

Environmental Conditions

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1 Introduction

1.1 Purpose

This document details the environmental conditions which can be expected to experience while signalling equipment is being stored, transported and operated. Suppliers and installers shall consider the extent to which any signalling equipment will be subject to some or all of the environmental factors listed in this Standard.

1.2 Scope

The document covers signalling equipment installed in control centres, lineside equipment housings, and in the open. It also includes transportable equipment designed for short term, temporary deployment at worksites.

Environmental conditions for rail vehicle mounted signalling equipment are not included.

Present-day signalling equipment is almost completely electro-mechanical or electronic in design. For this reason, this is based to a large degree on the applicable parts of the relevant international (IEC) environmental standards for electrical, electronic and electromechanical equipment.

This document is applicable to entire ARTC network.

1.3 Document Owner

The Manager Engineering Services is the Document Owner. For any queries, initial contact should be directed to standards@artc.com.au

1.4 Equipment Housing Classifications

Railway signalling equipment being stored and operated may experience a wide range of conditions. These are mitigated to varying degrees by the situation in which the equipment is installed and operates. The standard situations are classified and described in Table 1 “Equipment Housing Classifications” which follows.

Individual equipment specifications may refer to the classification or range of classifications with which that equipment is to comply.

Equipment housed in:	Classification
Control Rooms	
Signal Box or Control Centre, air conditioned, continuously manned	A1
Signal Box or Control Centre, heated, continuously manned	A2
Signal boxes and traffic rooms, manned as required	A3
Equipment housings	
Relay rooms – brick veneer buildings or similar	B1
Concrete unit huts (old style) and bungalows	B2
Metal/foam sandwich panel huts	B3

Steel or aluminium cupboards	B4
Externally mounted equipment:	
Track mounted	C
Mounted off-track – within 5 metres of running rail	D1
Mounted off-track – more than 5 metres from running rail	D2
Buried equipment	E
Portable equipment	F

Table 1 – Equipment Housing Classifications

1.5 Reference Documents

The following Australian and International Standards have been used in the preparation of this document:

BRB 967	Environmental Conditions
AS 60529	Degrees of protection by enclosures (IP Code) – (follows IEC 60529 – 1989)
AS/IEC 60947.4.1	Low-voltage switchgear and control gear, Part 4.1: Contactors and motor starters – Electromechanical contactors and motor-starters
IEC 60068 – 1	Environmental testing – Part 1: General and guidance
IEC 60068 – 2	Environmental testing – Part 1: Basic environmental test procedures
IEC 60721 –1	Classification of environmental conditions – Part 1: Environmental parameters and their severities
IEC 60721 –2	Classification of environmental conditions – Part 2: Environmental conditions appearing in nature
IEC 60721 –3	Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities
AS/IEC 60870-1-1	Telecontrol equipment and systems – Part 1: General considerations Section 1: General principles
AS/IEC 60870.2.1	Telecontrol equipment and systems – Part 2: Operating conditions – Section 1: Power supply and electromagnetic compatibility
AS/IEC 60870.2.2	Telecontrol equipment and systems – Part 2: Operating conditions – Section 2: Environmental conditions (climatic, mechanical and other non-electrical influences)
IEC/TR3 61000-1-1	Electromagnetic Compatibility (EMC) – Part 1: General

IEC/TR3 61000-2	Electromagnetic Compatibility (EMC) – Part 2: Environment
IEC 61000-4	Electromagnetic Compatibility (EMC) – Part 4: Testing and measurement techniques
IEC 61000-6	Electromagnetic Compatibility (EMC) – Part 6: Generic standards

1.6 Definitions

The following terms and acronyms are used within this document:

Term or acronym	Description
Track Mounted	Equipment mounted either directly or indirectly to rails, sleepers, track slab, ballast or bridges.
Operate Correctly	Equipment parameters are within the limits as laid down in the equipment specification and standard. Where a piece of equipment fails for no other reason than the effects of environmental conditions under which it is required to operate then, for the purposes of this document, it shall be considered as not having operated correctly.
Permanent Damage	Environmentally provoked deviations from the specified parameters which are not self-corrected when there is a return to normal working environmental conditions.

2 Environmental Factors

2.1 General

Depending on its particular circumstances of design and application, every item of signalling equipment will be subject to a variety of environmental factors which may adversely affect its safe and reliable operation.

In some ARTC Signalling Equipment Specifications, a number of environmental factors are noted, which are of particular significance to the type of equipment covered by the Specification. Those particular factors shall in all cases be considered and taken together with all applicable environmental factors listed in this Standard. Where the two documents differ in the specified severity of any factor, the more severe case shall apply.

The following environmental factors have been identified as affecting the operational reliability and service life of signalling equipment.

- Electrical power supply disturbance
- Ground currents
- Electromagnetic Fields (EMC)

- Temperature
- Humidity and condensation
- Wind
- Solar Radiation
- Rain and falling water
- Flood and standing water
- Vibration
- Shock (non-seismic) (Seismic shock is not considered in this Standard)
- Atmospheric pollutants
- Flora and Fauna
- Fire

2.2 Electrical Power Supply Disturbance

Signalling equipment operates from electrical supplies derived from commercial or railway traction mains supplies, or from motor alternator plant. Such supplies will contain significant levels of harmonics and other noise, and be subject to voltage surges, dips, skips and 'brownout' situations.

- Surge – transient voltage wave propagating along a line or a circuit and characterized by a rapid increase followed by a slower decrease of the voltage.
- Dip – short term reduction in supply voltage of duration not exceeding one second
- Skip- short term reduction of supply voltage to zero, for duration not exceeding one second
- Brownout– long term reduction of supply voltage, for periods exceeding 1 second
- Spike – very short term increase in voltage, with fast rise time, duration less than 1mS, and voltage exceeding normal by a factor of 5 or more
- Noise - superimposed low-amplitude voltage, random in nature or at frequencies significantly higher than the mains supply frequency (typically higher than 10 KHz)
- Ripple – superimposed voltage at frequencies which are low-order harmonics of the mains supply frequency

Signalling power supplies may also be subject to noise generated by particular items of signalling equipment. Typically, the high current pulses generated by high-voltage impulse track circuits can induce noise in the adjacent wiring, and back-emf spikes caused by the switching of highly inductive relays, can be conductively transferred on DC supplies and capacitively coupled between independent circuits.

All equipment, irrespective of the classification into which it fits, shall operate correctly when supplied from an electrical supply containing not more than the levels of

distortion, ripple and noise specified in Table 2. The values in Table 2 are shown as percentages of the normal operating voltage of the equipment in question.

Safety critical equipment shall be prevented from operating in an unsafe manner under conditions where the supply voltage is outside the specified limits.

2.3 Electrical Ground Currents

The majority of signalling equipment on the ARTC network operates on lines equipped with DC traction systems. In these areas, significant amounts of stray DC current flowing towards each traction substation have the potential to cause electrolytic corrosion of metallic pipes, cable sheaths, etc., installed along the railway alignment and either fully or partially buried.

Buried and semi-buried equipment shall be configured to minimise the appearance of longitudinal DC voltages and the consequent conduction of stray traction DC currents.

2.4 Electromagnetic Fields (EMC)

All equipment, irrespective of the classification into which it fits, shall be provided with protection against electromagnetic interference where this is necessary to ensure correct operation and avoid permanent damage.

Interference may derive from:

- Stray magnetic fields (e.g. from transformers and relays)
- Electrical interference conducted along power lines, input and output connections
- Radiated electrical interference
- AC or DC electric traction systems
- Surge or spikes from lightning, power supply faults, traction system faults
- Handheld radios and mobile telephones transmitting at distances as close as 1 metre from open equipment housings

The degree of exposure to electromagnetic interference is classified into the following levels, as defined in AS 60870.2.1¹:

“Level 1	Equipment installed in well-protected environment: equipment of main, regional or district control centres
Level 2	Equipment installed in normal protected environment: equipment of control centres located in industrial or electrical plants
Level 3:	Equipment installed in not specially protected environment: equipment of controlled stations or remote terminal units located in residential and industrial areas
Level 4:	Equipment for heavy disturbed environment: equipment of controlled stations or remote terminal units located in close [proximity of MV and HV

¹ AS/I EC 60870.2.1 *Telecontrol equipment and systems – Part 2: Operating conditions – Section 1: Power supply and electromagnetic compatibility*

open air and any GIS or vacuum switchgear, cables with direct connection to HV switchgear, long branch telecommunication lines.”

2.5 Temperature

Equipment in each classification shall operate correctly in the temperature conditions set out for that classification in Table 2.

All temperatures quoted are ambient air temperatures in shade or within the nominated class of enclosure. They do not include the heating effects of solar radiation on any particular item of equipment.

Estimation of equipment operating temperature must also take into account the effects of solar radiation.

Equipment shall be designed such that self-generated heat which results in temperatures within the unit higher than the specified maximum ambient does not result in incorrect operation or permanent damage.

2.6 Humidity and Condensation

Equipment in each classification shall operate correctly in the humidity conditions set out for that classification in Table 2.

Condensation on and within equipment may occur under some combinations of temperature and humidity. Equipment shall continue to operate correctly under these conditions.

Equipment, especially in classes B, C and D shall be resistant to tracking. Tracking is the formation of conductive paths across the surface of an insulating material under the combined influence of contaminants, humidity and temperature.

In class C and D equipment, electrical circuits and terminations shall be protected from accelerated corrosion of terminals and conductors, which can result from a combination of moisture or condensation and continuous impressed DC voltage.

2.7 Solar Radiation

Equipment in classifications C and D will be subject to daily solar radiation. The principal effects of this are heating (infra-red radiation) and materials degradation (ultraviolet radiation), especially affecting plastics, rubber and other synthetic materials.

Unprotected synthetic materials may suffer severe reduction in service life from the effects of ultraviolet radiation. Equipment that is metallic, or completely enclosed in metallic housings, can be considered to be immune to the effects of ultraviolet radiation.

Estimation of the effects of solar radiation shall take into account the effects of any windows in the enclosing building.

2.8 Wind

Equipment in classifications C and D, and equipment housings, shall be proof against incorrect operation or permanent damage caused by wind not exceeding the specified levels.

2.9 Rain and Falling Water

Equipment in classifications B4 shall be proof against incorrect operation caused by ingress of water from rain, or from condensation.

Equipment in classifications B4, C, D and E shall be proof against incorrect operation caused by ingress of water from rain, hoses or splashing from any direction or from condensation.

In general equipment in classifications C and D should provide protection from falling water to a degree at least equivalent to IPX5, as specified in AS 60529 – 2025 Degrees of protection by enclosures (IP Code)

2.10 Flood, Standing Water and Ground Water

Equipment in classifications C and D may be subject to submersion in water due to local flooding. The water will generally be pH neutral, with the addition of gross suspended soil and sand particles.

Selected equipment in classifications C and D shall be capable of operating correctly when under 150 mm of water and shall not suffer permanent damage when submerged under 1000mm of clean water.

Buried equipment (classification E) may be subject to submersion in groundwater due to rain, local flooding or a naturally high water table. Depending on local soil conditions, the water may range from alkaline, through neutral (pH 7.0), to acidic (pH 4.0 or lower).

2.11 Vibration

Equipment in each classification shall operate correctly under the vibration conditions set out for that classification in Table 2.

Vibration amplitudes quoted are maxima. Since vibration will usually result from passing trains, it will be intermittent.

The variation of vibration with time which the equipment must withstand on test is:

- From zero the amplitude increases to a maximum at a uniform rate over a period of 10 seconds
- The amplitude remains at the maximum value for 90 seconds
- From maximum the amplitude decreases to zero at a uniform rate over a period of 10 seconds
- The cycle is repeated after 90 seconds

2.12 Shock (non-seismic)

Equipment in all classifications, except incandescent lamps, shall not suffer permanent damage by shock equivalent to a free drop of 250mm onto a rigid, flat surface.

For equipment in classifications C and D this requirement applies to equipment in working condition. When packaged for transport, equipment shall not suffer permanent damage by shock equivalent to a free drop of 500mm onto a rigid, flat surface.

2.13 Atmospheric Pollutants

Equipment, particularly in classifications C, D and E, will be in contact with the atmosphere which will generally be polluted. Pollutants may include diesel engine exhaust products and brake dust, and may be chemically active (corrosive), conductive or inert.

All equipment shall operate correctly a dust-laden atmosphere. Means must be provided to prevent either the ingress of pollutants or their direct or indirect effects preventing correct operation of equipment or causing permanent damage.

Chemically active pollutants may occur in seaside areas (salt-laden atmosphere) or in industrial areas. In the latter case gases (especially compounds of sulphur and nitrogen, and halogens) may dissolve in condensation or themselves condense in or on equipment. A comprehensive range of significant chemically active airborne substances is given in Part 4 of Table 1, IEC 60721.1 Classification of environmental conditions Part 1: Environmental parameters and their severities. Equipment shall be protected against the effects of such corrosive substances.

Equipment in classifications C, D and E shall also be of materials resistant to chemical attack by water borne active pollutants, detergents, herbicides, fuel oils and hot lubricating oils.

The degree of electrically conductive airborne pollution is classified into the following categories²

- | | |
|----------|--|
| Degree 1 | none, or only dry, non-conductive |
| Degree 2 | normally only non-conductive. Occasional conductivity caused by condensation |
| Degree 3 | conductive pollution, or dry non-conductive which becomes conductive due to condensation |
| Degree 4 | pollution generating persistent conductivity |

2.14 Flora and Fauna

Signalling equipment may be subject to the effects of a variety of live organisms.

Apart from weeds, which can be controlled by normal maintenance procedures, the main vegetative organism likely to affect signalling equipment is mould. Equipment required to operate in an environment likely to support the growth of mould shall be manufactured of materials that do not support mould growth or treated to prevent it.

Signalling equipment and housings can offer a variety of dry, warm recesses which offer attractive shelter to a range of animals and insects. Principal among these, in terms of their potential to damage signalling equipment, are rodents (especially rats) and ants.

Rodents can cause serious damage by gnawing away insulation, and by depositing faeces and highly corrosive and electrically conductive urine on top of items of equipment. All equipment in housings that are not secured against the entry of rodents shall be protected against the effects of rodent attack.

² AS/IEC 60947.4.1

Externally mounted equipment, especially where buried or in contact with earth, may be subject to attack by termites. Equipment in classes C and D shall be of materials and design which does not attract or support attack by termites. Equipment in class E (buried) shall be inherently resistant to attack by termites.

2.15 Fire

Equipment in classification D2, and possibly D1, may be subject to short-term fire exposure due to grass- or bushfires, or the burning of accumulated trackside rubbish. This applies particularly to cables in galvanised steel cable troughing runs.

Equipment in category D2 maybe exposed to fire generating peak temperatures of 1000°C, of duration up to 1 minute³.

3 Transport and Storage

No equipment shall suffer permanent damage when stored under the vibration conditions for working classification C equipment nor when transported by road or rail vehicle. Environmental conditions during transportation should also not exceed those specified for classification C.

Equipment shall not suffer permanent damage when transported, or stored for up to 7 years, in ambient temperatures between -10°C and 50°C (continuous) or -10°C and 70°C for short periods.

Where the requirements for transport and storage exceed the in-service requirements packaging or temporary protective coatings may be used.

Equipment which has protective coatings which must be removed before the equipment is brought into use shall carry a label advising the recommended method of removal for the protective coating.

4 Environmental Conditions (Table 2)

The environmental factors and severities applicable to equipment in each of the nominated housing classifications are tabulated on the following pages.

The factor severities relate to normal operating conditions, without allowing for short-term deviations outside the limits, due to unusual conditions or failure of environmental conditioning equipment. Equipment shall be designed to accommodate such short-term deviations, where applicable.

³ *Pers comm.* N.P. Cheney, CSIRO Division of Forestry & Forest Products, Canberra, June 1999

Table 2 – Environmental Conditions (Part 1)

Factor	Unit	Equipment Housing Class					
		A1	A2	A3	B1	B2	B3
2.2 Electrical Supply							
surge	V%	+50%	+50%	+50%	+50%	+50%	+50%
dip	V%	-20%	-20%	-20%	-20%	-20%	-20%
skip	mSec	10	10	10	10	10	10
brownout	V%	-30%	-30%	-30%	-30%	-30%	-30%
spike	V%	500%	500%	500%	500%	500%	500%
noise	V%	1%	1%	1%	5%	5%	5%
ripple	V%	2%	2%	2%	10%	10%	10%
2.3 Ground currents							
2.4 Electro-magnetic Field (EMC)	Level	1	1	1	3	3	3
2.5 Temperature	Min °C	15°	10°	10°	10°	10°	0°
	Max °C	35°	40°	50°	50°	60°	60°
2.6 Humidity & Condensation	%	60 %	80 %	90 %	90 %	90 %	90 %
	n/a						
2.7 Solar Radiation	Watt/m2						
2.8 Wind	Km/hr						
2.9 Rain	IP no						
2.10 Flood							
2.11 Vibration							
0 – 50 Hz	mm	0.1	0.1	0.1	0.15	0.15	0.15
50 – 100 Hz	mm	0.02	0.02	0.02	0.05	0.05	0.05
2.12 Shock	mm drop	250	250	250	250	250	250
2.13 Airborne pollutants dust conductivity	degree	negligible	low	low	low	low	low
	degree	1	1	1	2	2	2
Chem/corrosive	degree	negligible	negligible	negligible	low	low	low
2.14 Flora & Fauna	N/a	*	*	*	Y	Y	Y
2.15 Fire							
Max temp	°C						
duration	minutes						

Table 2 – Environmental Conditions (Part 2)

Factor	Unit	Equipment Housing Class					
		B4	C	D1	D2	E	F
2.2 Electrical Supply surge	V	+50%	+50%	+50%	+50%		
dip	V	-20%	-20%	-20%	-20%		
skip	mSec	10	10	10	10		
brownout	V	-30%	-30%	-30%	-30%		
spike	V	500%	500%	500%	500%		
noise	V	5%	5%	5%	5%		
ripple	%	10%	10%	10%	10%		
2.3 Ground currents				Y	Y	Y	
2.4 Electro-magnetic Field (EMC)	Level	3	4	4	4	4	
2.5 Temperature	Min °C	0°	-10°	-10°	-10°	0°	-10°
	Max °C	70°	50°	50°	50°	30°	50°
2.6 Humidity & Condensation	%	100 %	100 %	100 %	100 %		100 %
	n/a	yes	yes	yes	yes		yes
2.7 Solar Radiation	Watt/m ²		1000	1000	1000		1000
2.8 Wind	Km/hr		160	160	160		100
2.9 Rain	IP no	X5	X5	X5	X5	X7	X5
2.9 Flood			Y	Y	Y	Y	
2.11 Vibration							
0 – 50 Hz	mm	0.2		0.2	0.2	0.2	10
0-10 Hz	mm		20				
10-25 Hz	mm		10				
25-50 Hz	mm		2				
50-100 Hz	mm	0.05	0.7	0.15	0.15	0.02	0.7
2.12 Shock	mm drop	250	250	250	250	250	250
2.13 Airborne pollutants dust	low	med	high	high	high		low
conductivity	degree	2	3	3	3		2
Chem/corrosive	degree	low	med	med	med		low
2.14 Flora & Fauna	degree	high	med	med	med	high	low
2.15 Fire							
Max temp	°C		1000	1000	1000		
duration	minutes		10	10	10		