AUSTRALIAN RAIL TRACK CORPORATION LTD

Discipline: Engineering (Track & Civil) **Category: Standard**

Automatic Rainfall Monitoring

ETD-10-01

Applicability

New South Wales	✓	**CRIA (NSW CRN)**	

Primary Source

ARTC NSW Standard RMP 04 and RGP 01

Document Status

Version	Date Reviewed	Prepared by	Reviewed by	Endorsed	Approved
1.1	18 Jun 10	Standards	Manager Standards	Exec Manager SS&P 21/06/2010	CEO

Amendment Record

Version	Date Reviewed	Clause	Description of Amendment
1.0	01 Dec 09		Implementation draft. Supersedes NSW Standards RMP 04 v1.2 and RGP 01 v1.2
1.1	18 Jun 10		Banner added regarding mandatory requirements in other documents and alternative interpretations.

Contents

Mandatory requirements also exist in other documents.

Where alternative interpretations occur, the Manager Standards shall be informed so the ambiguity can be removed. Pending removal of the ambiguity the interpretation with the safest outcome shall be adopted.

1 General

Australian Rail Track Corporation policy is to provide a safe operating system at all times including periods of extreme environmental condition.

This policy deals with the requirements for automated monitoring of rainfall, together with the appropriate engineering and operating response.

Civil Engineering staff certify the running line as fit for operations under the Track Examination System and Structures Examination System. This system, together with the Safeworking Rules, make provision for specific action when known extraordinary conditions occur.

Automatic Rainfall Monitoring (A.R.M) is an indication of a change in environmental condition which may alter the level of risk to train operations.

When the level of risk exceeds predetermined limits, train operations are to be restricted accordingly.

2 Accountability

Infrastructure Managers are responsible for the management of the integrity of the infrastructure and the safe operation of services on the region.

Infrastructure Managers shall determine where an A.R.M. is to be installed.

The authorised ARTC representative is responsible for the regular examination and certification of the infrastructure as fit for operations. They are also responsible for modifying or withdrawing this certification where track conditions are, or may be, affected by rainfall and to provide an appropriate response.

Train Control staff are responsible for the effective management of train services on the network. Where the A.R.M. indicates the need for a change to the certification of the running line, they are responsible for:

1) the immediate introduction of the pre-arranged modified operating conditions; and
2) the prompt notification of the appropriate engineering staff and other nominated persons.

3 Automatic Rainfall Monitoring System

When determining the need for the installation of an A.R.M. consideration must be given to:

- Local geography;
- Climatic condition and local rainfall history;
- Drainage capacity;
- Earthworks stability;
- Operating factors (load, tonnage, response time etc.);
- Risk characteristics.

4 Rainfall Reports

Reports are to be on the basis of a two level Alarm System:

Level 1: Yellow alarm

- Trains to be warned of yellow alarm conditions;

- Civil engineering staff to be called to inspect the track and report.

Level 1: Red alarm

- All trains to be stopped immediately;
- Civil engineering staff to attend and report;
- Modified operating conditions to apply, when authorized by Civil Engineering Staff;
- Normal conditions not to apply again until track certified fit for operations.

The A.R.M. is to be established so that the primary alarms are situated in the Operations Control Centre as appropriate for each line. Secondary systems for monitoring the system or its data may be installed in infrastructure offices.

Each A.R.M. must be constructed to provide a continuous self check mechanism and provide assurance of its continued operation.

5 Automatic Rainfall Monitoring System Procedures

The procedures for determining and implementing ARM Systems are shown schematically in Figure 1.

There are four principal stages:-

Initial Assessment - a needs analysis for an ARM System.

Investigation - where the needs analysis concludes that an ARM system may be warranted, the problem sites and locations are defined and the nature of the problems determined, forming a framework for the detailed design.

Detailed Design - the design of the complete system, which requires the co-ordination and integration of a number of disciplines (see Figure 2).

Purchase, Installation and Commissioning - the purchase, installation and commissioning of the ARM facility, training of staff and the operation of the new ARM management systems.

5.1 Initial Assessment

a) The authorised ARTC representative is required to make an assessment as to whether ARM is required and if such monitoring is required, then to make representation for the design, installation and maintenance of appropriate equipment, in accordance with these procedures.

b) In making such an assessment the following factors need to be considered:

- Are there particular sites or generalised areas where the line is at serious risk as a result of rainfall alone or in combination with other conditions?
- Is the rainfall event that poses a threat one where an appropriate response cannot be achieved via the existing provisions in Safeworking Units which require patrol of track in rainfall/flood conditions? Excluded would be situations where there is ample warning of a coming flood peak or where the event builds up slowly such as water level rising gradually until it gently over tops the line.
- Is the problem of a sufficient threat to warrant an ARM system? Excluded may be situations where the traffic density is very low or only seasonal.
- Are there more appropriate or economical alternatives, such as people monitors for short term or localised problems, the use of speed restrictions to protect nominated risk sites; or slip detectors for isolated slip problems?

c) The assessment must be fully documented by the authorised ARTC representative and must consider any historical, geographical, engineering, hydrological, geotechnical or other information which may impact on the likely risks.

Note: In view of the likelihood of changing conditions over time, the authorised ARTC representative must be on the alert for the need for ARM at new locations and the adequacy of existing ARM Systems. Reassessment must be conducted at 2 year intervals (or less if specified by ARTC).

5.2 Investigation

The investigation should be carried out for all locations nominated by the authorised ARTC representative. This will involve a number of tasks, some specialist skills and the integration of these to produce a schedule of requirements suitable for design, namely:

- physical location and type of problems. Locations can be specific (eg. a slip at 157.205Km) and general (eg. unstable upslopes 53.060Km to 61.210Km),
- the rainfall conditions that are critical for each,

The information should be combined into a schedule and any anomalies and omissions corrected. Separate schedules need to be prepared for Geotechnical and Hydrological investigations. Relevant historical evidence should be made available in each case.

a) Geotechnical

Advice must be obtained from the authorised ARTC Geotechnical representative regarding:

- the rainfall conditions which are critical for each problem, at least in general terms. Examples could include, sustained heavy rainfall over many hours (determined by say an 8 hour rainfall event) or very high intensity rainfall (determined by say a 20 min to 30 min event),
- the allowable head of water in the case of culvert surcharge behind embankments,
- the geotechnical risk at each site (assessments are currently available for many locations),
- the preferred geotechnical options or monitoring at each site such as:
    - slip detectors rather than rainfall monitors,
    - piezometers rather than rainfall monitors,
    - a rainfall monitor on site,
    - a rainfall monitor in the general area in conjunction with some other monitoring,
    - generalised monitoring in the general area,

Note: A degree of uncertainty must be expected in this sort of analysis and later refinement should be expected.

b) Hydrological

Specialist hydrological advice is essential. Hydrological input is critical for both the investigation and design phases. Determinations should include:

- waterway capacities for nominated critical locations,
- critical storm events (duration and intensity), time to peak flow, and return periods for critical waterways,
- critical storm events (duration and intensity), and return periods for critical geotechnical locations,
- catchment details, boundaries and return period of various storm events, determination of which catchments are likely to be critical (ie. to be first to detect major storm events),
- an assessment of past rainfall events where the impact was known, eg. the return period, intensities and durations of storms,
- an assessment of significant climatic factors in the study area such as the expected variability of rainfall distribution, the propensity for unexpected high intensity storms and the impact of tides on coastal waterways.

c) Risk Characteristics and Protection Levels

The risk characteristics of the nominated sites need to be assessed in order to determine the level of protection required. Factors to be considered include:

- traffic density and type of traffic,
- whether long trains are running which require long stopping distances,
- whether there is life threatening risk to adjoining landholders,
- the level of risk involved in the rainfall generated problems.

d) System Characteristics

An assessment needs to be made of the response characteristics of the Train Control/Civil Maintenance organisation. How long does it take for trains to be warned/stopped, how long for Perway Inspection Staff to inspect the track if it is closed? What is the impact of holding up traffic, eg. a peak period red alert (particularly if unnecessary)?

Note: Because of the inherent inaccuracy of rainfall related problems a balance needs to be determined between unnecessarily stopping trains and missing what should be a real red alert.

5.3 Detailed Design

The detailed design needs the resources of a project team, including the nominated project leader and expertise in hydrology, computer systems and communications. In addition some involvement may be required from ARTC nominated Geotechnical representative, Engineering and Operations Staff.

All systems will normally comprise remote rainfall monitoring installations consisting of a rainfall measuring device and a datalogger or similar intelligent device. The datalogger records the rainfall and triggers red or yellow alerts when critical rainfall levels occur. The alerts are communicated back to a computer (or other approved system) at the control centre, which immediately notifies control officers. The control officers respond by warning trains (yellow alert) or stopping trains (red alert) and by notifying engineering staff. Various backup and supplementary systems are also required.

Expected design outcomes are detailed in Appendix 1.

5.4 Purchase, Installation and Commissioning

The purchase and installation of equipment can proceed once design has been completed.

ARM commissioning can be done when:

- the equipment is in place, functioning and fully tested,
- an adequate burn-in period has been allowed of at least 48 hours for computer and communications equipment,
- operational and testing schedules are in place and handbooks are available,
- staff are trained in the new systems and issued with the appropriate handbooks,
- Operating staff have been notified and the appropriate operating circulars issued,
- staff duty statements have been amended and staff clearly instructed in their revised duties,
- at least one trial exercise has been held for alert conditions.

6 Appendix 1 - Design Outcomes

Remote Sensors

- locations (generally which sites are to have devices);
- placement (the exact physical placement);
- type to be used (type and characteristics of device);
- security details (housing, disguise, placement consideration);
- backup (secondary devices, multiple gauges if required).

Communications

- from remote site/Telecom [Telstra or other telephone] line/ARTC line radio link;
- connection to phone network if applicable;
- connection to Control Centre;
- communications protocol to be used.

System Software and Hardware

- capacity of data collection devices to be used on site;
- capacity and location of computers or other devices for control of the system;
- particular software and hardware devices to be used.

Alarm Settings

- The settings at each site to detect the critical rainfall events. There could be several at each site. An example could be:

Site 1	Yellow	20mm in 30 min
	Red	30mm in 30 min
	Yellow	50mm in 4 hrs
	Red	75mm in 4 hrs
	Yellow	80mm in 12 hrs
	Red	120mm in 12 hrs

The alarm settings are based on the critical conditions determined in the design phase, modified by consideration of risk and the uncertainty in the system. Initial settings will be modified as the operation of the system generates more reliable information.

Procedures

- Schedule of responses required by operating staff for alarms at each site or section, covering:

Red alarm	where to stop trains
Yellow alarm	what speed or other restrictions to apply and where and how trains are to be warned
Faulty device	procedures for dealing with faulty devices

- Additional responses may be required such as notifying emergency services groups, notifying adjoining landholders in some locations.
- Schedule of responses by engineering staff to alarm conditions (including equipment failure) covering who is to carry out inspections for what areas and how is it to be co-ordinated, who is to be spokesperson for instructing Control on applying and removing restrictions. Procedures need to cover both minor and major events including situations where alert conditions may continue for several days.

- Maintenance and testing schedule for the equipment involved, detailing the equipment, testing required and testing intervals.
- Data collection arrangements nominating who is responsible for data collation and evaluation and how and when alarm settings are to be adjusted.

Figure 1 - Procedures: ARM Assessment to Implementation

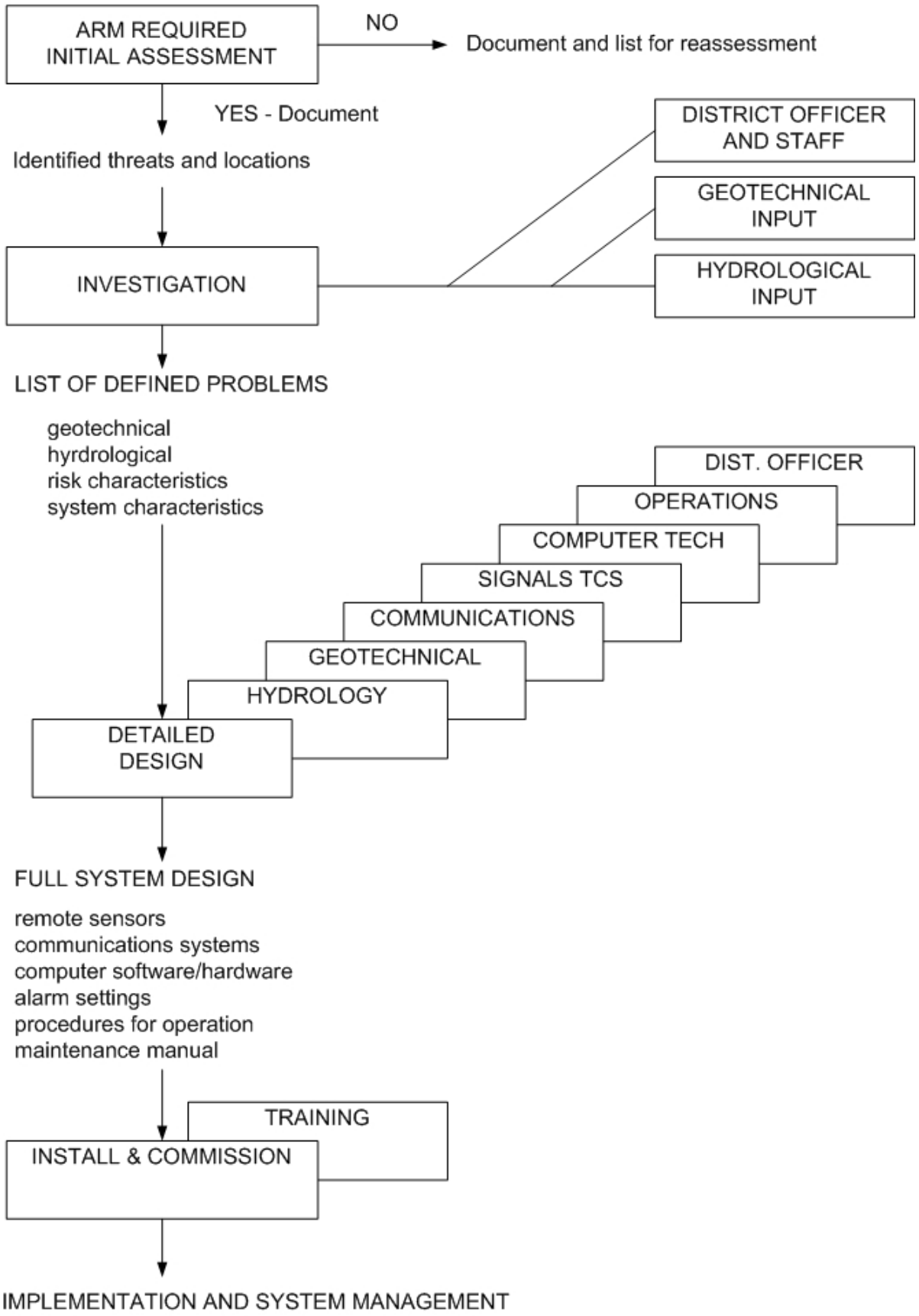

Figure 2 - System Design