maintenance and operation of the power supplies.

These include consideration of the following.

(a) Changes to external systems contributing to the power system.

(b) Changes to the rail network.

(c) Changes to the signalling equipment being powered.

(d) Changes to the amount of signalling equipment being powered

(e) Changes to the rail operations that can affect the total load on the system.

(f) Degradation of system components over time and the need to replace the equipment.

(g) Ongoing maintenance requirements can require secondary or alternate systems be operational while the primary system is being maintained;

(h) Changes to regulatory framework for power systems and the materials used in the power system can impact on the need to update the system.

3 Signalling power supply equipment

3.1 Primary power source

The suitability and reliability of any power supply shall be considered as part of the power supply design requirements.

There are a range of primary power sources that can be used for railway signalling.

(a) Supply authority mains supply. These are readily available in cities and large towns.

(b) Railway mains supply such as supplies from railway traction substation or other substation.

(c) Motor alternator systems.

(d) Solar supply direct current.

(e) Solar supply with Inverter or convertor.

(f) Wind generators.

The primary supply could have variability or other issues that need to be addressed as part of meeting the signalling system requirements which include:

(a) storage of power;

(b) redundant power supplies;

(c) power quality.

The criticality of the above issues can also be dependent on the type of signalling equipment that is being operated at the location.

A secondary or alternate supply may be designed and installed to meet the signalling power system performance requirements. This secondary supply will provide power when the primary source is not available. A means of change over between the supplies is provided. This may be automatic or manual. The secondary supply may be any of the same types as used for the primary supply.

3.2 Power distribution

There can be a need to distribute the power from the source signalling location to other signalling locations. The following should be considered when designing a suitable power supply distribution system.

(a) Some signalling equipment that is microprocessor based can be more sensitive to power fluctuations.

(b) Some equipment such as point motors and possibly boom gate motors can have very high initial and momentary inrush currents followed by high operating currents and then low currents for other sustained operation.

(c) Obstructions in the mechanisms leading to short term overloads.

(d) The distance from the location can affect the voltage drop along the cables.

(e) There can be a need to separate out distribution mains for different types of equipment.

(f) Cables for distribution can have limiting factors including volts drop, temperature rise, surge protection.

Appendix E provides further information regarding power sensitivities to be evaluated.

3.3 Power systems protection

3.3.1 Assessment

The RIM conduct and document an assessment of the power system and how it might be affected by other external systems or effects including:

(a) harmonic induction from other systems including railway traction systems;

(b) surges from start-up of the signalling power system;

(c) surges from start-up of external systems on the same grid;

(d) surges from other systems induced into the power mains;

(e) surges from lightning storms;

(f) surges or over currents from equipment failures.

Overload and short circuit devices shall be suitably rated for the environment they operate in e.g. electromagnetic over thermopneumatic circuit breakers.

3.3.2 Discrimination of separate sub-systems

Signalling systems could have many different signalling systems at a location. These should be able to be powered and protected as individual sub-systems to reduce the risk of a single fault removing power from all other sub-systems.

3.4 Power system monitoring

The signalling power system shall be monitored remotely to ensure that any faults or failures are brought to the attention of maintenance and/or network control personnel in a timely manner. This should be done by:

(a) monitoring of power at individual locations or groups of locations

(b) separate power voltages or separate supplies at the same location be separately monitored and indicated;

(c) monitoring may have warning indications and alarm indication depending on the immediate impact on signalling functionality;

(d) back-up power supplies also be monitored and indicated to control systems.

The control centre power indications should have consistent meaning.

3.5 Signals safety systems

The signalling system functions cover the status of the signalling interlocking at a particular point in time including the associated safe control functions. In some situations, the signalling system stores the system status for a number of events or scenarios. In these cases, continuous signal power shall achieve the intended control functions based on the previous changes in state of the inputs and functions. This includes:

(a) issues like special requirements for approach locking circuits and route holding circuits;

(b) any other functions that require continuity of power supply;

(c) impact of momentary or longer interruption of power supply to signalling functions;

(d) interruptions to train operations resulting from a loss of signal power supply.

The design of the signalling safety system and interface to the signalling power system should consider the above issues.

The signalling system functional requirements should be matched to the signalling power systems capabilities and performance. Where this cannot be achieved, then consideration to changes to the signalling functional requirements should be undertaken.

3.6 Approval of signals power equipment

3.6.1 General considerations

Electrical systems are hazardous and are covered by various legislative requirements. The following issues should be addressed when approving electrical equipment as part of the signal power supply system.

(a) Power equipment and sub-systems meets regulatory requirements.

(b) Equipment meets the RIMs standards and requirements.

(c) Equipment is compatible with other equipment to which it is connected.

(d) Design or performance limitations for the equipment.

(e) Requirements for installation or construction for the equipment.

(f) Equipment meets the environmental conditions of installation location.

AS 7702 covers processes for application when undertaking the assessment and approval of equipment for use on railway infrastructure.

3.6.2 Approval conditions

The documentation of the approval of the power equipment should include conditions relating to:

(a) limitations of the equipment including design, installation and maintenance;

(b) purposes for which it can be used;

(c) any special requirements for disposal after de-commissioning.

3.7 Approval of generic power equipment

As well as the power equipment that is custom designed and manufactured for railway signalling use, there is also equipment that is generic and can be used for railway signalling power supplies.

The following should be considered for this equipment.

(a) That the usage is not different from that in other applications;

(b) That the design or performance of the equipment does not change over time without specific advice from the supplier/manufacturer;

(c) That the equipment is able to be maintained and that spares and technical support is available.

4 Design

4.1 Signalling system power loads

A RIM should establish and document typical power loads for signalling equipment.

For the purpose of this section the following terms are defined:

(a) Static load is the load when the signalling system is in its quiescent or steady state;

(b) A dynamic load is the current drawn by a load that is normally off and is typically a significantly higher load on a per unit base than the static load;

(c) A transient load is of a much shorter duration than the dynamic load and is best represented by the turn on of a reactive load e.g. a motor or a transformer.

The process for determining the nominal power load for an item of signalling equipment includes:

(a) review of data sheet for the equipment;

(b) determine the standing or quiescent load;

(c) determine the dynamic load;

(d) determine the transient load;

(e) impact of multiple items of load simultaneously;

(f) actual testing of the load at a location under various operating scenarios;

(g) validation of the load ratings by other means;

(h) determine the equipment tolerance for interruptions of power supply when there is a change over from one source supply to another source supply;

This information should be documented as a guideline for all signal design engineers to use in a consistent manner.

Further information on calculation of power loads can be found at Appendix C

4.2 Signalling equipment performance requirements

A RIM should determine the power limitations of the signalling equipment individually including:

(a) minimum voltage requirements;

(b) maximum voltage requirements;

(c) inrush current;

(d) hold up time during power supply change over;

(e) susceptibility to transient (surge) events.

4.3 Primary power source

A RIM should consider when designing a primary power source for a signalling system a range of issues including:

(a) availability of supply;

(b) reliability of supply;

(c) control of the supply for managing other works and interruptions;

(d) any contractual arrangements with external organisations for the supply;

(e) future needs for railway supply;

(f) consolidation of railway supply needs;

(g) impact of other major electrical users on the supply reliability;

A decision on the requirements and the selection of a supply to meet these requirements should be documented in the signalling functional specification for a new project or major alteration to signalling.

4.4 Power conditioning

A RIM should document the power conditioning requirements in the signal functional specification. The proposed design solution requirements should also be documented.

4.5 Power transformation

The electrical power could be provided at a lower or higher voltage than that required for the signalling equipment. Various items of equipment can operate at different voltages. In this case the electrical power shall be transformed into each of the required voltages.

The required input and output voltages at each of the power supply locations should be defined and documented as part of the signal power system design.

Transformation to a higher voltage may also be used as part of the distribution network to reduce the voltage losses.

4.6 Power distribution

The signalling equipment load for each voltage type at each location is detailed as part of the design activity. From this information the electrical power distribution architecture can be designed.

After the architecture design has been finalized the power mains cables can be designed. These should consider the impact on volts drop on each item of equipment. The subsequent design could require the separation of items such as computer-based signalling equipment that are sensitive to voltage fluctuations from point motor mains that could have a short transient voltage drop for motor inrush currents. Appendix E provides further information regarding sensitive equipment.

The required equipment current loads at each of the power supply locations should be defined and documented as part of the signal power system design. This should cover standing load and transient load when equipment is operating.

The voltage drop across the distribution system shall be within limits to meet the performance of the end equipment. The change in voltage from equipment as quiescent to active should be assessed to ensure correct performance. This may be referred to as the voltage regulation of the circuit.

4.7 Power protection

It is important that the surge and lightning protection is included as part of the distribution design. This should consider the earthing arrangements and the sensitivity of the specific signalling equipment to surges.

The system shall include over current protection. The OCPD design shall ensure that each individual circuit is protected from an overload and short circuit but not trip due to a short spike of current at the time of inrush. Coordination of protective devices on individual circuits shall ensure effective discrimination such that one fault will not cause the whole power supply at the location to fail.

5 Construction

5.1 Safe separation of equipment and touch potentials

The signals power supply includes different busbars at different voltages.

If the IT system of power distribution is used, there are no direct connections to earth for the purpose of system safety however a functional earthing system is required for the purposes of shielding / screening and surge protection.

A single functional earth shall be provided.

Typically, there is also an external power from a supply authority which is connected under the Multiple Earth Neutral (MEN) configuration. This MEN earth shall be kept separate from the signalling surge protection earth.

The signals power supply equipment shall also be physically separated from the external MEN based power supply. This separation shall ensure that a person cannot inadvertently touch both sets of power supply when arms are outstretched. Where space is limited an insulated protective cover over the external power supply may be used to provide the physical separation.

Where space is limited or the distance between the separate earths can be compromised by an earth potential rise due to a surge, then additional requirements including surge protection should be provided. Refer to AS 7708 for guidance.

Any SPD connected to a signalling power circuit for safety applications shall not have any mechanism to cause an un-revealed fault to earth.

Wiring terminations shall use touch safe terminals to prevent inadvertent contact.

5.2 Layout construction for earthing, protection, heat and clean/dirty wiring

Power supply equipment will typically generate heat which is conducted upwards. This equipment should not be placed underneath other equipment such as computer-based signalling items or electronic items that are susceptible to performance issues due to elevated temperatures.

The signalling power supply connects to multiple signalling circuits. It is susceptible to impact from surges and lightning strikes. The wiring to and from the power supply should be run in such a way to be consistent with the principles of separation of clean and dirty wiring in locations cases and relay rooms.

The power supply equipment requires a connection to the signalling earth. This should be a low resistance and a low impedance path to the signalling earth. The earth connections should not have sharp bends which inherently have a high impedance. A minimum radius of 50mm on all bends on the earth wire should be applied.

5.3 Ergonomic issues for equipment position

Power supply equipment can be bulky and heavy. In addition to the issues in clause 5.2 consideration should be given to where the equipment is mounted on the floor or on equipment racks. Two person lifts could be required for heavy and bulky equipment.

The positioning of the equipment should also allow for ongoing maintenance and fault finding without stressing single man maintenance teams.

6 Test and commissioning

6.1 Inspection of new power systems

Following the installation of new signalling power systems they should be inspected for the following issues.

(a) Installed in accordance with the design requirements.

(b) Installed in accordance with the relevant standards, procedures and good practice.

(c) Installed in a manner that will not adversely impact on other signalling equipment.

(d) That all equipment is identified as to its design identification and all power terminals are clearly labelled as to voltage and identity.

(e) That danger labels are applied as appropriate.

6.2 Testing of new power systems or modifications

All signalling equipment including signalling power supplies shall be tested in accordance with the standards and procedures of the RIM. This includes and is not limited to:

(a) all wiring is as per the design;

(b) all wiring is free from earth where required;

(c) no additional wires have been added that are not on the design;

(d) all voltages are tested to be within the required voltage range;

(e) all OCPDs will operate when required and correctly discriminate circuits under failure conditions. This can be determined by type testing;

(f) earth resistance is within the required range;

(g) all surge protection devices are of the correct type and are installed correctly.

6.3 Test records

The results of all tests and inspections shall be recorded as part of the new works testing and commissioning records. These records shall be kept for a period of time after the commissioning in accordance with the SMS of the RIM.

6.4 Commissioning of signalling power systems

Prior to commissioning into service the signalling power supply equipment should:

(a) have all inspections and tests completed;

(b) have output side equipment isolated;

(c) be powered up and final check of output voltages;

(d) then connect output busbars to the live output.

6.5 Equipment not in service

All signalling power supply equipment that is installed and not in service should be tagged with a label that it is not in service. The input fuses for the equipment should be removed and any circuit breakers switched off and tagged.

7 Operation

7.1 Operational reliability of signals power systems

The safety of train operations is higher under engineered systems. In the event of power failure there is a fall back to manual systems that are inherently less safe.

The operational reliability of the signal power system contributes significantly to the operational reliability and safety of the signalling system. The electrical power system by itself will not meet the operational reliability requirements. The design should include provision for secondary or back-up power supply systems. The amount and independence of the back-up systems shall be evaluated to be proportional to the operational criticality of the signalling system.

7.2 Changes to train operations and power supply impacts

A RIM shall evaluate the impact of changes to train operations when designing or redesigning signalling power supplies. These changes include, but are not limited to:

(a) significant increase or decrease in number of trains travelling through the location;

(b) significant increase or decrease in train speeds travelling through the location.

To assist future assessments a RIM should detail the train operations that the signalling power system was designed to accommodate. Where there is a significant change in railway operations the changes should be compared to the original design specifications and the signalling power system assessed for suitability.

7.3 Monitoring of signals power systems

The operation of the signalling system requires the availability of the power system. Where there are secondary or back-up systems there should be remote monitoring of the backup system. Monitoring of power systems operating at normal state assists signal maintenance staff when there is a signal failure to do an initial diagnosis of the cause of the fault.

This monitoring also can provide a remote indication of good power availability or power failure prior to an impact on rail operations. Main incoming SPDs should be monitored. Consistency of items being monitored and displayed to remote operators can also reduce ambiguity of interpretation of warnings and alarms.

The items being monitored should be documented in standard design practices or guidelines.

8 Maintenance

8.1 Safe maintenance of power supply systems and equipment

Electrical power supplies are inherently dangerous. The procedures for maintenance of the equipment should consider both the electrical hazard, working in a live railway corridor and the safety of the signalling system.

8.2 Power supply maintenance records

The signalling power system can vary in performance over time. The RIM should maintain a record of the voltages and currents of the power supply equipment to allow any trends to be identified and appropriate action taken. The following should be recorded.

(a) Recording of voltages for each individual power supply unit or busbar.

(b) Recording of loads for each individual power supply unit or busbar.

(c) Recording of earth leakage values.

(d) All maintenance service items should be recorded.

It is advantageous to maintain a permanent record of the voltages and current for each item of power supply equipment.

8.3 Preventative maintenance

The signalling power system should be maintained under a process of routine and periodic services. The items to be examined and the regularity of the examinations should be documented as part of the signalling maintenance procedures. These should address the following issues.

(a) Recording of voltages and loads at each service action.

(b) Inspection of batteries that they are in good condition.

(c) inspection of all equipment for signs of stress or overheating.

(d) Inspection of all fuses, circuit breakers.

(e) Inspection of surge protection equipment and related earth rods.

(f) Inspection of secondary or back up power supply equipment and test of its availability.

(g) Running of motor generators with a load to ensure correct operation.

(h) Routine tests of the cable insulation.

(i) Testing of earth leakage devices.

(j) The above items may be covered by different service schedules with different periods.

(k) All maintenance service items should be recorded.

8.4 Corrective maintenance

When electrical power equipment for the signalling system fails, corrective maintenance shall be required. Following the completion of the corrective task, the power supply and the signalling system should be tested for correct operation and recorded on the power supply history card or other record.

9 Modifications and alterations

9.1 Changes to signals systems

A change to the signalling system can have an impact on the overall signalling power supply for the location or the interlocking. Any change to the signalling design should also include a review of the signalling power supply design.

9.2 Changes to signalling equipment

In the signal system life cycle of a signalling installation there will be occasions when individual items of equipment are replaced with a similar or like item. These changes may cause:

(a) increase in power consumption (e.g. motors with different windings);

(b) reduction in power consumption (e.g. LED units);

(c) less tolerance to voltage fluctuations than previous equipment;

(d) less tolerance to unfiltered DC supply.

Where there is provision of alternate equipment the design should ensure that it is suitable for the specific circuit. Tests for correct operations should be recorded as part of maintenance records.

9.3 Changes to signalling primary power supply

The following items should be reviewed on each occasion of a change to the signalling primary power supply.

(a) Recalculation of the standing, dynamic and transient load of the signalling system.

(b) Review of the power source.

(c) Recalculation of voltage drop on distribution cables.

(d) Review of the surge protection of the power system.

(e) Review of the design and selection of the fuses and circuit breakers.

Following this review the RIM shall determine whether changes to the design of the signalling power supply are required

9.4 Changes to power supply equipment components

Power supply equipment can have many individual components. The ratings printed on the component do not always cover all of the technical specifications. For example:

(a) electrolytic capacitors are rated for voltage and capacity which is marked on the case. They are also rated for the inrush current which is usually not marked on the case. Insufficient inrush current performance could lead to the item failing and even catching fire;

(b) surge protection devices are rated for voltages and currents and shall be of the correct value for the equipment being protected.

Changes to a component should only be undertaken after consideration and evaluation by a suitably qualified person and the evaluation recorded and checked.

10 Decommission and/or disposal

10.1 Disposal of environmentally sensitive materials in power equipment

Power supply equipment can contain a number of environmentally sensitive chemicals. These shall be disposed of in accordance with legislation and RIM standards and procedures. These include:

(a) battery chemicals;

(b) transformer chemicals;

(c) rare earth or radioactive materials;

(d) hazardous materials such as the thermal conducting paste on heatsinks;

(e) insulation materials

The decommissioning of such materials shall include work instructions for the disposal of the environmentally sensitive materials.

10.2 Partial de-commissioning of signals power equipment

The signalling power equipment can operate multiple individual circuits. It is possible to de-commission all of the circuits without de-commissioning the power source. This leaves a number of hazards.

(a) There is an active power supply that is connected to busbars and could potentially cause a false energisation of a circuit.

(b) The power supply is not monitored or maintained and creates a hazard in its continued operation.

(c) There is a fault to earth or other system which could adversely impact on signalling functions.

The decommissioning of signalling circuits should consider the source of the power to the busbars as well as the downstream circuits. If all downstream circuits are decommissioned then the power source should also be decommissioned unless required for future stagework. Power supplies not in use should be considered for isolation

Appendix A Hazard register

Hazard number	Hazard
9.9.1.1	Low voltage at equipment (during operation)
9.9.1.6	Loss of power supply
9.9.1.7	Loss of power supply – lack of redundancy
9.9.1.8	Loss of power supply – failure of redundancy
9.22.1.14	Signalling power supply connected to earth

Appendix B Environmental condition ranges for signaling and power supply equipment

In Australasia there is a wide variety of environmental conditions where signalling equipment may be installed. This covers:

(a) elevated locations

(b) dry locations

(c) locations with high rainfall and consistently high humidity

(d) locations with high temperatures and high radiant energy

The power supply equipment will generate heat and the placement should ensure that the heat does not impact other signalling equipment on the same rack or in the same location. It is recommended that signal power equipment generating heat be placed at the top of a rack unless there are other issues to be considered.

Appendix C Signaling power calculation tools and results

Some RIMs have available a power supply calculator. These included the power load consumed by a wide variety of signalling equipment items. They may also include the dynamic load of devices including point motors operating under all credible operating scenarios. The calculators will assist in determining the power load for a signal equipment location based on the installed equipment. They also include a volts drop calculator for the cables running to the location from the power source.

The use of these calculators will provide consistent outcomes for signalling design of power equipment and the distribution network. Typically the power loads only vary by a small amount for the number of trains.

In the case of a level crossing, the number and type of trains may have a significant impact on the level crossing operating power requirements. This is particularly so because of the general need to have a battery back up to the power supply for 24 to 48 hours and to up to 7 days for remote locations.

The load on the level crossing power supply with no trains may be low. The presence of a train causes the track circuits to draw current, and the operation of the lights and boom gates if installed. An 1800 metre freight train will result in greater power consumption than a 200 metre self-propelled passenger train for a given period. The speed of the train will also impact on the total power consumption.

A level crossing power calculation should consider the number and type of rail traffic for the particular location and not be a standard allowance. Consideration of future changes in rail traffic levels should also be taken into account. The power supply calculations should be part of the design that is checked and verified.

The input and output results of all power calculations should be fully documented, and form part of the design documents handed over with the as-built drawings and data. This should also include detailing any special considerations for the signalling location.

Appendix D Signaling equipment testing and data sheets

D.1 Signals equipment testing

Items of signalling equipment undergo assessment and testing to allow for project approvals and rail equipment type approvals. This testing should verify the electrical power load under various static, dynamic and operational scenarios. This verified information should form part of the approval documentation and used as the source of power load requirements.

D.2 Data Sheets

Supplier data sheets shall include information on the electrical power load under static and dynamic operational scenarios.

Appendix E Signaling equipment sensitivity to power fluctuations

Some signalling electrical equipment is sensitive to the voltage level for correct operation. Review of data sheets and testing should confirm the minimum voltage at which the equipment will perform appropriately. This information should be recorded as part of the equipment approval documents.

Appendix F Suitable controls for electrical hazards

Suitable controls for electrical hazards cover the following range of issues.

(a) Training and qualifications and licences for the people who are permitted to work on the signals power systems.

(b) Procedures under the SMS covering the safe work on the signals power systems.

(c) Procedures under the SMS to ensure that the signals power systems are maintained in good order to prevent electrical hazards.

(d) Procedures under the SMS to ensure that the signals power systems are tested as safe before they are commissioned into operational service.

(e) Engineering standards covering the equipment approval processes before the equipment is incorporated into the signals power systems.

(f) Engineering standards covering the performance requirements of the signals power systems.

(g) Engineering standards covering the design of the signals power systems to meet safety and performance requirements.

Appendix G Bibliography

The following referenced documents are used by this Standard for information only:

(a) AS 3015 Electrical installations – extra low voltage.

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