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Signalling

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Standard Requirements for Signalling Electronic Systems

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The technical content of this document has been approved by the relevant ARTC engineering authority and has also been endorsed by the ARTC Safety Committee.

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About This Standard

This specification details the standard requirements for any Signalling Electronic System provided to the ARTC.

Signalling Electronic Systems are defined as those non-safety electronic or computer control and information systems used as part of control, indication, or monitoring of signalling systems and related train management systems or in the provision of Customer information concerning these systems.

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1.1	01/09/2004		Reformatting to ARTC Standard
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Contents

1. Introduction

1.1. Scope

This specification details the standard requirements for any Signalling Electronic System provided to the ARTC.

Signalling Electronic Systems are defined as those non-safety electronic or computer control and information systems used as part of control, indication, or monitoring of signalling systems and related train management systems or in the provision of Customer information concerning these systems.

1.2. Definitions

The following definitions apply for this specification:

ARTC

The Infrastructure Owner, Australian Rail Track Corporation

ARTC's Representative

A person, company or authority nominated by ARTC to make engineering determinations on ARTC's behalf.

System

The system is defined as the product as a whole being supplied under the specific contract. The system may consist of a number of sub-systems which form the complete system.

Supplier

The person, company or authority responsible for providing a system in accordance with this specification.

Magnetic Media

Computer disk or CD-ROM that is compatible with the Microsoft Windows® product range and IBM® compatible Personal Computers.

2. Applicable Documents

2.1. ARTC Specifications

The following ARTC documents are referenced:

SPS 05 *Electrical and Electronic Components.*

SCP 04 *Lightning and Surge Protection.*

SPS 06 *Connections for Signalling Interface.*

SPS 04 *General Requirements for Labelling of Signalling Equipment.*

ESR 002 *Engineering Publications Management manual*

Safeworking procedures, SWU 900 *General Safety Precautions.*

The particular specification which applies this specification should be read in conjunction with this specification.

2.2. Australian Standards

a) The following Australian standards are referenced by this specification:

AS 1768	*Lightning Protection.*
AS 2107	*Acoustics - Recommended design sound levels and reverberation times for building interiors*
AS 3000	*Electrical Installations - Buildings, structures and Premises known as the SAA wiring rules*
AS 3563.1	*Software quality management system - requirements.*
AS 3930	*Reliability and maintainability - Introductory guide.*
AS 3960	*Guide to reliability and maintainability program management.*
AS 4006	*Software Test documentation*
AS 4251.1	*Electromagnetic compatibility - Generic emission standard Part 1: Residential, commercial and light industry.*
AS 4252.1	*Electromagnetic compatibility - Generic immunity standard Part 1: Residential, commercial and light industry*
AS 4360	*Risk Management*
AS/ISO 9001	*Quality systems for design/development, production, installation and servicing.*
AS/ISO 9002	*Quality systems for production and installation.*
AS/ISO 9003	*Quality systems for final inspection and test.*
AS/ISO 9004	*Quality systems - Guide to quality management and quality system elements.*

b) All relevant Australian Standards shall be met except where they conflict with this specification, in which case this specification has precedence.

2.3. International Standards

International Standards Organisation Open System Interconnection (OSI) model is referenced by this specification.

3. Rights/License

The supplier shall vest the Intellectual Property rights for any software or hardware developed for this particular installation in the ARTC.

The supplier shall supply Licenses in the name of the ARTC, for any third party software used:

- as part of the system or
- as part of the system building or
- for data generation and or
- for testing.

4. System Requirements

4.1. Fitness for Purpose

The standard of design, materials, and workmanship shall ensure that the installed system is fit for purpose over the expected life of the system in its physical and operational environment, achieving not only the functionality requirements but also the standards of safety, reliability, durability, maintainability, operability and supportability as set out in this Specification and referenced documents.

The quality of design and materials and workmanship shall also ensure that the necessity for regular preventative maintenance tasks to retain the safety, availability and useability of the system over its lifetime is minimised.

4.2. Memory Check on Start-Up

All information stored in EPROM, EEPROM, and battery backed-up RAM shall have a predefined checksum associated with it. The checksum of the information shall be compared with the predefined checksum upon start-up. If these two values conflict the system shall indicate a checksum error on the device and take appropriate action.

4.3. Logging

a) The system shall store on non-volatile media any change of system status, change of state of inputs, and change of state of outputs with the date and time the event occurred. Storage shall be for a minimum of 14 days.

b) There shall be a new log file for each day, the file name shall clearly identify which day's information it contains.

c) The log shall time stamp events to an accuracy of one second or better and have a resolution of at least one second.

d) All changes of state of inputs and outputs of duration greater than 0.2 sec shall be logged.

e) The accuracy of the reference clock shall be better than one second a day and there shall be facilities for displaying and setting the clock without disruption to logging or system operation.

f) The log shall be maintained even if the system has been left without power for 31 days and then re-started.

g) The oldest event shall be automatically replaced by the next event when the event log is full.

h) It should be noted that logging is a system requirement and not required for each subsystem in a particular installation.

i) Facilities shall be provided to extract information from the log and produce

reports in both printed and magnetic form.

j) The report shall be tabular and in a readable text format, containing the following:

Header containing:

- source file name
- identifier for type of logger
- identification of logger
- any restrictions on what entries the report includes
- the times for which the report is produced Each entry shall contain
- date and time of event
- unique identifying input/output number or address
- text name
- new state

k) The report format shall require approval from ARTC General Manager ISP or nominated Signalling representative.

l) A copy of a log file, (including the current day's log) shall be obtainable from the system, without disruption to the operation of the system or accuracy of the current log.

m) Where the logging system is in a location remote from the maintenance staff, then remote access to the log files shall be provided, for example, via a dial up modem and standard file transfer communication software. Remote display and adjustment facilities for the clock shall be provided in this case.

4.4. System Status

All systems shall have an indication that shows the health of the system and sub-systems with associated procedures for determining what is the cause of a reduced health state.

4.5. Indications

Indications or reports provided by the system shall be presented in a logical and consistent manner.

Indications shall comply with pre-existing indication practices unless approval is granted for variation.

4.6. Spare Capacity

The system shall be designed for incremental expansion without the need for replacement of major capital items or reconstruction.

The system can expand in two ways -

- the area covered can expand in area or complexity, or
- the system activity can increase.

The system shall be designed so as to be able to be expanded by 25% in area or complexity covered.

The system shall be designed so as to be able to be expanded to handle a 33% increase in system activity.

The system shall have 10% spare capacity (rounded up to the next whole number) in both area or complexity and system activity without the need for additional hardware or system software, only modifications to system data where required.

4.7. Response Times

a) Response times are for the whole of the system, ie from the signalling indications (field and interlocking) to the operator or information user and/or vice versa.

b) Indication response time is defined as the time taken from when an indication change is first available at the system's interface to when that change is displayed or delivered to the system output.

The indication response time shall be less than 1 second.

c) Control response time is defined as the time taken from the moment that a control is issued to the system, to the time that the system has finished processing an internal control or delivered an external control to the appropriate system that interfaces to this system, as applicable.

The control response time shall be less than 1 second.

d) Control Indication time incorporates the control response time and the indication response time and is defined as the time taken from when an Operator issues a control to when an indication in response to that control is displayed.

The control indication time shall be less than 2.5 seconds.

e) All operator commands with the exception of report commands shall be completed within 2 seconds. Processing of report commands should be completed within 20 seconds.

f) The maximum time to update and display information for dynamic reports which are already on display shall be less than 1.5 seconds.

4.8. Reliability and Life

a) The following details the minimum requirement for the reliability and life for the system. Particular systems may need a higher level of reliability and or longer life and this will be specified in the particular specification.

b) Australian Standards AS 3930 *Reliability and maintainability - Introductory guide,* and AS 3960 *Guide to reliability and maintainability program management* shall be used in determining the reliability and maintainability of the system.

c) The system shall be designed for a 90% confidence level that the number of failures over its life will be less than the following limits:-

Failure with No Operational Impact

A failure that does not cause any disruption to the service the system provides and results in no impact on users of the system or users of the information provided by the system, occurs less than once every 2 500 hours of operation. An example of this would be the failure of one side of a duplicated system with automatic changeover.

Failure with Small/Medium Impact

A failure that causes disruption to the service the system provides, either to users of the system or users of the information provided by the system, will occur less than once every 5 000 hours of operation.

Failures with small/medium impact from which the system automatically recovers within 4 minutes without the need for the user or maintainer to take any action may be classed as a no operational impact failure.

High Impact Failure

A failure that causes loss of more than 25% of the service the system provides, either to users of the system or users of the information provided by the system, will occur less than once every 20 000 hours of operation.

Failures with high impact from which the system automatically recovers within 4 minutes without the need for the user or maintainer to take any action may be classed as a small/medium impact failure.

d) The expected life of the system shall not be less than 10 years from commissioning. The system shall be engineered such that the expected life can be achieved and that spare parts will still be obtainable throughout the expected life of the system.

e) The supplier shall demonstrate to ARTC GM ISP or nominated Signalling representative that the system will provide the required level of reliability and life.

4.9. Recovery Times

The supplier shall nominate any modules that take longer than 4 minutes to return to full operational service after their replacement or power on, with a description of the modules function, MTBF and recovery time.

4.10. Automatic Start-Up and Re-Start

Any system or sub-system shall automatically start-up or re-start after loss of power or recoverable failure unless maintenance personnel are available during all operating hours.

A recoverable failure is one where the corrective action would be to re-start the system, in order to repair the failure.

4.11. Display Symbols

The symbols used to display signalling information to a user or operator must be approved by ARTC GM ISP or nominated Signalling representative prior to use.

Symbols for displaying signalling information on a VDU screen shall be equivalent to those used on traditional panels or systems.

4.12. Data Entry

The supplier shall produce a set of data entry principles. These principles shall be structured to ensure consistent data construction and data entry.

The data entry shall be in accordance with the supplier's data entry principles.

If the system requires an initial data entry effort of more than one working day for one person then facilities shall be provided to assist in the data entry and maintenance of the data.

The format of the data, method of entry, and interfaces to other systems requires approval by ARTC GM ISP or nominated Signalling representative.

4.13. Service Degradation

The system shall lose less than 1 item of information or data in 10 million processed items of information or data.

Displays and records shall automatically be corrected for any lost information or data within 1 minute.

In an overload situation the system may discard information until the overload has ceased, provided that the overload event is logged and a warning provided to all operators and users when the system commences discarding information and again when the system has returned to normal operation.

4.14. Provision for Safeworking Procedures

The system shall provide all facilities necessary for operators and maintainers to comply with the applicable / relevant ARTC Safeworking Procedures.

All facilities used to comply with the ARTC Safeworking Procedures shall have the appropriate level of integrity for their purpose and shall minimise the need for manual procedures.

An example of a Safeworking facility is Blocking for Signalling and Points controls.

The supplier shall demonstrate to ARTC GM ISP or nominated Signalling representative that the level of risk is low in all cases. The method for determining the level of risk shall be in accordance with AS 4360 *Risk Management.*

5. Documentation

5.1. General

a) The documentation supplied shall be sufficient to enable the system to be effectively maintained, repaired and modified.

b) The source files for all manuals, and associated documentation, shall be supplied on magnetic media of good quality. The preferred format of the files is the current Microsoft Word for Windows format.

c) Documentation shall be prepared in accordance with the applicable ARTC standard.

d) Documentation shall cover the following areas:

- System Test,
- System Manual,
- Operators Manual,
- Maintenance Manual,
- Hardware Reference,
- Software Reference,
- Installation Procedure,
- Data Generation,
- Technical Maintenance Plan

e) One preliminary copy is required for approval. Three final copies shall be supplied.

f) Copies for approval shall be provided to ARTC GM ISP or nominated Signalling representative at least four (4) weeks prior to the commissioning.

g) Final copies should be issued prior to the commissioning of any part of the system.

h) The supplier shall authorise the ARTC, and the ARTC's Contractors to copy, alter or amend and distribute any document supplied with the system for the purposes of the management and maintenance of ARTC's infrastructure.

5.2. System Test

The System Test documentation shall cover the formal testing of the system supplied. The test documentation shall detail all tests to be carried out, how each test is to be conducted and provide a record of each test.

See section 15 on testing for the required contents.

5.3. System Manual

The System Manual shall describe the overall functional operation of the system.

This manual shall include drawings showing the system's interconnection of functional blocks, detailing the information flows between them.

Details on all the documentation for the system including their issue date and version shall also be included.

5.4. Operators Manual

The Operators Manual shall describe the purpose of the System, Facilities provided, Operating procedures, and Actions to be taken for any alarms or system problems.

A Reference section shall be included detailing all available commands and any other relevant information.

5.5. Maintenance Manual

a) The Maintenance Manual shall include:

a1) A Troubleshooting Guide (fault indications, their likely cause and suggested solutions);

a2) A set of Maintenance procedures including: preventative maintenance, back-up and restore operations, module testing and module replacement.

a3) Details on Equipment Repair procedures and where to purchase replacements parts.

a4) Identification of different versions, configurations of modules, and their operational differences.

a5) Detailed drawings showing cable routes and wiring diagrams.

b) It is envisaged that the Maintenance Manual will be in continual use for the life of the system and therefore shall be presented in a form that is suitable for continual use.

5.6. Hardware Reference

a) The Hardware Reference manual shall include:

a1) Overview of system hardware

a2) System block diagram, with the identity of each module or sub-system and its interconnection

a3) Complete schematic and wiring diagrams for the interconnection of modules.

a4) Complete configuration details for each piece of hardware, detailing switch settings, EPROMs and revisions, any setting that can be set or adjusted eg dB level, configuration strings. The purpose of all configuration details shall also be detailed.

a5) Source of supply for each module

a6) Full details of any cables used, and the labelling of sockets/plugs.

b) The Hardware Reference manual should include complete technical, and user manuals for each module with circuits and PCB layouts. If the supplier can not or does not want to provide these details then a response is required to this specification detailing how the system can be economically maintained over its expected life without access to the information.

5.7. Software Reference

a) The Software Reference manual shall include:

a1) Data listings,

a2) Command or batch file listings,

a3) Status report for each executable file.

a4) Functional description of the software and its operation, including directory structures and purpose of each file.

b) When software is developed for the particular installation, the Software Reference manual shall also include:

a1) Software Design documents,

a2) Source code listings, (including an index of functions in files)

a3) Software change procedure,

a4) Firmware programming procedure.

5.8. Installation Procedure

During the life of the system, it may be required to be rebuilt due to component failure (such as hard disk failure), relocation, destruction due to fire or any unforeseeable circumstance.

The purpose of the installation procedure is to provide local maintenance personnel with a procedure to follow to rebuild the system when required, given that the local maintenance personnel may have very limited experience with computers.

Details for installing the system, that are not obvious from the Hardware/Maintenance manual, and details for installing any operating system or software shall be included in an Installation Procedures manual.

Details shall include but not be limited to:

- The Operating system
  - for the copy (and format ie floppy / cd rom) of the operating system supplied
  - for each machine the operating system is installed on
- all installation options
- any user configuration, such as user groups, user names, passwords, privileges.
- any network configuration items
- any configuration items required by the software or system.
- the procedures for hardware that has lost all software and operating system; and for a system that has a corrupt operating system and requires reinstalling.
- application Software
- any application specific installation / configuration details.

Where a test system or simulator is supplied, installation procedures shall also be provided for the test system or simulator as applicable.

5.9. Data Generation

a) The Data Generation manual shall include:

a1) Details on configurable data items (include their purpose).

a2) Procedure for changing configurable data items.

a3) Details on how to produce data listings.

a4) Procedure for building system based on new database.

a5) Installing and testing new system.

5.10. Technical Maintenance Plan

a) The supplier shall provide a recommended Technical Maintenance Plan for routine preventative maintenance tasks and task frequencies.

b) The supplier shall provide the supporting details for determining the Technical Maintenance Plan, (for example failure mode effect and or fault tree analysis).

6. Training

a) Training courses for the personnel required to maintain and operate the system must be provided prior to commissioning.

b) Each course shall be appropriate for the level of competence of the participants. Course notes provided shall be appropriate to the level of the course being provided.

c) Training shall be of a level so as to achieve at least the maintenance and reliability requirements of this and any other relevant specification.

7. Spares

a) Sufficient unique spare hardware modules shall be provided to enable the maintainer to meet the system's specified Mean Time To Repair throughout the expected life of the system.

b) The supplier shall provide adequate evidence to ARTC GM ISP or nominated Signalling representative for assurance that the spares being provided with the system are sufficient to allow the system's specified Mean Time To Repair to be met throughout the expected life of the system

The level of spares to be provided may be less than otherwise needed under this requirement if the module is either available "off the shelf" from a number of suppliers with a delivery time of less than 14 days, or sufficient evidence is supplied to convince ARTC GM ISP or nominated Signalling representative that the module can be reasonably expected not to need replacement during the expected life of the system.

c) Spare hardware modules are in addition to the modules needed to achieve the 'Spare Capacity' requirements of this specification.

d) If configuration changes are required before a spare module can be used for a particular purpose and the configuration changes are not part of the normal maintenance personnel's role then each particular configured module shall be

considered as unique.

e) If configuration changes are required before a spare module can be used for a particular purpose and the configuration changes will take longer than 30 minutes then each particular configured module shall be considered as unique.

f) All spares supplied shall be fully configured for each unique module as ready-to-use replacements for the operational items.

g) All spares shall be 100% compatible with installed equipment.

h) Spare parts shall be supplied packaged such that their storage life will be at least equal to the expected system life.

8. Quality Assurance

a) The supplier shall be accredited to the appropriate Australian Quality Standard or provide evidence that they are actively working towards accreditation.

b) It is considered that the following are appropriate Australian Quality Standards:

b1) AS ISO 9001 Quality systems for design/development, production, installation and servicing.

b2) AS ISO 9002 Quality systems for production and installation.

b3) AS ISO 9003 Quality systems for final inspection and test.

b4) AS ISO 9004 Quality systems - Guide to quality management and quality system elements.

b5) AS 3563.1 Software quality management system - requirements.

9. Approval

All hardware and/or software shall be type approved by ARTC GM ISP or nominated Signalling representative. A list of type approved items is available.

If items that are not type approved are being used, full justification in writing of why the relevant type approved module is not acceptable is required and the alternative must be submitted and pass type approval before being approved for use.

Any item which has to be customised or modified to suit the particular application shall be declared in the offer.

Type approval is required for each item that:

- interfaces to a safety system, or
- is used as part of a safety system, or
- is used in an application which can have a negative impact on the usage of the railway infrastructure, and
- has not been type approved in the proposed form (build/version) and application.

Any aspects that directly affect the integrity, functionality, or operation of the system that are not covered by this specification shall be referred to ARTC GM ISP or nominated Signalling representative for decision.

All equipment, installation practices, and maintenance practices shall comply with the requirements of ARTC GM ISP or nominated Signalling representative.

10. Physical Aspects

10.1. General

a) All components shall comply with the ARTC Specification SPS 05 *Electrical and Electronic Components.*

b) All equipment supplied shall meet the relevant Australian Standard and be suitable for the environment in which it is to be located.

c) All plug-in modules and components should be incapable of incorrect insertion.

d) All plug-in modules and components shall be provided with a retaining mechanism to secure them firmly in position and to prevent them working loose due to any vibration which may occur in service.

e) The equipment shall be rated for 10 degrees centigrade above the maximum expected temperature and 10 degrees below the minimum temperature expected at the installed location.

f) Any monitor point, test point adjustment point or status indication shall be readily accessible whilst the unit is in service.

g) Cable terminations to modules shall have sufficient slack for maintenance purposes i.e. inspection of a module.

h) The physical location and mounting of equipment shall take into consideration:

- safety of the user and the rail network customers,
- safety of the installation and maintenance personnel,
- safety clearances for engineering work which are documented in the ARTC Safeworking procedures, SWU 900 *General Safety Precautions.*
- practicality of performing maintenance tasks.

i) Equipment shall be protected from the ingress of dust, dirt, and moisture.

j) Equipment that is not readily accessible for maintenance purposes should not contain parts that require preventative maintenance or periodic inspection to check correct operation.

10.2. Surge Protection

a) The equipment supplied shall be protected against power supply and lightning surges.

b) Australian Standard AS 1768 *Lightning Protection* and the ARTC Specification SCP 04 *Lightning and Surge Protection* shall be used as the basis for the

provision of surge protection.

c) The supplier shall demonstrate to ARTC GM ISP or nominated Signalling representative that the system as installed shall withstand, without it's normal operation being degraded:

- more than 200 of each type of Category B pulse on the power supply.
- more than 100 of each type of Category A pulse on each communications interface.
- more than 100 of each type of Category A pulse on all other electrical interfaces to the system.

10.3. Durability

The parts used in the system shall be selected such that durability, robustness, and environmental aspects are suitable for their proposed use in the proposed environment and shall still be providing the minimum level of service at the end of their expected life.

10.4. Electromagnetic Compatibility

a) The supplier shall demonstrate to ARTC GM ISP or nominated Signalling representative that the system as installed does not exceed the limits of emission as specified in AS 4251.1 *Electromagnetic compatibility - Generic emission standard Part 1: Residential, commercial and light industry.*

The supplier is responsible for ensuring that the system will not emit Electromagnetic Radiation at such a level as to affect existing systems or equipment at the particular installation site.

b) The supplier shall demonstrate to ARTC GM ISP or nominated Signalling representative that the system as installed will pass the tests as specified in AS 4252.1 *Electromagnetic compatibility - Generic immunity standard Part 1: Residential, commercial and light industry,* including tests A1.2, A2.1, A2.2, and A4.5 listed in Annex A when configured and operating as intended in the final installation.

The supplier is responsible for ensuring that the system will not be affected by the Electromagnetic Radiation at the particular installation site, including that produced by fault conditions on external equipment.

10.5. Sound Levels

The audible noise created by the system shall comply with AS 2107 *Acoustics - Recommended design sound levels and reverberation times for building interiors.*

Areas that are intended for personnel to work in shall comply with the requirements for office building - general office areas.

Areas in buildings that are not intended for personnel to work in shall comply with the requirements for office buildings - computer rooms.

Track side locations and other areas that are not intended for personnel to work in shall comply with the requirements for industrial buildings - light machinery.

10.6. Fire Hazard

The system shall present a minimal hazard, either as a source of ignition for a fire or as flammable material.

10.7. Labelling

Labelling shall comply with the ARTC Specification SPS 04 General Requirements for Labelling of Signalling Equipment.

11. Interfaces

11.1. Power supply

a) An uninterruptible power supply shall be used when:

power supply interruption at one site prevents the correct operation of equipment at another unaffected site that is independent of the affected site;

or

the state of the system can not be automatically restored at power on;

or

the system startup time exceeds 4 minutes.

b) The preferred method of providing an uninterruptable power supply is by the use of two normally available independent supplies, a normal supply and an emergency supply. The supply to the system is then provided via an automatic switch which selects emergency supply when the normal supply is not available. The change-over time between supplies shall be 20% faster than the maximum break in supply that the system can handle without disruption.

c) The standard voltages used within the ARTC Signalling infrastructure are 240v AC, 120v AC, 50v DC or 24v DC. These voltages are nominal and in general are given a +/-10% tolerance for 120V AC and 240V AC, and -10%, +20% for 50V DC and 24V DC. The DC supplies are not normally filtered. If the system requires a voltage supply which differs from the standard voltages listed this must be declared in the offer.

d) The operation of equipment from 240 volts is accepted provided that the installation complies with the following requirements:

d1) The 240 volts supply shall be wired in full compliance to AS 3000 Electrical Installations - Buildings, structures and Premises known as the SAA wiring rules. It shall enter the housing in conduit, and terminate in standard double General Purpose Outlets.

d2) The power supply units shall be fully-enclosed units, provided with either a three-core flexible lead or an IEC mains socket (male) and lead. In either case the lead shall be provided with a 3-pin mains plug, for connection to the GPO.

d3) Any functional module designed to be operated directly from the 240 volts supply shall be fully enclosed and be provided with a lead and plug for mains connection. Each such unit shall be provided with its own switched GPO outlet.

d4) Each 240 volt GPO and 240-volt direct-supplied unit shall bear a label clearly identifying it as such.

e) The system shall be immune from power supply interruptions and fluctuations of less than 0.25 seconds.

f) Unless otherwise confirmed in detail it shall be assumed for the installation that the power supply external to the system will not be protected against Under Voltage, Power Surges or Lightning.

The supplier is responsible for ensuring that the power supply design is suitable for the system, and that power supply interruptions for the installation have been assessed and considered in the system's design to meet the specified reliability requirements.

11.2. Communications

a) The communications protocols used, should follow the recommendations of the International Standards Organisation (ISO) Open Systems Interconnection (OSI) model.

b) All modems used shall be ACA approved. The modem shall be connected to the communications line via an ACA approved 604 or RJ-11 data plug.

c) Modems shall be powered from the system's power supply and shall be considered as part of the system for all of the requirements of this specification.

d) The communications protocols used shall detect errors and cause the information to be re-sent immediately. Loss of information or changes to the sequence of information is unacceptable.

e) Communications protocols that always send all information may re-send the information in the next message given that the delay is less than 1 second.

f) The communications error rate shall be less than one invalid message in 1,000 for point-to-multipoint links and less than one invalid message in 10,000 for point-to-point links.

g) All communications lines and data lines shall have monitor points for the use of test equipment normally used in testing or fault finding on the particular communications or data line.

h) In any installation it shall be assumed that the communications external to the system will not be protected against surges or Lightning.

i) The supplier is responsible for ensuring that the communications design is suitable for the system, and that failures of the communications links for the installation have been assessed and considered in the system's design to meet the specified reliability requirements.

11.3. Signalling

a) Any connection to a Relay based Signalling system shall comply with the ARTC Specification SPS 06 *Connections for Signalling Interface.*

b) The system shall comply with the interface requirements for any Computer Based Signalling system to which it is interfaced to or to be interfaced to.

c) The system shall be designed so as to not unnecessarily issue controls to the Signalling system.

11.4. User/Operator

a) All user or operator interfaces shall be ergonomically designed.

b) The system shall be designed so that the users and or operators of the system are not required to perform repetitive tasks that do not require the user or operator to use their expertise.

c) The system shall provide for the change of users and or operators without the loss of information or alarms.

d) If it is necessary or desirable for users to “log on” or “log off” the system then these procedures shall take less than 1 minute to complete.

11.5. Other

The supplier shall design the interface and obtain approval of the interface design from ARTC GM ISP or nominated Signalling representative.

12. Integrity

a) All facilities provided by the system shall have the appropriate level of integrity for their purpose.

b) The supplier shall demonstrate to ARTC GM ISP or nominated Signalling representative that the system has a rare likelihood for displaying incorrect information that could be interpreted as valid and acted on is such a way as to have a consequence either of:

- damage to life or property, or
- major disruption of train operations, or
- cause the system to be taken out of use.

c) The supplier shall demonstrate to ARTC GM ISP or nominated Signalling representative that the system has a rare likelihood for issuing spurious controls that may have a consequence either of:

- damage to life or property, or
- major disruption of train operations or
- cause the system to be taken out of use.

d) The supplier shall demonstrate to ARTC GM ISP or nominated Signalling representative that the proposed usage of the system has a low level of risk.

e) The method for determining the level of risk shall be in accordance with AS 4360 *Risk Management.*

f) The supplier shall demonstrate to ARTC GM ISP or nominated Signalling representative that the system is protected against unauthorised access, either physically or via any other means.

13. Occupational Health and Safety

a) The typical operator or user of the system works an 8-hour shift with no relief available. The system will normally be in service 24 hours per day, every day of the year, with an operator or user in control.

b) The system shall be designed to cater for the Occupational Health and Safety of the users and maintainers of the system.

c) The system shall comply with the current standards for Occupational Health and Safety for all personnel involved with the system, or affected by the system.

14. Maintenance Aspects

14.1. Maintainability

a) The following details the minimum requirement for the maintainability of the system. Particular systems may need a higher level of maintainability which will be specified in the particular specification.

b) The system's Mean Time To Repair for failures shall be 20 minutes or less and 95% of all failure repair tasks shall be completed in less than 30 minutes. These times do not include travelling time. It is to be assumed that the repairer's knowledge of the system is limited to that provided in the first line maintenance course and that the repairer only has access to the spare parts supplied, hand tools and a multimeter. The use of any specialised test equipment supplied may be assumed at the main location only.

c) Repair shall be performed by the replacement of plug-in modules. All parts that can be expected to fail shall form part of a plug-in module.

d) All non built-in test facilities shall be designed to run from a portable Personal Computer.

e) All specialised equipment required to maintain the system other than a Digital Multimeter, Dual Channel Storage CRO and Protocol Analyser shall be supplied as part of the system.

f) The supplier shall demonstrate to ARTC GM ISP or nominated Signalling representative that the maintainer can meet the specified maintainability requirements.

14.2. Diagnostic Indications

a) The system shall have built-in diagnostic indications that allow maintenance personnel to verify correct system operation without disruption to the use of the system.

b) Identification of a faulty module shall be able to be performed using the diagnostic indications for 90% of all faults.

14.3. Diagnostic Test Facilities and Data

a) A comprehensive set of diagnostic test facilities shall be provided, so that maintenance personnel can identify 95% of all fault conditions that cannot be identified by using the diagnostic indications.

b) The system shall automatically perform a set of built in diagnostic tests upon reset and power on. The tests shall be sufficient to identify 80% of possible system fault conditions. The system shall halt, and indicate the particular fault if any of the reset and power on tests fail.

c) Any problems encountered during testing shall be recorded on non-volatile media. This record shall include the date, time, test performed and the problem encountered.

d) The system shall create diagnostic data which shall be recorded in a non-volatile form. This record should include the date, time, test performed and details of the results.

e) The diagnostic data created by the system shall at least include:

- Data communications statistics, for each communications node.
- System, and sub-system startup
- Software errors detected by the system
- Hardware errors detected by the system
- Condition Based Maintenance data for the system and equipment controlled by the system.

15. Testing

15.1. General

The testing of electronic systems shall be based on test plans. The test plans should be based on Australian Standard AS 4006 *Software test documentation* and cover:

i) what is to be tested

ii) when the test is to be carried out

iii) what qualifications are required to carry out the test

iv) procedures for the tests

v) procedures for controlling changes

vi) guidelines for re-testing of changes

vii) procedures for incident reporting

viii) what is to be recorded

15.2. Factory Tests

a) A formal set of tests shall be conducted at the supplier's facilities prior to the equipment being installed on-site.

b) These tests shall fully test the system hardware and software. Only those aspects that are dependent on equipment only available on-site and not practical to simulate will be exempt.

c) System tests shall include coverage of the following:

- the particular use of the system does not exceed any of its design limits.
- the physical configuration design is correct.
- the physical system is installed and configured in accordance with the particular design, using accepted system software and, hardware versions with the correct version of the application data.
- the system interfaces (both internal and external) have been fully considered, and tested.
- application data has undergone a complete test.
- application data has undergone a complete inspection.
- each hardware module has been tested.
- correspondence testing of inputs and outputs.
- each system requirement has been met.
- response time and performance criteria have been met.
- All functions of the system software shall be sample tested, each reporting facility shall be tested
- stress testing

d) Where possible the test procedures should be automated.

e) A reduction in the level of testing will be granted in cases where it can be proven that comprehensive testing has already been carried out on the system.

15.3. Commissioning Tests

a) A formal set of tests shall be conducted on the final installed system.

b) Commissioning tests shall fully test those aspects of the system hardware and software that were not tested during the factory testing.

c) Commissioning tests shall include stress testing of the system, correspondence testing, response time testing, sample testing of each function, system disruption testing, and a reliability demonstration.

16. Deliverables

a) Deliverables shall be supplied no later than 2 weeks after the relevant part of the system is commissioned.

b) The following shall be supplied when applicable:

b1) System Hardware installed and tested on-site.

b2) All Spares.

b3) Executable software and firmware.

b4) A copy of all source code on magnetic media.

b5) A copy of all aids used in creating executable's on magnetic media.

b6) A copy of all aids used in the formal testing of the system on magnetic media.

b7) Printed copies of the documentation as well as a copy on magnetic media.

b8) Licenses.

b9) All documentation initially supplied with the purchased/delivered items, for example the manual for a monitor, or modem.

b10) Test equipment if required.