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3 May 2024

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CSSI 7474 Narrabri to North Star, Phase 1 (N2NS) Ministers Conditions of Approval

Dear Alex,

Please find enclosed, the Operations Environmental Management Framework (OEMF) to fulfil the Ministers Condition of Approval (MCoA) D4 of the Critical State Significant Infrastructure (CSSI) 7474 Narrabri to North Star, Phase 1 (N2NS). The condition requires an OEMP (Operational Environmental Management Plan) or EMS (Environmental Management System) to be submitted to the Secretary for information at least one (1) month prior to the commencement of operation of the CSSI.

Further to this, I refer to the letter from the Department dated 27 October 2022 approving the Narrabri to North Star Phase 1 Operational Staging Report under MCoA A11, which states the Interstate Environmental Management Framework (IEMF) will be updated and submitted prior to commissioning of N2NS P1 in its entirety. Accordingly, ARTC has finalised its review of this document and has attached to this letter a copy of the OEMF for information to the Department in accordance with MCoA D4 and the approved Narrabri to North Star Phase 1 Operational Staging Report.

If you have any further questions, please do not hesitate to contact myself via the details below.

Yours sincerely,

Stuart Ross
Corporate Environment Manager

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0438 272 840

EHS-PR-001 – Operational Environmental Management Framework (OEMF)

Applicability

ARTC Network

Publication Requirement

Internal / External

Primary Source

N/A

Document Status

Version #	Date Reviewed	Prepared by	Reviewed by	Endorsed	Approved
1.0		Michael Moller	Catherine Bowlzer	Ben Leske	Peter Winder, Group Executive, Interstate Network
1.1	May 2020	Michael Moller	Catherine Bowlzer	Ben Leske	Peter Winder, Group Executive, Interstate Network
1.2	November 2022	Hayley Frazer	Michael Moller	Ben Leske	Simon Ormsby, Group Executive, Interstate Network
1.3	February 2024	Tyler Warren	Matt Doherty / Michael Moller	Nelius Murphy/Holly Mepham	Stuart Ross, Corporate Environment Manager

Amendment Record

Amendment Version #	Date Reviewed	Clause	Description of Amendment
1.0	N/A		N/A
1.1	May 2020	Multiple	Minor updates
1.2	November 2022	Multiple	Updates to reflect the completion of Narrabri to North Star SP1 section of Inland Rail
1.3	February 2024	Multiple	Title change / Minor updates for currency

Table of Contents

1 Introduction

1.1 Purpose

This Environmental Management Framework (the Framework) is a document that:

- Describes desired outcomes and processes for the prevention and management of environmental impacts resulting from the operation of the ARTC network;
- Sets out the responsibilities and accountabilities within ARTC (the Railway Manager) and others in this regard; and
- Identifies key management systems that support the delivery of environmental compliance across the ARTC Network.
- As well as outlines how performance outcomes, commitments and mitigation measures, made and identified in the EIS and Submissions Reports and approvals can be achieved.
- The framework also notes that issues identified through ongoing risk analysis can be actively managed by ARTC through the use of internal processes and procedures that are implemented for compliance auditing, assurance and incident management.

1.2 Scope

The Framework document is focussed on the function of ARTC's operations and it's contractors, in undertaking railway activities, control of railway operations and routine railway infrastructure maintenance activities.

In accordance with CSSI Part D conditions pertaining to Operational Environmental Management, this plan has been prepared to outline how the terms of the conditions of approval (CoA) will be addressed and complied with, regarding operational activities along the Inland Rail Network that have completed construction and commissioned into operation as part of the Inland Rail Program.

All other approval requirements and mitigations identified are tabled and addressed in the relevant compliance reports to each project as per the Post Approval Requirements - Compliance Reporting (2018).

Major capital upgrades and construction activities will be subject to additional environmental assessment requirements under Federal and State laws and regulations.

1.3 Responsibilities

All ARTC procedures and work instructions outline responsibilities for specific activities. Some key responsibilities are summarised below with others outlined throughout the document.

Roles	Responsibilities
Chief Executive Officer and Managing Director	Approve the ARTC Environmental Policy.

Executive Committee	Approve the Environmental Management System.
Group Executive (GE) / General Managers (GM)	Initiate any preventative measures to mitigate, rectify or prevent environmental harm arising from activities, incidents, breaches or audits. Ensure that alliance partners and contractors who are engaged to undertake activities on property managed by ARTC, have the systems in place to meet the requirements of the EMS. Ensure that the environmental aspects of projects are assessed and managed in accordance with ARTC's requirements. Ensure that all rail operators comply with the ARTC EMS.
General manager of Safety and Environment	Provide advice to the relevant GE to enable the above objectives of the Committee to be fulfilled. Oversee the impact and responses to legislative and policy developments in the environmental field, which may have material impact on ARTC. Report breaches and non-conformances of the EMS. Ensure appropriate risks and environmental matters are assessed and maintained in the ARTC Risk Register. Liaise with regulatory authorities and industry bodies as required and ensuring compliance with all laws and regulations as appropriate. Promptly advise receipt of any statutory notice and take appropriate action in support of responding to that notice.
Environment Advisors	Maintaining records in accordance with the IEMF. Demonstrate compliance with the Ministers Conditions of Approval (CoA) Ensure that environmental incidents, non-conformances and complaints within ARTC are reported, recorded, investigated and corrective actions are managed (and monitored) and recommendations implemented. Provide technical expertise, advice and appropriate training in environmental management matters to enable ARTC employees. Liaison with Environmental Regulators as required.
Community Relations Officer	Administer and maintain the ARTC Engagement Management System, Consultation Manager and the Enviroline service. Record, track, and close all enquiries and complaints made to ARTC from direct phone calls and emails. Identify trends and risk areas from the review of engagement data.
Managers Project Managers	Ensure that new employees, alliance partners and contractors inducted to their place of work are aware of their responsibilities as outlined in the EMS and specific to their position and training. Ensure that employees with environmental responsibilities have appropriate training. Complete TBEIAs for all rail maintenance activities.

Network Controllers Train Transit Managers	Comply with relevant plans, procedures, and instructions. Report all environmental incidents and assess notification requirements. Undertake external notification to environmental authorities as required.
Employees	Adhering to procedures developed by ARTC. Identifying, assessing and avoiding or mitigating any adverse environmental impact that may result from carrying out activities including the construction and maintenance of ARTC infrastructure. Reporting any environmental incident or breach to the appropriate Environmental Advisor and respective Corridor Manager
Alliance Partners Contractors	Comply with all applicable environmental legislation and the ARTC EMS. Report promptly to ARTC any environmental incident or complaint. Ensure their employees, contractors and sub-contractors comply with applicable legislation and align with ARTC's EMS.

1.4 Related Documents

The following documents support this framework:

- ENV-PR-001 Environmental Management System
- ENV-WI-002 Pollution Incident Response
- ENV-PR-004 EMP for Operators on the ARTC Network
- ENV-WI-004 Standard Environmental Management Measures
- ENV-PR-005 Environmental Site Inspection
- ENV-WI-005 Task Based Environmental Impact Assessment
- RLS-PR-001 Risk Management
- RLS-PR-044 Emergency Management
- EGP-20-01 Project Management
- ENV-GL-001 State Environmental Limitations
- EGP-10-01 Asset Management System
- COR-PR-035 Event Investigation
- COR-PR-034 Event Response and Notification
- LEG-PR-003 Internal Audit Procedure
- ETE-09-01 Structures Inspections
- ETE-09-02 Structures Inspections Procedure

1.5 Definitions

The following terms and acronyms are used within this document:

Term or acronym	Description
ARTC	Australian Rail Track Corporation Ltd.
ARTC Corporate Headquarters	11 Sir Donald Bradman Drive, Keswick Terminal, South Australia 5035.
ARTC Map	ARTC's Geographical Information System that contains datasets of known places of environmental sensitivity such as waterways, cultural heritage, flora and fauna within the rail corridor and extending 500m either side.
ARTC Risk Matrix	A standardised method of scaling risk analysis across different aspects of the business including environment, financial, and safety.
CoA	Ministers Conditions of Approval
Consultation Manager	ARTC's online enquiry and complaints handling system used to record and track enquiries and complaints and the work done to address them.
Contaminated Land Database (CLD)	ARTC's Contaminated Land Database (excludes State regulatory databases).
Contam-Map Library	ARTC's SharePoint Library of contaminated land reports and associated information used to populate the Contam-Map Register. This forms part of the ARTC CLD.
Contam-Map Register	ARTC's SharePoint Register of contaminated land and dataset information used to inform priorities and exposure risks. This forms part of the ARTC CLD.
Document Development Group	ARTC SME Business Representatives reviewing and approving internal documentation.
Ellipse	ARTC's asset management system.
EMP	Environment Management Plan
Enterprise Risk Management System (ERMS)	A system that is utilised to record and manage risks, controls, treatments and actions across the whole of the organisation, including projects. CGR foundation is ARTC's mandated Enterprise Risk Management System.
Enviro Essentials	Legal compliance system.
Enviroline	ARTC's enquiry and complaints handling service.
Environmental Incident Response Contractor	A pre-approved contractor with the required qualifications and competencies to carry out environmental incident response activities.
Environmental Management System (EMS)	Part of an organisation's overall management system that focuses on the development and implementation of its environmental policy and the documenting and management of very high/ high environmental risks.

Term or acronym	Description
Environmental Non-Conformance	An environmental non-conformance is a non-compliance with a condition of approval, a licence condition; or another environmental regulatory requirement.
Environmental Risks	An organisation's activities or services (e.g. infrastructure maintenance, train operations) that can cause actual or potential threat of adverse effects on living organisms and the environment.
Formal Risk Assessment	A full, documented risk assessment that identifies risks, causes, consequences and controls associated with organisational objectives, operational activities, projects and change.
Horizon 360	Enterprise-wide Health, Safety and Environment (HSE) Management System, which enables reporting, management, analysis and investigation of events and hazards.
Noise Prediction Tool (NPT)	An online tool that provides quantitative noise assessment useful for determining impact on noise sensitive receivers.
Site Inspection	The process used to assess site environmental performance and to identify potential environmental non-conformances.
Standard Environmental Management Measures (SEMMs)	A set of management measures developed to manage common environmental impacts identified during routine infrastructure maintenance activities.
Task Based Environmental Impact Assessment (TBEIA)	A document detailing the environmental impacts and associated SEMMs for maintenance tasks performed by ARTC.
Track Access Agreement (TAA)	A legal agreement between ARTC and an Operator which defines the conditions under which ARTC agrees to grant the Operator access to the network.
WI	Work Instruction

2 Management Systems

ARTC is the rail infrastructure manager for more than 8,500 route kilometres of track in New South Wales, Queensland, South Australia, Victoria and Western Australia. ARTC also manages the Hunter Valley coal rail network. In this role, ARTC manages the operation of the rail network and the maintenance of the rail infrastructure.

The rail infrastructure that ARTC maintain include the rail track, sleepers, associated electrical components, level crossings, as well as structures including environmental enhancement features, bridges, culverts and buildings associated with rail operation.

To help ensure ARTC's role as rail infrastructure manager is carried out according to relevant state and federal requirements, ARTC have developed a range of processes and systems to manage, plan, assess and review the environmental aspects of maintenance and operations.

2.1 Environmental Management System

ARTC operates under an Environmental Management System (EMS) that provides a structured framework for the consideration, evaluation, management, compliance and reporting of environmental issues associated with ARTC, operator and contractor activities on the rail network. ARTC has developed the EMS in consideration of ISO14001 – Environmental Management Systems.

ARTC's EMS outlines processes that are designed to guide compliance with environmental laws, statutes, regulations and corporate policies while managing ARTC's environmental impacts.

The EMS is used in accordance with the Environmental Management System Procedure.

2.2 Event and Compliance Management Systems

Key environmental information is stored between Horizon 360 and the SharePoint EMS site. Some examples of this are:

- Horizon 360
- SharePoint EMS
- Environmental Site Inspections;
- Environmental Incidents;
- Contaminated Sites;
- Legislation Reviews;
- Environmental Training conducted; and
- Operator EMP reviews and refuelling approvals.

ARTC monitor and report on the information within the SharePoint EMS and Horizon 360 to help the continuous improvement of ARTC's environmental management.

Incidents (events), investigations and corrective actions are entered, tracked and close out using the ARTC Horizon 360 system.

2.3 Asset Management System

ARTC's asset management system *Ellipse* is used to manage and track the condition, maintenance requirements, monitoring commitments and compliance requirements for all ARTC assets. This includes inspections and maintenance of structures including culverts. See Appendix B and Appendix C.

ARTC assets include all track and rail infrastructure as well as environmentally relevant sites including, but not limited to the following:

- Contaminated sites;
- Heritage structures, sites and buildings;
- Noise walls;
- Fauna furniture;
- Environmental monitoring equipment / locations;
- Invasive weed species sites; and
- Threatened species and threatened community locations.

All assets within *Ellipse* have maintenance and monitoring requirements, including relevant frequencies and dates that informs ARTC's environmental compliance priorities.

Use of the *Ellipse* system is governed by the Asset Management System Procedure.

The environmental asset class strategy guides the framework for how environmental related sites are entered, maintained, assessed and prioritised for rectification management (if required).

2.4 Geographical Information System

ARTC Map is ARTC's internal GIS mapping system that supports primary Environment Impact Assessment (EIA) process for rail maintenance activities. ARTC Map contains state, commonwealth and ARTC developed environmental, planning and geotechnical datasets for Qld, NSW, Vic, SA and WA. Data including but not limited to land contamination, threatened species sightings, cultural heritage and surface water locations is included to provide a single desktop resource for assessing the environmental values across the ARTC network.

All data within ARTC Map is reviewed and updated on a regular basis, or as the data source provider allows and extends outside of the rail corridor where possible to provide regional context and ensure potential offsite environmental impacts are captured in EIA activities. This includes updating when environmental aspect data is handed over from the Inland Rail Program as project sites are commissioned into Operation.

ARTC have several supporting materials and training options to guide users in the ARTC Map system.

2.5 Engagement Management System

ARTC maintain a centralised database of all complaints and enquiries via the *Consultation Manager* system. The system logs relevant details, tracks and closes actions. The system allows for interpreted reporting of data.

The ARTC Community Engagement Framework provides guidance in the appropriate management processes to ensure ARTC communities are notified of works and complaint response processes are consistent.

3 Environment Policy and Legal Requirements

3.1 ARTC Environment Policy

ARTC Environment Policy is provided in Appendix A.

3.2 Legal

ARTC operates under the legal jurisdictions of South Australia, Victoria, Western Australia, New South Wales, Queensland and the Commonwealth of Australia. ARTC employees may access a Compliance Register which lists laws applicable to ARTC in all of these jurisdictions.

Subscription services to a number of external standards are available to employees to help inform of legislative changes and as a consolidated source of up-to-date legislation. This includes a subscription to *Enviro Essentials* which acts as ARTC's primary source of updated environmental legislation and informs ARTC of updates specific to all states ARTC operate in.

Environmental compliance requirements including lease conditions, are tracked and updated on an as needed basis, when key dates are reached, when new legislation is released or when legislation is revised and updated. Compliance requirements are incorporated into ARTC processes and documents as necessary with all compliance requirements tracked, managed and recorded using compliance tracking registers.

3.3 Environmental Planning

ARTC has developed state specific Environment and Planning Compliance manuals that consider specific legislative requirements in relation to the delivery of asset maintenance. The manuals are suitable for adaptation to individual projects and identify key requirements and any exemptions relevant to ARTC activities where there is no other prevailing legislation or project approval.

3.3.1 Annual Work Plans

Annual Work Plans (AWPs) detail ARTC's maintenance activities and locations for the upcoming year. The AWPs allow ARTC to budget time, money and other resources to the highest priority maintenance activities, with suitable lead time to ensure all planning and assessment requirements are completed.

AWPs are reviewed annually for consideration of the potential for:

- Environmental planning or license requirements;
- Impact to known sites of contamination;
- Impact to invasive or protected vegetation communities; and
- Impact to local communities and residents including local councils and road authorities.
- Impact to Aboriginal and non-Aboriginal heritage

3.3.2 Sustainability

ARTC have developed an Environment and Social Governance (ESG) Strategy that lifts the stature of sustainability within the operating business through the following 5 priorities:

1. Growing new markets,
2. Developing our skilled and diverse workforce,
3. Enhancing network safety and resilience,
4. Approach to social responsibility; and
5. Environmental Benefits

Goals set under these pillars of Environment and Social Governance aim to drive Australia's national and international sustainability commitments as well as allow our organisation to continue to provide rail as a sustainable mode of transport for people and goods.

Our commitment to this pledge can be demonstrated in day-to-day operations where future thinking is encouraged to break through challenges and barriers that may be faced in a changing environment. Our unwavering dedication to these goals can be seen through the delivery of major construction projects, including Inland Rail, to catalyse regional economic development, forge stronger connections in our local communities in which we operate, and provide a resilient service to our customers and the community of Australia.

3.4 Environmental Compliance

ARTC have multiple compliance obligations across all states in which ARTC operate outlined in ***Table 1***.

ARTC will use Horizon 360, as a holistic way of managing environment obligations particularly in the context of project approvals and other governing obligations.

This provides assurance oversight of major project approvals, operating licenses, lease agreements, existing site conditions and state specific regulations.

Table 1: ARTC Environment Approvals and Licenses

License Number	Description	Access
EPL 3142	EPA License for Operations	EPL 3142
SSI 7475	Conditions of Approval for Inland Rail - Parkes to Narromine SSI 7475	P2N Conditions of Approval
SSI 7474	Conditions of Approval for Inland Rail – Narrabri to North Star Phase 1 SSI 7474	N2NS P1 Conditions of Approval

3.4.1 Obligations Management

The Horizon 360system supports the ability to undertake key activities in order to ensure compliance is achieved by way of:

- Site identification, detail and location, specific to the location and requirements;
- Scheduling of activities including site inspections, audits and reporting;
- Condition scoring and assessment of site controls and conditions;
- Escalation processes;
- Short- and long-term planning and budgeting for condition response; and
- Reporting.

3.4.2 Environmental Assurance Activities

The Environmental Assurance Guideline documents the environment assurance processes in place within ARTC. This guideline provides visibility of assurance tasks, responsible roles, frequency of tasks and related documentation. This supports ARTC to achieve the compliance obligations associated with the delivery of its operations.

4 Risk Management

This section outlines ARTC's approach to risk assessment and management at a corporate and project level.

4.1 Risk Hierarchy

ARTC identify and manage risks at a corporate level as guided by the Risk Management Procedure. The Risk Management Procedure defines a tiered risk structure with the following categories:

- Top Risk Events – a risk determined by the Executive as a high-level risk event which could adversely affect the achievement of the company's objectives. Top Risk Events are the "Parent" risks to subsidiary risks from the other risk tiers.
- Enterprise Wide – a risk that has been identified as affecting more than one part of ARTC, commonly a specific breakdown of a "Top Risk Event" risk.
- Operational - a risk owned by a particular part of ARTC, related to a particular Division, or a specific type of task.
- Geographic/Location – a risk that is specific to a particular geographical vicinity, section of track or specific location.
- Programme – a risk that is relevant to a particular programme of projects that is usually able to be closed at the end of the programmes.
- Project – a risk that is relevant to a particular project that is usually able to be closed at the end of the project.

4.2 Primary Environmental Risks

In relation to the core business activities, ARTC's primary environmental risks are derived from the following aspects:

- Noise and vibration;
- Incidents and emergencies;
- Air quality;
- Environmentally sensitive or significant areas;
- Contaminated land;
- Statutory planning and approvals;
- Environmental legislation;
- Aboriginal and non-aboriginal heritage; and
- Biodiversity.

4.3 Risk Assessment Process

The levels of risk assessment relevant to environmental risks are:

- Formal Risk Assessment,
- Environmental Impact and Planning Assessment Aspects and impacts in relation to ARTC for operational activities, legislative requirements as well as internal and external stakeholder views.

These risks are assessed at a strategic business level and are assessed using Bow Tie Analysis where risk causes, consequences and controls are identified in sequence with inherent, current and target risk ratings allocated according to the severity and likelihood of the consequences. All risk ratings correspond to those defined in the ARTC Risk Matrix and range from low to very high.

ARTC's enterprise-wide environmental risks are all assessed regularly using Formal Risk Assessment.

4.3.1 Projects

All projects will assess and manage risks specific to the project. The ARTC Project Manager is responsible for assessing and rating all project risks including risks relating to environmental aspects. The Operational Readiness process also documents any risks that are captured by the construction contractor across the Inland Rail program and ensures handover and acceptance into the relevant operating business unit.

Assessment of environmental risks related to individual rail maintenance activities is generally accomplished using a Task Based Environmental Impact Assessment (TBEIA). TBEIAs assess the risk of conducting a particular activity in a specific location and determine what site-specific controls are appropriate to address the risks identified. Please see section 5.1 for more details.

All project risk management is conducted in accordance with the Project Management Procedure.

4.3.2 Climate Change and Business Resilience

ARTC are currently working on board endorsed Environment Social, and Governance (ESG) Strategy, which has a 2025-2030 timeline that encompasses priority ESG issues, aligns with government policies, and the changing (regulatory) landscape. The strategy sets out targets and metrics and provides a roadmap with detailed actions.

Further to this, ARTC has developed net zero roadmap. This roadmap targets the following 4 key areas:

- electricity procurement and generation strategy
- fleet transition strategy
- Continue to implement and broaden identified projects in:
    - energy efficiency actions
    - renewable energy
    - embedding into systems and processes.
    - Behaviours
- ARTC's role in supporting decarbonisation of the rail sector.

Resilience

ARTC also has an approved Resilience Strategy which has been designed to develop and monitor the climate-focussed Network Resilience, focusing on:

- Redundancy – spare capacity and diversion routes
- Resistance -physical robustness
- Reliability – Ability to operate under a variety of conditions
- Recovery – Respond and recover from disruptions

4.4 Controls

All risks will be evaluated to determine the degree of control required for each risk and whether the activity associated with the risk should be undertaken using the existing and proposed controls or whether more controls are required. Risks are assessed regularly to ensure controls are current and appropriate at managing the risk.

ARTC allocate controls to all risks to reduce the risk to an acceptable level. All controls are tracked and managed through the ERMS with individual control owners responsible for implementing the controls.

5 Environmental Impact Assessment and Management

5.1 Routine Infrastructure Maintenance

Within all states, environmental legislation guides the environmental assessment and approval process. ARTC have adopted a consistent process nationally which addresses the general environmental duty.

5.1.1 Annual Work Plans

ARTC organises all routine infrastructure maintenance activities according to AWPs. AWPs allow suitable lead time to organise all aspects of maintenance activities including the type of EIA required to carry out activities and where environmental site inspections will be completed.

AWPs are reviewed and adjusted on an annual basis. Information entered in Ellipse throughout the year is used to inform maintenance priorities and is balanced based on budget and track access restrictions.

5.1.2 Task Based Environmental Impact Assessment

A TBEIA is a form style environmental assessment that has been developed specifically for routine rail maintenance activities where impacts are low and readily identifiable.

TBEIA is also a risk management tool which identifies potential impacts to indigenous and non-indigenous heritage, flora and fauna, water, air quality and sensitive receivers based on a desktop assessment. All permit and approval requirements, controls and activity limitations will also be identified as part of a TBEIA.

ARTC will assess all environmental impacts for routine infrastructure maintenance activities according to the Task Based Environmental Impact Assessment WI and the associated TBEIA form, except where activities are specifically excluded (see section 5.1.3).

5.1.2.1 Assessment of Predicted Noise

The Noise prediction tool (NPT), is used to assess noise impacts when works are proposed outside of standard working hours and/or near sensitive receivers such as residences.

Sensitive receivers identified as potentially impacted according to the NPT will be notified according to the TBEIA WI, the Maintenance Noise Guideline and relevant state legislation.

5.1.3 Excluded Activities

Where rail maintenance activities represent small scale and low intensity works, a TBEIA may not be required. A relevant Environment Advisor will provide advice regarding the need to complete a TBEIA in these situations. Any activity not requiring a TBEIA will be managed in accordance with Standard Environmental Management Measures (SEMMs) as relevant.

5.2 Supporting Tools

The series of tools outlined in the following table assist in the completion of TBEIAs and improve environmental awareness generally. Access to these tools is available to all ARTC employees.

Tool name	Description and use	Impacts assessed
ARTC Map	See section 2.3. Provides employees with a readily accessible display of known environmental values within and adjacent to the rail corridor. ARTC Map will be used in initial desktop environmental impact assessments for all TBEIA activities.	Indigenous heritage, non-indigenous heritage, flora, fauna, water, contaminated land
Contaminated Land Database (CLD)	The CLD contains details on sites that have been assessed for contamination or may be contaminated. Locations on the CLD are displayed geographically on ARTC Map to enable staff to easily identify known potentially, and actually contaminated land. The CLD will be used in all EIA activities to assess whether land contamination is a factor that must be mitigated.	Contaminated land
Noise Prediction Tool (NPT)	The NPT is used to assess noise impacts when works are proposed outside of standard working hours and/or near sensitive receivers such as residences and hospitals. Sensitive receivers identified as potentially impacted according to the NPT will be notified according to the TBEIA WI, the Maintenance Noise Guideline and relevant state legislation.	Noise, sensitive receivers
State Environmental Limitations	The State Environmental Limitations Guideline outlines the statutory restrictions relevant to ARTC maintenance activities and will be considered when undertaking a TBEIA.	Permits, approvals and activity limitations

5.3 Additional Assessment

Where maintenance activities are scheduled in sensitive areas, pre-work planning inspections are conducted by Environmental Advisors to identify whether further assessment is required or whether certain SEMMs may be appropriate.

Where potential environmental impacts are suspected or likely based on a TBEIA, additional assessments will be arranged to be completed by a Suitably Qualified Person prior to the activity commencing. Where an additional assessment outlines controls further to the SEMMs, these will be included in the list of controls to be implemented as part of the maintenance activity.

5.4 Standard Controls

ARTC's SEMMs for maintenance activities are listed within the SEMMs Work Instruction and are incorporated into the TBEIA form. For each maintenance activity, SEMMs relevant to the maintenance task will be selected from the TBEIA form. Additional controls will be selected and utilised where potential impacts to sensitive sites are identified as per the TBEIA Work Instruction or any additional assessment.

6 Operators on ARTC Network

6.1 Rail Operators

Rail operators are required under their respective Track Access Agreement (TAA) to submit an EMP relating specifically to their operations conducted on the ARTC network.

The requirements for rail operators accessing the ARTC Network are outlined in the Environment Management Plan (EMP) for Operators on the ARTC Network Procedure.

A number of potential environmental impacts from operator activities have been identified. These are:

- Noise and vibration from rolling stock affecting surrounding communities;
- Regulator involvement and reputational damage; and
- Land and water pollution from accidents and incidents.

See section 7 and 8 for an outline of ARTC's processes that help to manage these potential impacts.

7 Environmental Incident Management

Environmental incidents that occur in relation to ARTC and rail operator activities are managed in accordance with the Pollution Incident Response Work Instruction and the Event Response and Notification Procedure. Rail accidents and emergencies are managed in accordance with the Emergency Management Procedure.

7.1 Incident Response

Following identification of an environmental incident, ARTC will take all reasonable and practicable steps to stop, reduce and/or prevent further impacts. Where ARTC does not have the resources or necessary specialist equipment to undertake immediate response actions, an Environmental Incident Response Contractor will be engaged.

7.2 Internal Reporting

All pollution incidents will be immediately reported to ARTC Network Control except where external notification is not required, or another arrangement is in place. For pollution incidents reported to Network Control, Train Transit Managers will ensure the immediate completion of an event within Horizon 360 and any subsequent notification obligations.

Other environmental incidents (e.g. non-conformances, damage to heritage items) will have an Event Report raised with Horizon 360.

7.3 External Notification

All state specific requirements for external notification are included in the Event raised within Horizon 360 .

For major projects, or when operating under a CSSI, notification of an incident will be reported in accordance with the methodology noted in the CSSI.

7.4 Incident Investigation

All incident investigations will recommend corrective actions on a case-by-case basis depending on the type of incident, the severity and the potential for further impact. Corrective actions typically include:

- Site clean-up;
- Increased site inspections and monitoring;
- Increase environmental awareness (re-training, tool-box meetings); and
- Review and improve existing environmental controls.

Environmental incident investigation is undertaken in accordance with the Event Response and Notification Procedure as well as the Event Investigation Procedure.

8 Complaints Management

The operation of trains and the carrying out of maintenance activities on the rail network has a number of potential environmental effects which may impact receivers adjacent to the corridor. As the land manager, ARTC administer the receipt and management of community complaints related to environmental effects including noise, air and/or land pollution in accordance with ARTC complaints management procedure, as per section 2.5 of the framework.

ARTC undertake the following in the management of community complaints:

- Ensure compliance with applicable regulatory requirements;
- Investigate and resolve complaints related to ARTC infrastructure or land;
- Maintain a complaint register for the ARTC network; and
- Liaise with operators and customers to resolve complaints as required.

Complaints are managed through Consultation Manager and include phone calls and emails to ARTC personnel, onsite enquiries, formal correspondence and Enviroline messages or emails.

8.1 Enviroline

Enviroline is ARTC's complaints handling service for pollution complaints (e.g. noise, dust, spills). Enviroline is operated by the Community Relations Officer for all states that ARTC operates in.

9 Training and Competency

ARTC environmental inductions and training are provided to employees according to how each employees role relates to the content provided. The current modules include:

- ARTC Environmental Induction;
- Environmental Incident Management Induction;
- Pesticide Use and Recording Induction;
- Noise Prediction Tool;
- Fire Ant Management;
- Introduction to Task Based Environment Impact Assessment; and
- Using ARTC Map for Task Based Environmental Impact Assessments.

All ARTC employees complete the ARTC environmental induction and the Induction Procedure sets out the processes by which managers will induct employees, contractors, consultants and visitors to ARTC.

Training is provided to employees according to the training matrix with the following topics forming the primary modules available:

- Completing a Task Based Environmental Impact Assessment;
- Erosion and Sediment Control; and
- Environmental Awareness for Maintenance and Construction.

Environmental training sessions and the attendees are recorded on location specific Training Register’s. . Environmental training and inductions are reviewed and updated regularly, and where legislative and ARTC procedural changes require it.

9.1 Environmental Awareness

Environmental Toolbox Talks are provided to help communicate key environmental and community information to operation, maintenance and project teams as required. These Toolbox Talks provide ARTC staff with information to aid in improving environmental performance during maintenance works.

An Environmental Field Guide has been developed and is intended to assist staff involved in ARTC's maintenance activities by identifying environmental management measures that can be adopted to prevent environmental and community impacts.

10 Auditing and Review

10.1 Document Governance

The review and approval of ARTC documents varies depending on who the owner of the document is. For documents relevant to the carrying out of maintenance activities the following applies:

- All new and revised Corporate level documents are reviewed and approved by the approved Document Development Group..
- All new and revised division specific WIs are reviewed and approved by the division Group Executive.
- All new and revised local documents are reviewed and approved by the division Environment Team.

All documentation and information is managed in compliance with the document management procedure.

10.2 Environmental Site Inspections

Environmental Site Inspections are used by ARTC to ensure that all requirements of relevant legislation are addressed, permits and approvals are complied with and the EMS is implemented. Environmental site inspections are managed according to the Environmental Site Inspection Procedure.. All site inspections, including corrective actions where applicable, are recorded in Horizon 360 for reporting and auditing purposes.

10.3 Independent Audits

Independent audits will be undertaken as required, based on the source of requirement. This may be due to requirements within licenses, leases or conditions of approval following project completion.

10.4 Internal Audits

ARTC conduct internal audits to ensure compliance, improve performance and provide assurance that ARTC’s current controls are effective at managing key risks. Internal audits occur approximately annually according to the in force Internal Audit Plan and can be focussed on ARTC’s EMS or environmental compliance generally.

All internal audits are completed according to ARTC’s Internal Audit Procedure.

11 EMS Review and Continuous Improvement

11.1 Review Scope

The review of the EMS is undertaken collaboratively by the ARTC operational and corporate environment teams.

Regular management review of the EMS identifies opportunities for improvement to be implemented.

The EMS review also ensures that budget allocations are reflective of the resources that are required to maintain a compliant asset. Management review of the EMS will involve:

- review of audit findings,
- inclusion of updates of strategic business targets and objectives,
- changes to aspects and impacts during the risk management process

Appendix A – ARTC Environment Policy

POLICY

ENVIRONMENT POLICY

The Australian Rail Track Corporation (ARTC) commits to undertaking our activities in a safe and environmentally responsible manner to achieve positive outcomes for our customers, stakeholders, community and the environment.

ARTC will:

- Comply with relevant environmental laws and regulations, and apply standards that promote the economic, social and environmental performance of ARTC;
- Implement and maintain an Environmental Management System aligned with ISO14001 to identify, evaluate and manage environmental risk;
- Design, construct, operate and maintain our assets with consideration to the principles and practices of ecologically sustainable development;
- Respect the natural and human environments by avoiding, minimising, mitigating and offsetting impacts as required;
- Be accountable for our environmental impacts and proactively engage with communities, stakeholders and regulators;
- Optimise resource use, reduce waste, and seek reuse and recycling opportunities;
- Cultivate an environmentally conscious and responsible workforce; and
- Monitor and evaluate environmental performance to drive continual improvement.

This Policy will be available to ARTC staff and contractors.

Wayne Johnson
Chief Executive Officer

03 January 2024

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Australian Rail Track Corporation
This document is uncontrolled when printed.

ARTC

Appendix B – ETE-09-01 Structures Inspections

Division / Business Unit:	Corporate Services & Safety
Function:	Engineering (Track & Civil)
Document Type:	Code of Practice – General Appendix

Structures Inspection

ETE-09-01

Applicability

ARTC Network Wide SMS

Publication Requirement

Internal / External

Primary Source

Document Status

Version #	Date Reviewed	Prepared by	Reviewed by	Endorsed	Approved
2.6	19 Aug 19	National Bridges & Structures Engineer	Stakeholders	Manager Standards	General Manager Technical Standards 20/08/2019

Amendment Record

Amendment Version #	Date Reviewed	Clause	Description of Amendment
1.0	01 Jul 06		First issue. Includes minor editorial changes following final approval of Risk & Safety Committee.
2.0	13 Nov 09		Applicability changed to ARTC Network and some minor corrections to Defect Categories and terminologies. BFB inspection regime reverted to existing monthly intervals
2.1	18 Jun 10		Banner added regarding mandatory requirements in other documents and alternative interpretations.
2.2	24 Oct 11	3	Changes to Frequency and Scheduling of Inspections. Minor editorial change to remove CRN applicability box.
2.3	10 Feb 14	Various	Various changes and clarifications throughout. Clause 7.1 updated with addition of intervention criteria table for Fibre Composite Bridges. Addition of

			new clause 7.5 Redundant Structures.
2.4	18 Jun 15	Various	Review of Documents to align with Ellipse 8 and AS7636 Railway Structures. Approved by OSERC 13 Nov 2015
	20 Nov 15		Minor editorial updates and document rebranded
2.5	1 Jul 16	Various	Editorial changes Engineering Inspection for large culverts, large retaining walls and tunnels downgraded to Visual Inspection. Communications Towers added to structures group. Exposure and Condition Rating removed as they are no longer utilised. Material Properties and Capacity Factors removed as they are now in AS 5100 and AS 7636.
2.6	19 Aug 19	Various	Editorial changes Reference to EGP-10-01 Asset Management System and EGW-10-01 Data Classification – Structures (Work Instruction) added. Culvert description added. Inspection scope improved and, inspection work clarified further. Inspection frequencies for In Service and Redundant structures separated. Visual inspection frequency for tunnel increased from 3 to 2 yearly in lieu of the removal of Laser scanning. Special inspection for Sound Barrier gate added. Scheduled special inspection latitude for frequencies extra than 40 days added. General inventory requirements added. Priority and repair codes changed to align with asset management system. Priority Modification and Management of Repair Priorities clarified. Mandatory Defect Data added. Submission timeframes slightly improved. Document Records section added. In Appendix 1 – timber underbridge and culvert interventions amended.

Table of 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 Introduction

This document forms an integral part of Section 9 of the ARTC Track and Civil Code of Practice and details the requirements for the inspection of structures.

All inspections shall also comply with the requirements of EGP-10-01 Asset Management System and EGW-10-01 Data Classification – Structures (Work Instruction).

EGP-10-01 details management of asset and work management system and, EGW-10-01 details capturing of all nameplate attributes, asset configurations, asset description and defect attributes.

Culvert could be defined as arch, pipe or boxed shaped covered opening having walls, invert and roof cast integrally. Culvert unit could also have link slab roof suspended between adjoining box units. The deck width of ballasted culvert is measured between the ballast walls.

All culverts with an opening less than 500mm, typically track cess drainage pipes, are inspected and maintained by Civil Team personnel.

2 Levels of Inspection

2.1 Engineering Inspections

2.1.1 Purpose

An Engineering Inspection (also known as Level 3 inspection by other authorities) is a detailed inspection carried out on a structure by a structures engineer to assess:

- The physical condition and performance.
- The structural integrity.
- Corrective and preventative management requirements.

2.1.2 Scope

The scope of an Engineering Inspection shall include:

1. Review of previous engineering and visual defect reports, load rating reports, engineering investigation reports, specific maintenance management systems and procedures for specific bridges where documents are made available.
2. Review and update the inventory information as necessary.
3. Review, and update where necessary, the condition of defect, mandatory defect data and repair priority of previously identified defects. Recommend any short-term mitigation actions required to ensure safe operation until permanent repair of the defect can be completed.
4. Identify any new defects in all elements and components (including below water level where required) requiring maintenance. Recommend the repair priority and any short-term mitigation actions required to ensure safe operation until permanent repair of the defect can be completed. Upload defects with associated photographs in the asset management system

(AMS). All inspections shall be carried out from proximity that will enable capturing all essential details of defects adequately. For all steel elements and components, the inspection should be carried out from no more than at arm's length.

5. Capture a photographic record of the structure if required.
6. Undertake measurements and non-destructive testing as required to determine the extent of deterioration.
7. Site measurements of structural elements and components either to confirm drawing dimensions or to ensure adequate details are available for load rating purposes.
8. Identify rate of deterioration likely to occur in any elements prior to the next Engineering Inspection to ensure it is adequately accounted for in the load rating.
9. Prior to undertaking load rating of bridges, all matters listed in AS 5100 Part 7 – Clause 5: "Matters for resolution before design commences" must be resolved unless otherwise already clarified in the ARTC structures standards.
10. Provide a comprehensive load carrying capacity of the structure, including identifying under-strength elements. Load rating must be provided for all elements/components of bridge superstructure and only steel elements/components of bridge trestles/piers. The elements/components to be analysed, but not limited to, must include main girders/beams, cross girders, stringers, truss elements, deck slabs, bracing and all element connections and, any splices in them.
11. Where previous load rating is available then the rating must be reviewed and updated as required to account for any further and/or foreseen deterioration in that element and, also to align with current standards.
12. Provide/review a fatigue assessment of steel elements.
13. Identify elements which warrant further investigation.
14. Nominate those defects which require specific monitoring as part of a Special Inspection.
15. Engineering report must encompass all critical findings e.g. defects, load rating results, temporary speed restrictions for trains or load limit for road bridges, any special inspections and structures/elements that warrant special investigation. All calculations, software modelling and any other relevant materials associated with inspection and analysis must accompany the report.
16. Liaise with the structures personnel as deemed necessary.

2.2 Visual Inspections

2.2.1 Purpose

A Visual Inspection (also known as Level 2 inspection by other authorities) is carried out on a structure by a structures inspector to assess:

- The physical condition of structures.
- The structure is safe for operational purposes.

2.2.2 Scope

The scope of a Visual Inspection shall include:

1. Review of previous defect report.
2. Review and update the inventory information.
3. Review, and update where necessary, the condition of defect, mandatory defect data and repair priority of previously identified defects. Recommend any short-term mitigation actions required to ensure safe operation until permanent repair of the defect can be completed. Identify any new defects in all elements requiring maintenance, including below ground for timber piles where deemed necessary. Recommend the repair priority and any short-term mitigation actions required to ensure safe operation until permanent repair of the defect can be completed. Upload defects with associated photographs in the AMS as required.
4. Capture a photographic record of the structure if required.
5. Identify defects in elements which warrant further investigation.
6. Two types of communication towers that must be inspected by structures inspector are steel lattice or truss towers and concrete or timber mono poles. The inspection of communication towers also entails the following:
   a. Necessity to isolate microwave dishes, which emit radioactive waves, when accessing top of a tower. Where required, structures representative to arrange isolation of microwave dishes through ARTC Property Manager.
   b. Drone must not be flown within 10m of any microwave dish.
   c. Provide coordinates and adequate description of location of communication towers with reference to nearest track kilometrage.
   d. Each leg of lattice tower must be identified in clockwise manner by gluing a numbered 50 x 50mm plaque on exposed face or replace damaged plaque as required. Elements must be identified between the legs by bays, starting at Bay 1 at ground level between 1st and 2nd horizontal bracing from footing. All other conventions to be as per Inventory Standard: ETG-09-01.
7. Liaise with the structures personnel as deemed necessary.

2.3 Special Inspection

2.3.1 Purpose

A Special Inspection is undertaken outside of the prescribed inspection schedule of engineering and visual inspections. The reasons for special inspections are varied and include, but not limited to:

- Monitor specific defects.
- Reassessment of defects.
- Inspect for anticipated hazards following an event such as heavy rain, an earthquake or fire.
- Following an unforeseen event, such as impact from a road vehicle or derailed rolling stock.

The inspection is usually carried out by a structures inspector, or suitable person as nominated by the structures representative.

2.3.2 Scope

The scope of the Special Inspection shall be developed by the structures representative and documented prior to commencing the Special Inspection. The scope may include, but not limited to:

1. Review of any previous inspection and testing reports.
2. Review of the condition of previously identified defects or structural deficiencies.
3. Identify any additional maintenance or repair treatments.
4. Record a photographic evidence of any defective element.
5. Identify structures and/or elements which warrant further investigation.

2.4 Track Patrol

A Track Patrol is carried out to check the general serviceability of a structure for rail operations. Track Patrols assess such matters as the track geometry over underbridges, any general abnormality in structures and any build-up of debris around the structures.

All abnormalities shall be reported to the structures representative for further assessment.

3 Technical Maintenance Plan

All nominated inspections shall be carried out within the required timeframes (latitudes) nominated in Section 4 Table 2 below.

An Engineering Inspection may nominate the inspection frequency for engineering, visual or special inspections for that structure, but recommendations shall not be greater than the mandated frequencies. An engineering waiver must be sought for any alteration in mandated inspection frequencies and latitudes.

Table 1 below documents the mandated minimum inspection frequency for each type of structure on operational lines as well as for redundant structures:

Asset Class	**Structure Type**	**Span Material** **(includes Fibre Composite/** **Timber Deck/transom)**	**Engineering Inspection Frequency (Years)** **(Maximum period between inspections)**	**Visual Inspection Frequency (Years)** **(Maximum period between inspections)**
In Service Structures				
Engineering Inspections and Visual Inspection				
Bridge	Underbridge	Steel aged up to 40 years	12	2
		All other Steel (includes wrought iron)	6	2

Asset Class	Structure Type	Span Material (includes Fibre Composite/ Timber Deck/transom)	Engineering Inspection Frequency (Years) (Maximum period between inspections)	Visual Inspection Frequency (Years) (Maximum period between inspections)
In Service Structures				
		Concrete aged up to 40 years	12	2
		All other Concrete (includes Masonry)	6	2
		Timber	N/A (Capacity of timber elements is now based on pre-determined pipe sizes for all Grade F22 standard components)	1
	Overbridge	Steel & Concrete aged up to 40 years	12	2
		Timber	N/A (refer underbridges)	1
		All others	6	2
	Footbridge	Steel & Concrete aged up to 40 years	12	3
		All others	6	3
Culvert	Culverts	All	N/A	2
Tunnel	Tunnel	All	N/A	3
Miscellaneous Structures	Retaining walls ≥ 2m high and Comms Towers	All	N/A	2
	All Other Structures	All	N/A	4
Redundant Structures				
Redundant Structures	All	All	N/A	2
Special Inspection				
Bridge	Underbridge	Broad Flange Beam (BFB) spans over roadways	N/A	Monthly

Asset Class	Structure Type	Span Material (includes Fibre Composite/ Timber Deck/transom)	Engineering Inspection Frequency (Years) (Maximum period between inspections)	Visual Inspection Frequency (Years) (Maximum period between inspections)
In Service Structures				
Bridge & Culvert	All	Temporary Supports	N/A	3 monthly

Table 1 – Inspection Frequencies

Engineering Inspections take precedence over Visual Inspection. Therefore, a Visual Inspection is not required to be undertaken in conjunction with an Engineering Inspection.

4 Inspection Latitude

All inspections shall be completed within the latitude shown in the Table 2 below:

Engineering Inspection	
All	10% of days between any scheduled Engineering Inspection and the next Visual Inspection.
Visual Inspection	
All	10% of days between any scheduled Engineering Inspection and the next Visual or between 2 Visuals or between Visual and next Engineering Inspection.
Special Inspection	
Unscheduled	As soon as practicable following trigger event.
Scheduled	7 days for frequencies < 40 days, 14 days for 40 to 180 days and 10% as for Visual Inspection above for > 180 days.

Table 2 – Inspection Latitude

The Structures Representative shall seek an engineering waiver where inspection cannot be undertaken within the specified latitude for a scheduled inspection.

5 Inspection Requirements

All identified defects shall be recorded in AMS, in accordance with the data requirements specified below and in EGW-10-01.

5.1 Defect Category

During an inspection, each defect is required to be allocated a Defect Category and the actions undertaken as nominated in the Table 3 below:

Defect Category	Inspector Response	Structures Representative Response
A	Immediately stop trains in the case of an underbridge, culvert or tunnel; or close if an overbridge or footbridge. Advise Structures representative immediately for further assessment	As soon as Practicable
B	Immediately impose a 20km/h speed restriction in the case of an underbridge, culvert or tunnel. For footbridges and overbridge, the area is to be barricaded. Advise Structures Representative immediately for further assessment.	Assess within 24 hours of notification.
C	Report to Structures representative within 2 working days.	Assess within 2 working days of notification.
D	Report to Structures representative within 5 working days.	Assess within 7 days of notification.
MONITOR		
M	Record in inspection report, and submit within the timeframes described in Table 5.	Assess within 4 weeks of submission when requested by the Inspector.

Table 3 – Defect Category

The engineer / structures inspector shall use engineering judgement and/or experience when determining the Defect Category for each individual defect. ***Section 7 – Appendix 1*** *provides a general guide to defect limits and associated actions to be taken by the inspector. The defect categories against defect types and sizes for individual elements are typically based on defects being located at the most highly stressed areas of the elements.*

5.1.1 Category A to D Defects

Each defect, i.e. a deficiency with a Category of A to D, shall be allocated the following by the inspector:

- Element.
- Element Location.
- Defect type and location.
- Repair Priority.
- Recommendation.

5.1.1.1 Element

The structural element on which the defect has been found shall be identified.

5.1.1.2 Element Location

The location of the element that has the defect shall be defined as follows:

- For underbridges, and any other structure with spans parallel to the track, all descriptions are based on observations from the start of a structure, which is the end with the lowest kilometrage using the following abbreviations.
  - A – Abutment.
  - S – Span.
  - P – Pier.

  All elements shall be numbered from the Downside (left hand side when facing in direction of increasing kilometrage) progressing to the Upside (right hand side).
- For overbridges, culverts and any other structure with spans perpendicular to the track the numbering system shall be the same as for an underbridge with the start of a structure located on the Down Side of the track.

  All elements shall be numbered from the highest kilometrage side (left hand side when facing the Upside rail) progressing to the lowest kilometrage side (right hand side).

5.1.1.3 Defect Type and Location

A standard defect type and the location of the defect within the element shall be nominated.

5.1.2 Repair Priority

For each defect identified or reassessed during the inspection the inspector shall recommend a repair priority code as specified in Table 4 below. The repair priority shall take into account, but not be limited to, the following factors:

- the criticality of the structure and/or element under consideration.
- The severity of the defect.
- the urgency and nature of the work that will be performed.

Repair Priority Code	Rectification Period
E - Emergency	Rectification work to commence within 24 hours.
P1 – priority 1	Within 7 days
P2 – priority 2	Within 28 days
P3 – Priority 3	Up to 6 months
P4 – Priority 4	Up to 1 year
P5 – Priority 5	Up to 2 years
PN - no action required	Monitor

Table 4 – Repair Priority Codes

5.1.2.1 Recommendation

Depending on the nature of the defect, the inspector may recommend a short term action to be implemented such as:

- Impose a temporary speed limit on the structure.

- A special inspection of the defect, until the defect is rectified and/or.
- Temporary work, such as propping, until the defect is rectified.

The appropriate inspection interval should be set for monitoring the short-term actions (if different from the normal inspection cycle for the structure or element of the structure).

Recommended short-term actions shall be recorded in the defect comments by the inspector. The structures representative shall be responsible for reviewing the defect and actioning any short-term actions as required.

5.1.3 Category M - Monitor

Defects allocated as Defect Category M need to be recorded and monitored for further deterioration.

The defect shall be inspected at each inspection to assess if any rectification work is required.

5.1.3.1 Priority Modification

The structures representative has authorisation to change the repair priority assigned to the defect by the inspector or his own assessments. Sufficient justification and controls to support any such changes shall be documented appropriately.

The structures representative shall not modify the defect category assigned by an inspecting engineer without his prior written approval or approval of National Bridges & Structures Engineer (NBSE).

5.1.3.2 Management of Repair Priorities

Where the structures representative has determined that repair work on a critical defect (A-D) will not be performed within the allocated rectification period in Table 4 above then the criticality and repair priority of that defect must be re-assessed.

5.1.4 Mandatory Defect Data

The structures management system shall record the data and documentation required by the structures representative to assess and manage the risk of each defect to ensure the operational safety of the network.

To ensure sufficient data is recorded by the inspector, completion of the following attributes in the system is mandatory for submission of a defect:

- Equipment Reference (asset's unique ID number).
- Component identification and location.
- Defect type, size and category.
- Repair Priority.
- Date defect found.
- Recommendations for any repairs with any speed restrictions, inspection frequency changes or any other mitigation actions.
- Photos of Category A to D defects and photos of M defects as required.

5.2 Load Rating

As part of an Engineering Inspection, the structures engineer shall undertake a load rating for the bridges for the “As-New” and “As-Is” conditions and fatigue assessment in accordance with the procedures documented in the ARTC Code of Practice – Section 9 and Structures Inspection Procedure ETE-09-02.

Load rating shall be carried out for all elements of superstructure of every bridge and only for bridge substructures constructed of steel unless otherwise specified in the scope of work.

The elements to be analysed must include, but not limited to, the following:

- Main girders/beams.
- Cross girders.
- Stringers.
- All truss posts, diagonals, portals, etc.
- Bracing.
- Deck slabs.
- Connections of the above components.
- Splices in the above components.
- Critical gusset plates, stiffeners or any other elements likely to be overstressed under traffic.

Prior to undertaking load rating of bridges, all matters listed in AS 5100.
Part 7 - Clause 5: “Matters for resolution before design commences” must be resolved unless otherwise already clarified in the current ARTC structures standards.

6 Structures Inspection Submission Timeframes

All submissions of inspection and/or load rating reports to structures representative shall be completed within the timeframes shown in Table 5 below following the on-site inspection of individual structures:

Submission	**Timeframes**
Engineering Inspection	
Provide list of all defects identified, including Category M defects	2 weeks after inspection of individual structure
Submission of draft engineering report	10 weeks after inspection of all nominated structures
Submission of final engineering report	14 weeks after inspection of all nominated structures unless otherwise extended by structures representative
Visual and Special Inspection	
Provide list of all defects identified, including Category M defects	2 weeks after inspection of individual structure
Submission of final Report by external inspectors, if required	4 weeks after inspection of all nominated structures

Table 5: Structures Inspection Submission Timeframes

7 Document Records

Where communication is verbal or via e-mail with the structures representative, to meet the required timeframes in Table 5, the structures representative shall subsequently document all such communications in the AMS within a reasonable timeframe.

Structures representative to ensure all engineering and visual reports, load rating, defects, calculations, photos and any associated documents are uploaded against respective structure in the AMS within a reasonable timeframe.

8 Appendix 1 – Intervention Criteria Guidelines

This appendix provides a general guide to defect limits and associated actions to be taken by the inspector. The inspector shall use engineering judgement and experience when determining the Defect Category for each individual defect.

In general, the limits and defect sizes have been set on the basis of them being located at the most highly stressed area of the elements.

8.1 Asset Class - Bridge

<table>
<tr><th>Description</th><th>Defect Type</th><th>Defect Size</th><th>Defect Category</th></tr>
<tr><td colspan="4">A. Bridges – Steel (includes Wrought Iron)</td></tr>
<tr><td colspan="4">For steel, including wrought iron and broad flange beam bridges, items in the table are defined as follows:
Main structural elements are main girders, cross girders, stringers, truss chords, diagonals and verticals, columns, trestle legs and headstocks.
Primary structural components are typically a flange or web and may consist of multiple plates and/or angles.
Bearing zone components are bearing plates, bearing stiffeners and bearings.
Secondary structural components are bracing, gusset plates, web stiffeners, tie bars, etc.
For concrete / masonry substructures, refer “Bridges – Concrete”.</td></tr>
<tr><td rowspan="3">Main Structural Element (excluding Broad Flange Beams)</td><td rowspan="3">Crack in a primary structural component</td><td>> 80mm long</td><td>A</td></tr>
<tr><td>10 – 80mm long</td><td>B</td></tr>
<tr><td>< 10mm long</td><td>C</td></tr>
<tr><td rowspan="2">Broad Flange Beams</td><td rowspan="2">Crack in a primary structural component</td><td>> 25mm long</td><td>A</td></tr>
<tr><td>≤ 25mm long</td><td>B</td></tr>
<tr><td rowspan="4">Main Structural Element</td><td rowspan="3">Corrosion loss in sectional area of any primary structural component</td><td>> 50%</td><td>B</td></tr>
<tr><td>20 - 50%</td><td>D</td></tr>
<tr><td>< 20%</td><td>M</td></tr>
<tr><td>Missing</td><td>Any</td><td>A</td></tr>
<tr><td rowspan="5">Bearing Zone</td><td rowspan="3">Crack in a bearing zone component</td><td>> 250mm</td><td>C</td></tr>
<tr><td>50 – 250mm</td><td>D</td></tr>
<tr><td>< 50mm</td><td>M</td></tr>
<tr><td rowspan="2">Corrosion loss in sectional area of any individual component</td><td>> 50%</td><td>D</td></tr>
<tr><td>≤ 50%</td><td>M</td></tr>
</table>

Description	Defect Type	Defect Size	Defect Category
	Missing	Any	A
	Bearings locked in position	No movement	M
Secondary Structural Components	Crack	Any	D
	Corrosion loss in sectional area of any individual component	> 50%	D
		≤ 50%	M
	Missing	Any	B
Cast iron caissons of lattice girder truss bridges	Any crack	≥ 200m long	D
		< 200mm long	M

Impact Damage			
Main Structural Element (excluding Trestles)	Out of alignment (causing misalignment to track)	> 50mm	A
		30 – 50mm	B
		< 30mm	D
	Major structural damage	Structure likely to be unable to carry load	A
	Girder flange outstand deformed vertically	> 60% of outstand	B
		30 – 60% of outstand	C
		< 30% of outstand	M
	Flange deformed horizontally within bracing bay	> 60mm	B
		30 – 60mm	C
		< 30mm	M
	Element deformed horizontally	> 20mm between bracing bays	C
		≤ 20mm between bracing bays	M
	Notched	> 30mm	B
		≤ 30mm	C
Trestle	Column deformed in any direction	> 100mm	A
		50 – 100mm	B
		25 – 49mm	D
		< 25mm	M
Fasteners			
Main Elements - Splice/End Connections	Missing	> 25%	A
		5 - 25%	D
		< 5%	M
	Loose/Corroded Heads	> 25%	B
		5 - 25%	D
		< 5%	M
Main Elements - Components Connection	Missing (% in a group of any group of 10 continuous rivets or bolts)	> 40%	A
		10 - 40%	D
		< 10%	M
	Loose/Corroded Heads (% in a group of any group of 10 continuous rivets or bolts)	> 40%	B
		10 < 40%	D
		< 10%	M

Main Elements - Others	Missing/Loose/Corroded Heads	> 40%	B
		10% < 40%	D
		< 10%	M
Bearings	Missing bedding grout and/or HD bolts	> 30% per bearing	D
		≤ 30% per bearing	M
Secondary Elements – Connections to Main Members/ Splices, etc	Missing bolts/rivets	> 25%	B
		≤ 25%	M
	Loose/Corroded Heads	> 25%	D
		≤ 25%	M
Stitching rivets	Slackness due to excessive wear & tear	> 2mm play	D
		≤ 2mm play	M
	Corrosion in head	> 75%	D
		≤ 75%	M

B. Bridges – Timber					
Girder/Solid Headstock	Pipe/trough in any girder or solid headstock	UNDERBRIDGES (To maintain current TOC following actions must be implemented)		OTHER BRIDGES	
		Defect Size	Action	Defect Size	Category
		> 225mm	Replace immediately		
		201 - 225mm	Replace within 2yrs	> 250mm	A
		176 - 200mm	Replace within 3yrs	226-250mm	B
				200-225mm	C
		150 - 175mm	Replace within 4yrs	151-199mm	D
		< 150mm	Replace within 5yrs	50*-150mm	M
	Crushing	Any	Replace immediately	Any	B
	Troughing	> 150mm	Replace immediately	As for girder above	
		100 - 150mm	Replace in 1yr		
Corbel	Pipe/trough	Crushing	Replace immediately	Crushing	Replace immediately
		> 125mm	Replace within 1yr	>125	Replace within 1yr
Girder	Mid span deflection	Exceeds values tabulated below. (Span is the distance between centre line of supports)		B	

		Span (m)	< 4	4 - 5	5 – 7	> 7
		Deflection (mm)	8	10	15	20
Waling Headstock	Rotted out				B	
Body Bolts	Loose in a connection		> 25%		D	
			< 25%		M	
Corbel bolts	Loose in a connection		> 25%		D	
			< 25%		M	
Trestle Bolts	Loose in a connection		> 25%		D	
			< 25%		M	

Piles		UNDERBRIDGES (To maintain current TOC the following actions must be implemented)		OTHER BRIDGES	
		Defect Size	Action	Defect Size	Defect Category
	Section loss in > 50% of piles in any trestle or abutment	N/A		>75%	A
	Section loss in > 25% of piles in any trestle or abutment	N/A		> 75%	B
	Section loss in any pile	N/A		> 75%	C
		50 - 75%	Replace within 1 year	50-75%	D
		40* - 49%	Monitor	40*-49%	M
	Pumping	Any	Stump immediately	Any	D
Transoms	Rotted Out	3 Adjacent		B	
		2 Adjacent		C	
		One isolated		M	

Member	**Defect Type**	**Defect Size**	**Defect Category**
Transom Bolts	Missing	3 in adjacent transoms	B
		2 in adjacent transoms	C
		Both bolts in a transom	M

Member	Defect Type	Defect Size	Defect Category
Decking	Split or rotted out	> 30%	C
		20%* - 30%	M
BridgeWood decking	Surface checking	> 8mm	D
		≤ 8mm	M
	Crushing	Any	B
	Delamination (bubbles)	Any	C
Any Timber Section	Termite infestation	Any evidence of damage	D
C. Bridges – Concrete			
Superstructure structural elements include beams and decks. ***Substructure elements*** include piers, abutments, wingwalls, pile caps, piles and footings.			
Superstructure structural elements	Impact damage	Structure likely to be unable to carry load	A
	Differential deflection between units under live load	Visible	C
	Cracking	> 3mm	C
		1*- 3mm	M
	Spalled concrete with reinforcement exposed and corroding	> 30% cross section loss to exposed reinforcement	D
		< 30% cross section loss to exposed reinforcement	M
	Spalled concrete with prestressed tendon exposed	Any	C
Substructure structural elements	Cracking	More than 10mm wide	C
		3* - 10mm wide	M
	Spalled concrete with reinforcement exposed and corroding	> 40% cross section loss to exposed reinforcement	D
		< 40% cross section loss to exposed reinforcement	M
	Vertical/Lateral dislocation	> 50mm	C
		10* - 50mm	M
Deck – joint between slabs	Fouling with ballast/debris	Debris likely to cause deterioration of joint	D
Bearings	Fouling with ballast/debris or any other degradation	Debris likely to cause deterioration of bearing.	D
Bearing Pads	Missing bearing area	> 30%	D
		≤ 30%	M

Member	Defect Type	Defect Size	Defect Category
D. Bridges – Masonry and Concrete Arch			
For piers, abutments, wingwalls and reinforcement see "Bridges – Concrete".			
Arch Ring	Brickwork dislocation	> 50% in any square metre missing or unbonded	B
		20 - 50% in any square metre missing or unbonded	D
		10* - 19% in any square metre missing or unbonded	M
	Lateral cracking	> 3mm wide, through & across full arch width. Visible differential movement under live load	B
		2 - 3mm & not through & across	D
		< 2mm & not through & across	M
	Longitudinal cracking	> 6mm wide & > 2m long along arch	D
		3 - 6mm	M
	Distortion of profile	> 50mm – detectable by undulations in top line of spandrel walls/parapets or track	D
		20* - 50mm	M
Other than Arch	Brickwork dislocation	> 50% in any square metre missing or unbonded	D
		20 - 50% in any square metre missing or unbonded	M
Spandrel Wall	Displacement	Lateral > 30mm or > 20mm lateral + 20mm tilt	D
		15* - 30mm	M
Invert floor	Heaving	> 100*mm	M
Any other	Brickwork dislocation	Nil	D

E. Bridges – Fibre Composite			
Beams, Decks and Transoms	Coating Chipping (excludes decking)	> 25mm in diameter	D
		≤ 25mm in diameter	M
		> 5mm deep	D
		≤ 5mm deep	M
	Cracking	Any	C
	Crushing at support	Any	C
	Fire / Ultra Violet Radiation damage	Any	C
	Accidental / intentional damage	Any	C
	Excessive wear	Any	C

Member	Defect Type	Defect Size	Defect Category
F. Bridges – Miscellaneous Items			
Waterway Area			
Bridge Waterway	Scouring under Pier/Abutment	Safety Critical Issue	B
		> 10% loss in bearing area	C
		≤ 10% loss in bearing area or non-safety critical issue	M
	Blockage due to debris build-up	> 10% loss in waterway area	D
		≤ 10% loss in waterway area	M
Walkways, Refuges and Decking			
Handrails	Missing/Broken/ Loose/Decayed	Safety Critical Items	B
		Non-safety critical items	M
Deck	Walkway/refuge planks broken, decayed, missing or displaced	Causing safety concerns	B
		Not causing safety concerns	M
Deck-Nails, Screws	Protrusion above deck	> 10mm	C
		≤ 10mm	M
Clearance Signs	Missing	Any	D
	Illegible	Any	D
Footbridges			
Stairway	Broken front edges, protruding reinforcement or excessive slope	Safety Critical Items	B
		Non-safety critical items	M
Road/Pedestrian Safety Aspects			
Safety Screens/Barrier	Missing/Broken	Safety Critical Items	B
		Non-safety critical items	M
Road & Pedestrian Traffic Barriers	Missing/Broken/ Loose/Decayed	Safety Critical Items	B
		Non-safety critical items	M
Clearance Signs	Missing	Any	D
	Illegible	Any	D
Ballast	Falling	Any	B

8.3 Asset Class – Culvert

Member	Defect Type	Defect Size	Defect Category
A. Culverts			
For undefined elements and components refer to "Asset Class – Bridges".			
Culvert	Collapse	Subsidence of formation/ballast that undermines track safety	A
		Subsidence of formation/ballast that does not undermine track safety	M
	Blocked – preventing flood flow	> 20%	D
		≤ 20%	M
	Cracked Barrel	> 50mm wide	B
		10mm – 50mm	D
		< 10mm	M
	Joint/Broken Separated	Any defect within 2m from nearest rail or between toes of high embankment or within influence line of traffic loading.	D
	Deformation	> 50*mm	D
Expanda / Rotaloc PVC / Berolina or HDPE Plastic liners for CSP	Abrasion in sectional area	> 25%	C
		10% - 25%	D
		< 10%	M
	Fire / Ultra Violet Radiation damage	any	C
Headwall/ Wingwall	Cracked	> 50mm wide	B
		10 – 50mm wide	D
		< 10mm	M
Apron	Scouring under apron	> 150mm deep	D
		≤150mm deep	M
Floor	Heaving	> 150mm	D
		≤150mm	M

*Note** *Where the defect size is less than that shown with asterix (*) for intervention for Defect Category, there is no need to record the defect.*

8.4 Asset Class – Tunnels

Intervention criteria guideline shall be in accordance with the "Asset Class – Bridges" for the appropriate element type and material.

8.5 Asset Class – Miscellaneous Structures

Intervention criteria guideline shall be in accordance with the “Asset Class – Bridges” for the appropriate element type and material.

8.6 Redundant Structures

Intervention criteria guideline shall be in accordance with the “Asset Class – Bridges” for the appropriate element type and material for undefined elements.

Description	Defect Type	Defect Size	Defect Category
A. Redundant Structures			
Primary redundant structures are typically bridges, tunnels, water structures, platforms and loading banks.			
Structure	Integrity	Refer to ‘Asset Class – Bridges’.	
Vehicle and/or pedestrian access barricade	Damaged/Missing	Safety critical items	B
		Non-safety critical items	M
Fence	Damaged/Missing	Safety critical items	B
		Non-safety critical items	M
Signage	Illegible/Damaged/Missing	Safety critical items	B
		Non-safety critical items	M
Any other issues relating to safety of traffic operation or people on or in vicinity of redundant structures	Other Safety issues	Safety critical items	B
		Non-safety critical items	M

Appendix C – ETE-09-02 Structures Inspections Procedure

Division / Business Unit:	Corporate Services & Safety
Function:	Engineering (Track & Civil)
Document Type:	Procedure

Structures Inspection Procedure

ETE-09-02

Applicability

ARTC Network Wide SMS

Publication Requirement

Internal / External

Primary Source

Procedure Document Status

Version #	Date Reviewed	Prepared by	Reviewed by	Endorsed	Approved
1.7	19 Aug 19	National Bridges & Structures Engineer	Stakeholders	Manager Standards	General Manager Technical Standards 20/08/2019

Amendment Record

Amendment Version #	Date Reviewed	Clause	Description of Amendment
1.0	08 Dec 09		Originally published as ETN-09-01 Structures Inspection Manual version 1.0 Working Draft. Reissued as a Procedure.
1.1	18 Jun 10		Banner added regarding mandatory requirements in other documents and alternative interpretations.
1.2	31 Oct 11	Appendices	Updates to Appendix B, E, F & P. Minor editorial change to remove CRN applicability box.
1.3	12 Nov 12	Appendix B	Updated with pre-approved amendment (Nov 2011) to remove CRN related lines & data following hand over of CRN Network effective 15 January 2012.
1.4	10 Feb 14	Various	Updated inspection process for Bridge Wood panels, Fibre Composite products, ‘Expanda’ & ‘Rotaloc’ pvc pipes / liners and Redundant Structures.

1.5	18 Jun 15	Various	Review of Documents to align with Ellipse 8 and AS7636 Railway Structures Approved by OSERC 13 Nov 2015
	20 Nov 15		Minor editorial updates and document rebranded
1.6	28 Jul 16	Various	Minor editorial changes Exposure/Condition Rating of Elements deleted to align with ETE-09-01. References to BMS and BMS related processed deleted to align with EGP-10-01 and EGW-10-01
1.7	19 Aug 19	Various	Minor editorial changes and addition of references Added back structures management system process Added ‘at arm’s length’ visual inspection Underground inspection of timber bridges transferred from Engineering Inspection to Visual Inspection Enhanced ‘Assessment of Previously Reported Defects’, ‘Data Recording’ and ‘Repair Priority’ sections ‘T44 design road vehicle’ replaced with ‘nominated road traffic’ and added new load limit sign for road bridges. ‘Berolina Liner’ added to Appendix E Sonar and Naked Eye methods of underwater inspection added to Appendix I Review of documents to align with Appendices A to L

Table of 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 Introduction

1.1 Purpose

This document forms an integral part of Structures Inspection Standard ETE–09–01 and describes the system and processes for inspecting structures on the Australian Rail Track Corporation's (ARTC) network.

1.2 Scope

Section 9 of the ARTC Code of Practice identifies the minimum requirements for the inspection of structures.

This Structures Inspection Procedure applies to all structures under ARTC's responsibility and provides guidance for the processes for undertaking the following inspections:

- Engineering Inspections.
- Visual Inspections.
- Special Inspections.
- Track Patrol Inspections.

The systematic inspection of structures forms the basis of good asset management practice. The outcomes from the inspection process are used to:

i. Provide data on the current condition, performance and environment of a structure including the severity and extent of defects. The data enables those responsible for managing structures on ARTC's network to assess if a structure is currently safe for use and fit for purpose, and provides sufficient data for actions to be planned where structures do not meet these requirements.

ii. Provide analyses, assessments and processes where there is a change in condition, cause of deterioration, rate of deterioration, maintenance requirements, effectiveness of maintenance and structural capacity.

iii. Provide data for asset management planning in order to deliver an acceptable level of service.

iv. Compile, verify and maintain inventory data.

1.3 Procedure Owner

The General Manager Technical Standards is the Procedure Owner and is the initial point of contact for all queries relating to this Procedure.

1.4 Responsibilities

The Business Unit is responsible for implementing this procedure.

1.5 Reference Documents

The following documents are supported by this Procedure:

- ARTC Track & Civil Code of Practice Section 9 Structures.
- ETG-09-01 Structures Inventory.
- ETE-09-01 Structures Inspection.
- EGP-10-01 Asset Management System.
- EGW-10-01 Data Classification – Structures (Work Instruction).

2 Structures Management System

For effectiveness of structure management, it is important that data associated with an asset is as complete as possible, of high quality and consistent with other data collected on the network.

To ensure the *completeness of the data*, the Asset Management System (AMS) provides a means for recording, storing and accessing critical data for all structures on the network. A flowchart of the structures management processes is provided in Figure 1 below.

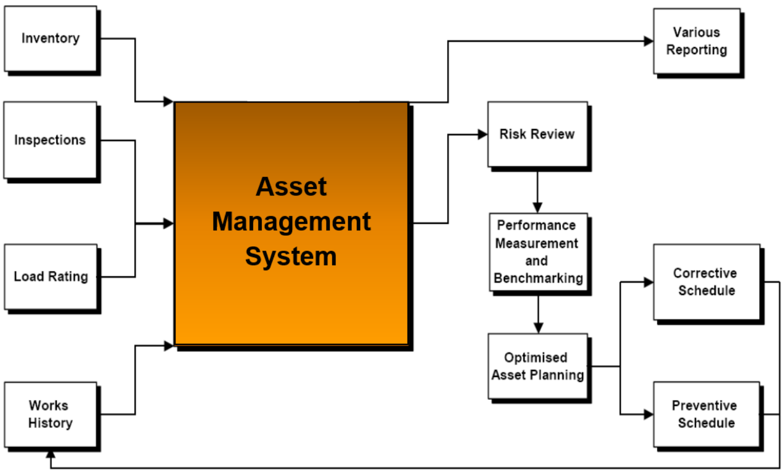


Figure 1 – Structures Management Processes

3 Engineering Inspection

The purpose and scope of an Engineering Inspection is provided in the Standard ETE-09-01 Structures Inspection.

Further general information for specific types of structures and load rating of bridges is provided in Appendices A – L of this procedure.

Appendices A to L, as listed below:

Appendix A	Inspection of Steel Structural Elements.
Appendix B	Inspection of Timber Structural Elements.
Appendix C	Inspection of Concrete Structural Elements.
Appendix D	Inspection of Fibre Composite Structural Elements.
Appendix E	Inspection of Structural Liners for Pipes.

Appendix F	Inspection of Masonry Structural Elements.
Appendix G	Inspection of Tunnels.
Appendix H	Inspection of Substructure Elements.
Appendix I	Inspection of Underwater Structural Elements.
Appendix J	Inspection of Miscellaneous Structures.
Appendix K	Inspection of Redundant Structures.
Appendix L	Load Rating of Bridges.

These appendices provide general guidance only and it is expected the structures engineer will use appropriate engineering judgement and experience when recommending actions from an Engineering Inspection.

3.1 Inspection Procedure

The process of undertaking an Engineering Inspection is as follows:

3.1.1 Pre-Inspection Investigation

Prior to undertaking an Engineering Inspection, the structures engineer should review the available relevant historical information for the structure, including:

i. Available inspection and engineering investigation reports.

ii. Maintenance history.

iii. Outstanding defects and proposed Major Periodic Maintenance.

iv. Defects identified for future observation from previous inspections.

v. Structural issues that have been recorded since the last inspection.

vi. “As-New” and “As-Is” load rating and load effects from current traffic from previous inspections and/or investigations.

vii. Nominated train operating configurations.

viii. Train loading history and previous fatigue assessments.

ix. Underwater Inspections (including assessing the need to undertake a further underwater inspection as part of this Engineering Inspection).

3.1.2 “As-New” Load Rating

Where a structure does not have an “As-New” load rating in terms of LA design rail traffic loading or nominated road vehicle loading in accordance with AS 5100.7 and construction drawings are available the rating should be calculated prior to undertaking the on-site inspection, so that there is a better understanding of the structurally critical elements. The drawing dimensions should later be confirmed by site measurements and rating results corrected as necessary.

The load assessment should identify:

- The capacity of each primary and secondary element.
- All splices and connections as deemed essential.

- The equivalent train load effects for each primary and secondary element and all concerned components for each nominated train consist.
- The equivalent road vehicle load effects for each primary and secondary element and all concerned components for each nominated road traffic.

The load rating should be determined in accordance with the "Load Rating of Bridges", which is included in Appendix L.

3.1.3 Fatigue Assessment

Prior to undertaking the on-site inspection, the fatigue assessment should be updated to include the train loading history for the period since the last fatigue assessment, so there is a better understanding of the critical elements that have reached or are approaching the end of their theoretical remaining fatigue lives.

Fatigue assessment for road bridges and culverts are not required unless otherwise included in the scope of work.

3.1.4 Preparation for Inspection

In preparation for the inspection, the structures engineer should liaise with the local structures representative and/or the structures inspector to ensure the appropriate arrangements are in place to undertake the inspection, including:

- Track protection.
- Inspection access arrangements.
- Safety equipment.
- Arrangements with relevant authorities/stakeholders.

The structures inspector must prepare a Safety Plan and submit to ARTC's nominated representative for approval.

3.1.5 Detailed Inspection

The detailed inspection should cover all elements and components of the structure, including below water level. The individual elements of the bridge should be visually examined either with the naked eye at arm's length or through the use of appropriate equipment such as mirrors, telescopic equipment or video recording in order to identify structural defects. All steel elements and components such as splices, connections, bearings, etc. of underbridge must be inspected from no more than at arm's length.

Review of Equipment Register

The structures engineer is required to review the existing equipment register information currently held in AMS for the structure and identify:

- Additional information to make the inventory data complete.
- Modifications to correct any errors or changes arising from maintenance work, to the existing information.

Photographic Record of Structure

For each structure, the following photographic records that form part of the equipment register information are required:

1. A view along the deck system.
2. One or two views (depending on the size of the structure) showing the elevation of the structure.
3. One or two representative photographs of more complex structures such as trusses.

The structures engineer should review the existing photographs in AMS for that structure and take additional photographs if currently inadequate or there has been a substantive change.

Following the inspection, the structures engineer should advise the structures representative of any required changes to the equipment register. The structures representative should review the proposed changes and arrange for the changes to be made in AMS.

Assessment of Previously Reported Defects

At the start of the inspection procedure, the structures engineer should review the status of all existing defects. Depending on the rate of deterioration of the defect the structures engineer should record one of the following:

- No Change - The original defect category and repair priority (where appropriate) allocated to the defect does not change.
- Re-Assess - The defect is reassessed, and a new defect category and repair priority recorded.
- Remove - The defect is not considered to be an issue any longer and is therefore not required to have any further monitoring at the next inspection.
- Completed - If a defect has been repaired but is still identified as an outstanding defect, the structures representative should be notified.
- Outstanding - If a defect has been reported as repaired but is still outstanding, the structures representative should be notified.

New Defect Identification

New defects identified by the structures engineer during an inspection shall have a defect record created in AMS. The defect record shall be created in accordance with this section of the CoP, and as per the data requirements specified in EGW-10-01.

Establishing the cause of an observed defect is crucial to determining the severity of a defect. If the structures engineer is unable to determine the mechanism responsible for the cause of a defect, further input should be sought from a specialist engineer. If the cause of a defect cannot be identified and the level of risk cannot be determined, further investigation should be recommended.

Data Recording

All defect information obtained during the Engineering Inspection must be uploaded to the AMS unless otherwise instructed to provide in hard and/or soft copies.

All defects should contain a clear and concise scope of work to allow forward planning and budget estimate. The information should include:

i. Inventory
ii. Photographic records of ALL defects.
iii. Outstanding Defects.
iv. New Defects.
v. Maintenance Works.

vi. Any changes to Inspection Frequency.

vii. General Information.

The structures inspector does not have permission to change Inventory in the AMS. The inspector should provide written advice of any changes related to these records.

The information should include all the required inventory attributes, whether controlled or uncontrolled, for that structure.

The structures inspector should provide the structures representative with the following information:

- Attribute information where there is currently no information.
- Information where there are changes required.

The structures representative should arrange for the information to be included in the AMS.

Repair Priority

All defects should be allocated a repair priority as shown in Table 1 below:

Repair Priority Code	Description	Rectification Period
E	Emergency	Rectification work to commence within 24 hours
P1	Priority 1	Within 7 days
P2	Priority 2	Up to 28 days
P3	Priority 3	Up to 6 months
P4	Priority 4	Up to 1 year
P5	Priority 5	Up to 2 years
PN	no action required	Monitor (include in Capital/MPM for repair in future)

Table 1: Repair Priority Codes

Specific Requirements for Engineering Inspections

In addition to the inspection requirements outlined above for all structures, it is necessary to undertake specific inspection and/or testing as listed below in Table 2:

Structure Type	Inspections / Testing	Procedure Reference
Steel and Wrought Iron Structures	• Magnetic Particle and Dye Penetrant testing.	Appendix
Substructures submerged in permanent water	• Underwater Inspection	Appendix I

Table 2 – Additional Inspection Requirements

3.1.6 Site Measurements

Site measurements should be undertaken to either confirm drawing dimensions or when drawings are not available, to ensure accurate dimensions of elements are available for load rating.

3.1.7 “As-Is” Load Rating

Where the condition of an element has deteriorated to the extent that it’s “As-New” load carrying capacity has been affected, a new rating for the element should be determined for the “As-Is” condition.

Where elements have a capacity of less than nominated rail/road traffic, the following information should be recorded for each deficient element:

- Location.
- Description of Deficiency.
- Member Rating.
- Capacity Ratio.
- Speed Restriction for current traffic where railway bridge or culvert has inadequate load carrying capacity (to provide a capacity ratio of ≥ 1.0).
- Load limit expressed in terms of axle loads for road bridges where capacity is less than nominated road traffic load.

3.1.8 Structures Management Strategies

Following completion of the fieldwork and "As-Is" load rating, the Structures Engineer should develop recommendations for:

Corrective Maintenance

Maintenance work or mitigation measures to defects that represent either an immediate or an unacceptable risk to train operations must be assigned an appropriate repair priority.

Preventive Maintenance

Rehabilitation work should be grouped into similar types of work that can be addressed during a single Major Periodic Maintenance (MPM) activity. Usually the work would be limited to Defect Category M defects and strengthening of deficient elements but may include Category A-D defects if the rectification timeframes coincide with the MPM program. The recommendations for MPM work should take into account corrective work already programmed for that structure.

Special Inspections

The structures inspector may recommend that Special Inspections are undertaken to monitor specific defects. Where a Special Inspection is currently being undertaken, the structures inspector may recommend a change in the inspection frequency if appropriate or recommend the special inspections are no longer required.

Engineering and Visual Inspections

The structures engineer may recommend an increase in the frequency of Engineering and/or Visual Inspections where deemed necessary.

The structures engineer should take into account the overall condition of the structure and the criticality of the line when developing the recommendations.

3.2 Inspection Review

3.2.1 Defects

The structures representative should review all defects within the specified timeframes.

3.2.2 Mitigation/Maintenance Work

Corrective Maintenance

The structures representative should allocate the corrective maintenance work to be actioned within the timeframe allowed by the allocated Repair Priority the structures representative should also arrange any short-term mitigation actions recommended by the structures engineer.

Preventive Maintenance

For preventive maintenance work, the structures representative should develop MPM strategies for the structure taking into account the recommendations of the structures inspector.

3.3 Engineering Inspection Report

Draft Engineering Report

The structures engineer should submit a draft soft copy of engineering report containing a summary of critical defects with photos, deficient elements, speed restrictions, load ratings, fatigue assessments, recommended inspection frequencies and short-term mitigation actions within the timeframes identified in the Inspection Standard, ETE–09–01.

Final Engineering Report

Following successful resolution of any issues, the structures engineer should upload the report, including all ratings, calculations, etc., into AMS unless otherwise instructed to provide in hard and/or soft copies.

The structures representative shall ensure any requirement for special inspections, speed restrictions, etc. is actioned in AMS.

4 Visual Inspection

The purpose and scope of a Visual Inspection is provided in the Standard ETE-09-01 Structures Inspection.

Further general information for specific types of structures is provided in the appendices of this procedure. These appendices provide general guidance only and it is expected the structures inspector will use appropriate judgement and experience when recommending actions from a Visual Inspection.

4.1 Inspection Procedure

The process of undertaking a Visual Inspection is as follows :

4.1.1 Pre-Inspection Investigation

Prior to undertaking a Visual Inspection, the structures inspector should review the available relevant historical information for the structure, including:

- Available inspection, engineering and any investigation reports.
- Maintenance history.
- Outstanding defects and planned Major Periodic Maintenance.
- Deficiencies identified for future observation.
- Structural issues that have been recorded since the last inspection.

4.1.2 Preparation for Inspection

In preparation for the Inspection, the structures inspector should liaise with the structures representative to ensure the appropriate arrangements are in place to undertake the Inspection, including:

- Safety Plan.
- Track protection.
- Inspection access arrangements and safety equipment.
- Arrangements with relevant authorities/stakeholders.

4.1.3 Visual Inspection

A visual inspection covers all elements of any structure above ground and water level. The individual elements of the bridge should be visually examined either with the naked eye or using appropriate equipment such as mirrors or telescopic equipment in order to identify structural defects.

Steel Bridges: Non-destructive testing, such as MPI and Dye Penetrant, may be necessary for specific steel structures from time to time.

Timber Bridges: The inspection of timber bridges should include timber boring, below ground level inspection and underwater examination at least every 4years or more frequently depending on degree of deterioration recorded at the previous inspection.

Review of Equipment Register

The structures inspector is required to review the existing equipment register data currently held in AMS for the structure and identify either:

- Additional information to make the equipment register data complete.
- Modifications to correct data errors or changes arising from maintenance work.

Photographic Record of Structure

For each structure, the following photographic records that form part of the equipment register are required:

- A view along the deck system.
- One or two views (depending on the size of the structure) showing the elevation of the structure.
- One or two representative photographs of more complex structures such as trusses.

The structures inspector should review the existing photographs in AMS for that structure and take additional photographs if currently inadequate or there has been a substantive change.

Following the inspection, the structures inspector should advise the structures representative of any required changes to the equipment register. The structures representative should review the proposed changes and arrange for the changes to be made AMS.

Assessment of Previously Reported Defects

At the start of the inspection procedure, the structures inspector should review the status of all existing defects.

Where existing defect records are incomplete, or the defect has changed (i.e. the measurement or severity has increased), the structures inspector should update the defect data entry as necessary.

Where the existing defect has not changed, no further action is required by the structures inspector.

All existing defects shall be retained in AMS, even if the defect is deemed to be inert over multiple inspections. The structures inspector may recommend to ARTC's designated representative that a defect should be closed in AMS if it has been rectified or the record is identified as being erroneous.

New Deficiency Identification

New defects identified by the structures inspector during an inspection shall have a defect record created in AMS. The defect record shall be created in accordance with this section of the CoP, and as per the data requirements specified in EGW-10-01.

Establishing the cause of an observed defect is crucial to determining the severity of a defect. If the structures inspector is unable to determine the mechanism responsible for the cause of a defect, further input should be sought from a specialist engineer. If the cause of a defect cannot be identified and the level of risk cannot be determined, further investigation should be recommended.

The structures inspector should take into account the required response timeframes documented in Table 5a in ETE-09-01.

Photographic records are required for all defects.

Data Recording

All defect information obtained during the Visual Inspection must be uploaded to the AMS unless otherwise instructed to provide in hard and/or soft copies.

All defects should contain a clear and concise scope of work to allow forward planning and budget estimate. The information should include:

i. Inventory
ii. Photographic records of ALL defects.
iii. Outstanding Defects.
iv. New Defects.
v. Maintenance Works.
vi. Any changes to Inspection Frequency.
vii. General Information.

The structures inspector does not have permission to change Inventory in the AMS. The inspector should provide written advice of any changes related to these records.

The information should include all the required inventory attributes, whether controlled or uncontrolled, for that structure.

The structures inspector should provide the structures representative with the following information:

- Attribute information where there is currently no information.
- Information where there are changes required.

The structures representative should arrange for the information to be included in the AMS.

4.2 Inspection Review

4.2.1 Defects

The structures representative shall review all defects within the specified timeframes.

4.2.2 Mitigation/Maintenance Work

Corrective Maintenance

The structures representative should allocate the corrective maintenance work to be actioned in accordance with the agreed repair priorities. The structures representative should also arrange for any short-term mitigation actions to be implemented.

Preventive Maintenance

For preventive maintenance work, the structures representative should review the outcomes of the Visual Inspection against the proposed MPM works for the structure and make modifications as required.

4.2.3 Overall Review of Inspection

Following successful resolution of all of the above issues the structures representative should upload the accepted visual inspection known conditions into AMS.

The structures representative shall ensure any requirement for special inspections, speed restrictions, etc. is actioned in AMS.

5 Special Inspection

The purpose and scope of a Special Inspection is provided in ETE-09-01.

5.1 Inspection Procedure

Special Inspections should generally be carried out in accordance with Section 4.1 of this Procedure.

6 Track Patrol

The purpose and scope of a Track Patrol inspection is provided in Standard ETE-09-01 Structures Inspection.

6.1 Inspection Procedure

Track Patrols should be carried out in accordance with ARTC Code of Practice (Track & Civil).

6.2 Data Recording

All defects should be reported to the structures representative, who should arrange for assessment and upload into AMS.

7 Appendix A – Inspection of Steel Structural Elements

7.1 Steel Degradation

In general, steel deteriorates in service in the following ways:

a. Erosion or corrosion at exposed surfaces, and at timber or concrete interfaces.

b. Cracking in elements or welds.

c. Relaxation of fastenings.

d. Distortion due to overload, or from direct impact from road or rail vehicles.

e. Fatigue from repetition of external loading.

7.2 Inspection Methods

The principal inspection methods are:

Visual

Most cracks in steel bridges are first detected by visual inspection. Once a crack is found, other non-destructive inspection methods, such as dye Penetrant and magnetic particle, are used to further clarify the extent of the crack.

The usual and most reliable sign of fatigue cracks is the oxide or rust stains that develop after the paint film has cracked. Experience has shown that cracks have generally propagated to a depth between one-fourth and one-half the plate thickness before the paint film is broken, permitting the oxide to form. This occurs because the paint is more flexible than the underlying steel.

In Broad Flange Beams inspect for notches caused by impact from vehicles or equipment. Report on loss of section on completion of grinding as required.

Inspect for water build-up, especially in areas that could cause corrosion.

Inspect for loose fasteners. The most reliable sign for loose structural fasteners is the leaching of rust stains from the interface of the connecting elements.

Elements are to be observed under load where possible, and any excessive movement in elements or fastenings is to be noted.

Hammer Test

When elements are tapped lightly with an inspector's hammer, it will help to identify loose plates and fastenings, the extent of corrosion, and effectiveness of corrosion protection. Care must be taken that hammering does not cause unnecessary destruction of protection systems.

Specialist inspection methods, including X-Ray, Ultrasonic, Acoustic Emission, and Laboratory analysis of steel samples, are beyond the normal scope of Visual Inspections and Engineering Inspections.

Advanced Inspection Techniques

Magnetic Particle Testing (MPI) or flaw detection penetrant dye will detect suspected cracking not clearly visible. The concerned area is to be properly cleaned to an acceptable level to perform the testing.

7.3 Element Inspection

General

Examine elements for:

- Corrosion and section loss.
- Buckled webs, web stiffeners and flanges.
- Cracks in webs, flanges and welds.
- Loose bolts, rivets, plates and bars.
- Distortion from corrosion products.
- Stain trails indicating hidden corrosion.
- Polished surfaces indicating movement between elements.

Particular defect areas to be examined are:

Main Girders (Plate Web or Rolled Section)

1. Corrosion under transoms or decking, at toes of bottom flange angles between flange plates, around bearings, at abutments and piers, at bracing connections, in rivet and bolt heads.
2. Loose rivets or bolts in flange angles, splices, bracing connections, web stiffeners and splices, bearing plates.
3. Cracks in bottom flange (tension zone), particularly in the area of mid-span.
4. Cracked welds in flange/flange fillets, web stiffeners with diaphragm bracing, bottom of web stiffeners, web/flange fillets.
5. Notches in bottom flanges from road vehicle impact, particularly in Broad Flange Beams.
6. Cracks, loss of section or buckling in webs at ends of girders.
7. Buckled webs of unstiffened girders.

Cross Girders

1. Corrosion under transoms or decking, at toes of bottom flange angles between flange plates, around bearings, at abutments and piers, at bracing connections, in rivet and bolt heads.
2. Cracks in flanges and webs at ends of girders.
3. Loose rivets or bolts in connections.

Stringer Girders

1. Corrosions under transoms or decking.
2. Cracks in bottom flange, particularly in the area of mid-span.
3. Cracks in top fillets at ends of girders.
4. Loose rivets or bolts in connections.
5. Detailing.

Bearings

1. Corrosion at flange plate/end bearing stiffener connections.

2. Cracks in bearing or bed plates.
3. Cracked welds between flanges and bearing plates.
4. Loose, broken or missing holding down bolts, studs, and clips.
5. Ineffective sliding, roller or segmented expansion bearings.
6. Expansion bearings not working and segmented bearings lying over.

Truss Girders

1. Corrosion in top and bottom chords, batten plates and lacing bars, portal and wind bracing over tracks, gusset plates, rivet and bolt heads.
2. Misalignment or distortion in chords.
3. Cracks in cleats and connector plates.
4. Loose rivets or bolts and turnbuckles.
5. Damaged steelwork from equipment or loads traveling out-of-gauge.

Stepways / Stairways

1. Corrosion at base connection, stepway risers, stringer webs, tread cleats and clips.
2. Loose bolts and clips to treads.

Trestles

1. Corrosion around baseplates, between angles in bracing, in rivet heads and holding down bolts.
2. Loose rivets or bolts in connections to girders or bracing.
3. Loose turnbuckles in bracing.

Piers/Caissons

1. Corrosion at crosshead connection at water or ground level.
2. Excessive movement of any element under load.
3. Cracks in cylinder walls.

Corrugated Steel Pipes

1. Corrosion in corrugation.
2. Distortion in pipe profile.
3. Breakdown of coating.
4. Change in invert alignment indicating bedding failure.

Rivets

There are two types of rivets in the bridge system:

- Structural rivets – rivets that need to be tightly fitted e.g. rivets connecting stringer to cross girder or lacing bars to top and bottom chords. Inspect for leaching of rust stain or looseness apparent to a hammer tap.

- Stitching rivets – that do not need to be tightly fitted to hold the elements together e.g. rivets connecting diagonal lacing bars or lacing bar spacers in truss bridges. Inspect for slackness due to excessive wear and tear.

Deflection

Deflection in steel elements is normally small. Any clear movement under live load is to be measured, or closely estimated, and reported.

Temporary Supports

Inspect visually for soundness and effective support, including footing, foundation and drainage. Packing and wedges are to be tightened and secured as necessary. Where temporary supports have been in service for more than 1year they must be thoroughly inspected in the same manner as other elements of the structure.

7.4 Broad Flange Beam

Introduction

Broad Flange Beam (BFB) spans over roadways are subject to a significant risk of fatigue and/or brittle fracture if damaged by road vehicle impact. The beams become brittle when the ambient temperature is less than 13°C. In order to minimize this risk all such structures are included in a special inspection program during winter months.

Inspection

The spans are to be examined for evidence of flange damage, i.e. cracking, notching, bruising, distortion, scores, and bends) as well as grinding or other repairs. Note that cracks can develop from previously ground or repaired areas.

Inspection must be carried out from close proximity to enable measurement of defects, and to give a reasonable chance of detection of cracking on any surface of the flanges.

Where there are welded flange plates special attention must be given to the BFB flange in the proximity of the welds, as there is a possibility of crack initiation and propagation from welds.

Recording

Each notch is to be individually measured and recorded. Where the flange is bent laterally or vertically, an estimate of the distance is to be recorded. The report should indicate whether damage is in the BFB flange, or the flange plate, or both.

Site action to be taken when cracking or damage occurs.

Where any cracking is found in the BFB bottom flange / flange plate / cover plate area, the structures representative is to be informed immediately and a speed restriction imposed, or the track closed, or the bridge temporarily supported, depending on the extent of the crack as detailed below.

If the track is not closed the bridge must be monitored very closely and a speed restriction imposed to suit. A significant risk and rapid crack growth exist with any un-plated BFB showing any crack, or a plated span showing cracks in both BFB and plate flanges. Plated flanges showing cracks in one element, but not in both, are less of a risk.

If a span is temporarily supported at a crack, trains may run indefinitely up to 50km/h depending on the quality of the supports.

If a span is not temporarily supported at a crack, the following action is required:

- If the flange is plated and a crack up to 25mm exists in either the BFB flange or in the flange plate, speed is to be limited to 20km/h, and the crack is to be checked after each train.
- If the crack is greater than 25mm but less than 100mm, road traffic is to be suspended during the passage of rail traffic.
- If the crack is greater than 100mm, rail traffic must NOT be permitted.
- Where the flange is not plated or both flange and flange plate are cracked, rail traffic may be permitted if the crack is up to 25mm long. Rail speed must be limited to 20km/h, road traffic must be stopped during the passage of each train, and the crack is to be checked after each train.
- Where the flange is not plated or both flange and flange plate are cracked, and the crack is over 25mm, rail traffic is to be stopped.

Repair method

No welding, straightening or cutting is to be done on BFB spans without the prior approval of ARTC.

7.5 Additional Inspection Requirements

When undertaking an Engineering Inspection for a Steel Bridge the structures inspector shall provide the following additional information:

Non-Destructive Testing

Non-destructive testing (NDT) shall be carried out on site to verify cracks and crack lengths where:

- Cracks on wrought iron structural elements exceed 50mm.
- Any new crack, or any extension to a previously noted crack, on steel structural elements.

The NDT shall include:

- Magnetic Particle Testing.
- Liquid Penetrant Testing.

The structures inspector is required to have the competency to undertake the testing or arrange for the testing to be undertaken by someone with sufficient competency. The minimum level of competency acceptable to ARTC is successful completion of National Unit of Competency in “MEM24001B – Perform basic penetrant testing” and “MEM24003B – Perform basic magnetic particle testing”.

8 Appendix B – Inspection of Timber Structural Elements

8.1 BridgeWood Decking

The BridgeWood decking consists of specially designed and treated plywood panels which are specifically designed for both road and rail bridge applications. It requires the similar examinations to traditional hardwood timber components to ensure continued safety of traffic operation.

8.2 Timber degradation

In general, timber deteriorates in service only when attacked by outside agencies. These can be categorized as follows:

- Weathering at exposed surfaces.
- Decay or rot.
- Insect attack, whether termites or borers.
- Fire.
- Mechanical damage from vehicles or equipment.
- Checks and splits.

Of the above categories, decay and insect attack usually cause deterioration inside an element and therefore are the hardest to measure.

8.3 Inspection methods

The principal timber inspection methods are:

Visual

All bridge elements are to be inspected for indications of deterioration or damage such as:

- Weathering, cracks, shakes, splits.
- Bubbles, especially in laminated panel indicating internal de-lamination.
- Surface decay where elements join or where elements project behind abutments.
- Damp sides of elements, especially of timber decking.
- Indicators of internal decay such as troughing, sides bulging, brooming out of fibres, body bolts hanging out or loose in their holes.
- Termite or fungus attack.
- Crushing of elements, especially headstocks, at seating and joints.
- Spike killing of transoms.
- Loose or missing bolts, including transom bolts.

Hammer Testing

Hammering, or sounding, a timber element gives an indication of internal deterioration. The presence of delamination, rot or termite attack may cause a hollow sound when struck by the hammer, indicating boring is required. The hammer should weigh about 1kg, with one face flat and the other face spiked.

Bore and Probe

Test boring is carried out with a 10mm auger in order to locate internal defects such as pipes, rot or termites. Holes are bored square to the face of girders, corbels, headstocks, piles, sills and other elements, as necessary. Boring must not be overdone and holes are to be preservative treated and plugged, leaving the plug 20mm proud. Unused holes are to be plugged flush. The extent of an internal pipe or other defect is found and measured with a feeler gauge made from 4mm steel wire with one end flattened and about 4mm bent over at right angle. By probing down the bore hole, the extent of a defect can be felt, measured and recorded.

NOTE: No boring of BridgeWood decking is required because the Engineered Wood Product is not subject to piping or internal rot as in sawn hardwood.

Deflection Test

A deflection test gives an indication of girder condition and riding quality.

Total deflection of a girder under designated train is the difference between the mid-point deflection and an average of deflections at end of corbels supporting that girder in the tested span and recorded.

If deflection limits are exceeded at permitted track speed, temporarily reduce train speed to suit. If the limit is exceeded at 20km/h, the structures representative is to be advised the same day.

8.4 Inspection procedure

The following inspections are to be undertaken by the inspector:

Transoms

Inspect for weathering, splitting, crushing, spike killing, fire damage, condition at rail seating, and condition at girder bearings for intermediate transoms.

Ballast Walls

Inspect for general condition, tightness of bolts, and capacity to retain ballast.

Runners

Inspect for general condition and tightness of bolts.

Decking

Determine the general condition of the timber decking. Note the number, size and location of pieces split, or with more than twenty percent (20%) section loss.

Ballast Logs

Inspect for general condition and tightness of bolts.

Girders

Inspect visually and hammer test for soundness. Bore new holes and probe girders at least every 4 years. Inspect compound girders individually. If necessary, the inspector may undertake additional boring, preferably using existing holes, depending on state of the timber.

Girders are to be inspected for signs of decay, particularly where this may be occurring on the top surface under the decking of ballast top spans. Bore girders horizontally at mid depth over corbel ends or sill face and at centre span.

Where a pipe is found over 125mm wide, cross bore vertically at the location and note size and position of the pipe. Where inspection raises any doubt or where termites appear active, additional boring is to be carried out as necessary.

Check the bearing areas for crushing of the beams near the bearing seat. Investigate for decay and insect damage by visual inspection and sounding and/or probing at the ends of the beams where dirt, debris, and moisture tend to accumulate.

Investigate the area near the supports for the presence of horizontal shear cracking. The presence of transverse cracks on the underside of the girders or horizontal cracks on the sides of the girders indicate the onset of shear failure.

Inspect the zones of maximum tension for signs of structural distress. The maximum tension generally occurs at the bottom half of the middle third of the beam span. Tension cracks in timber break the cell structure perpendicular to the grain and are typically preceded by the appearance of horizontal shear cracks.

Corbels

Inspect in a similar manner to girders. Bore holes to be 300mm from each end, and at the centre, but clear of bolt holes. Where packing is installed, the location, size and type are to be noted.

Headstocks

Inspect visually and hammer test for soundness. Identify solid and double waling types. Bore and probe ends of elements if hammer test indicates internal decay. Give special attention to corbel seatings and to pile bearings. Inspect waling headstocks for loose bolts and for bearing on pile shoulders.

Bracing

Inspect all horizontal and diagonal bracing visually and hammer test for soundness. Inspect for loose bolts, and effectiveness of bracing in restraining side-sway.

Sills

Inspect visually and hammer test for soundness. Identify solid and double waling types. Inspect for loose bolts, straps, decay of undersides on concrete bases, and bearing of walings on pile shoulders.

Piles

Inspect visually and hammer test for soundness. Bore new holes and probe piles at headstock level, ground level and below ground level at least every 4years. If necessary, the inspector may undertake additional boring, preferably using existing holes, depending on state of the timber.

To inspect below ground level, use a backhoe where possible, to excavate to a depth of 500mm, or more if necessary, and bore at trench bottom. Where spliced piles show signs of vertical or sideways movement, the splice rails and pipe stumps are to be exposed and inspected. All excavations are to be backfilled, rammed, and scour protection reinstated. Where inspection raises any doubt or where termites appear active, additional boring is to be carried out as necessary.

Spliced and planted piles are to be specially noted. Depth of splice, or of plant footing, below bottom waling is to be noted. Where piles have a surrounding concrete collar or invert, the concrete must not be cut away for inspection unless extensive pile necking or piping is evident.

Inspect piles in permanent water at least every 4years, or more frequently depending on deterioration shown at the previous inspection, or if major scouring is suspected. The underwater inspection should be carried out in accordance with the guidance of this Procedure.

When the cross-sectional area of a pile is found to be degraded to 50% of its original cross-sectional area the following procedure is required. The defect is to be rated a Defect Category D. Subsequently any such degraded pile that is assessed to be performing satisfactorily and deemed to be able to remain in place, must then have 2yearly cyclic boring carried out.

Abutment sheeting and wing capping

Inspect for general condition and for ability to retain backfill. Inspect sheeting behind girders of end spans.

Walkways and Refuges

Inspect for overall safety.

Truss spans

Inspect truss elements generally, as for girder spans. Bore new holes and probe top chords, bottom chords, cross girders, stringers and end posts at element ends. Tighten tension elements, taking care to avoid crushing of timber in joints.

Timber box drains

Inspect visually for general condition and note any indication of failure of roof or wall timbers.

Temporary supports

Inspect visually for soundness and effective support, including footing, foundation and drainage. Packing and wedges are to be tightened and re-spiked where necessary. Where temporary supports have been in service for more than 1year they must be thoroughly inspected, including new bore holes, in the same manner as other elements of the structure.

Termites and Fungus

Termite infestations found either visually or by boring during inspection are to be reported to the Structures Representative immediately. Suspected areas of fungal attack could be inspected by prodding the exposed surface with a sharp probe to detect areas of softness compared to the surrounding good timber.

Screwing Up

During the inspections, all bolts are to be inspected and tightened as necessary.

Packing is to be inspected, repacked and spiked as necessary.

Site condition

All dry grass, flood debris, and other foreign matter that may cause a fire hazard, or may accelerate timber decay, must be removed from the immediate vicinity of the bridge element.

9 Appendix C – Inspection of Concrete Structural Elements

9.1 Concrete Degradation

In general, concrete deteriorates in service in the following ways:

a. Weathering or spalling at exposed faces, resulting from erosion, poor quality concrete, chemical action, water action, corrosion of reinforcement, low cover to reinforcing bars, crushing at bearing surfaces and poorly compacted concrete.

b. Cracking from loading changes, including settlement.

c. Mechanical damage, especially collision damage from road or rail vehicles, or abrasion.

9.2 Inspection Methods

The principal inspection methods are:

Visual

Visual inspection will detect most defects in concrete structural elements. The inspector is to look for signs of:

- Weathering or spalling of surfaces or mortar joints.
- Cracking within elements or at joints.
- Stains on surfaces indicating reinforcement corrosion.
- Crushing especially at bearings or at pre-stressing anchorage points.
- Changed alignment of elements:
  - Vertically, e.g. abutments.
  - Horizontally, e.g. deck camber.
  - Laterally, e.g. footings and culverts.

Cracking in concrete structural elements is an indicator of weakness in the element. Cracks must be examined for size and movement under load, and details recorded. Shrinkage or hairline cracks need be noted only.

Cracking or crushing around pre-stressing anchorages must be noted.

Length, width, and location of cracks are to be measured. A short line scribed across the midpoint of a crack will give easy indication of further movement. Reference points scribed at each end of the line can be measured to indicate changes in crack width.

Examine all elements for the unplanned ingress of water. Scuppers, weep holes, and other outlets are to be cleared of rubbish. Any water build-up, or seepage into unwanted areas, is to be reported.

Hammer Test

Hammer testing, where surfaces are tapped lightly with an examination hammer, can indicate “drumminess” (a dull hollow sound) and potential spalling areas.

Advanced Inspection Techniques

Where the cause of cracking or bulging of an element cannot be explained by visual inspection, specialist testing such as X-Ray, Ultrasonic, and Acoustic Emission can be used to examine the internal condition of structures and the underlying cause of the observed defects. The inspector is to note such concerns for follow-up by the Structures Representative.

9.3 Locations

Bearing Areas

Examine bearing areas for spalling where friction from thermal movement and high bearing pressure could cause the concrete to spall. Check for crushing of the stem near the bearing seat. Check the condition and operation of any bearings.

Shear Zones

Investigate the area near the supports for the presence of shear cracking. The presence of transverse cracks on the underside of the stems or diagonal cracks on the sides of the stem indicate the onset of shear failure. These cracks represent lost shear capacity and should be carefully measured.

Tension Zones

Check for deteriorated concrete in the tension zones, which could result in the debonding of the tension reinforcement. This would include delamination, spalls, and contaminated concrete. Cracks greater than 2mm wide are considered wide cracks and indicate extreme bending stresses. They should be measured and recorded.

Cracks

Check for efflorescence from cracks and discoloration of the concrete caused by rust stains from the reinforcing steel. In severe cases, the reinforcing steel may become exposed due to spalling. Document the effective cross section of reinforcing steel since section loss will decrease live load carrying capacity of the element.

Deflection

Deflection in concrete elements is normally small. Any clear movement under normal traffic load is to be measured and reported.

Diaphragms

Diaphragms should be inspected for flexure and shear cracks as well as typical concrete defects. Cracks in the diaphragms could be an indication of overstress or excessive differential deflection between adjacent beams.

Areas Exposed to Drainage

Check around scuppers, inlets or drain holes for leaking water or deterioration of concrete.

10 Appendix D – Inspection of Fibre Composite Structural Elements

10.1 Fibre Composite Degradation

In general, Fibre Composite products deteriorate in service in the following ways:

Surface cracking

- When overstressed due to excessive loading a non-structural coating or paintwork on element will show signs of fine cracks or spalling at bottom and on side surfaces at load point.
- On impact the coating may spall, split or crack. Small localized damage is of no immediate engineering concern however, all damages should be reported.

Crushing

- Crushing at load points (on edges at bearings or around bolt holes) is most likely an indication of excessive loading. The coating will show signs of discoloring/spalling. All such discoloring/spalling shall be reported.

Wear and tear

- Excessive wear and tear or overstressing at bolt holes will show signs of discoloring or spalling in the coating. Loose fasteners will indicate wearing in threads of material.

Fire Damage

- The coating can be subject to fire damage in much the same way as timber however, the Fibre Composite product itself will withstand intense heat/fire.
- To determine the extent to which the element is affected, any lose or charred material must be removed until unburned material is exposed. If the fire damage is limited to the protective layer no immediate engineering concern exists however all fire damages should be reported.

10.2 Inspection

- Fibre Composite material will not rot or decay and it is resilient to any attack by termites or fungus.
- A close visual inspection is to be made of all exposed surfaces.
- No boring for inspection purpose shall be undertaken as it will not reveal any internal defects.
- No chemical etching or hard tapping with any object shall be undertaken.

10.3 Inspection Methods

The principal inspection methods are:

Visual

Visual inspection will detect most defects in fibre composite structural elements. The inspector is to look for signs of:

- Cracking within elements or at joints.
- Stains or discolouring on surfaces indicating overstressing of localized area.

- Crushing especially at bearings or load points.
- Changed alignment of elements:
  - Cracking in structural elements is an indicator of weakness in the element. Cracks must be examined for size and movement under load, and details recorded. Shrinkage or hairline cracks need be noted only.
  - Length, width, and location of cracks are to be measured. A short line scribed across the midpoint of a crack will give easy indication of further movement. Reference points scribed at each end of the line can be measured to indicate changes in crack width.

Hammer Test

Hammer testing, where surfaces are tapped lightly with an examination hammer, can indicate “drumminess” and potential spalling areas.

Advanced Inspection Techniques

Where the cause of cracking or bulging of an element cannot be explained by visual inspection, specialist testing such as X-Ray, Ultrasonic, and Acoustic Emission can be used to examine the internal condition of structures and the underlying cause of the observed defects. The inspector is to note such concerns for follow-up by the Structures Representative.

10.4 Locations

Bearing Areas

Examine bearing areas for spalling where friction from thermal movement and high bearing pressure could cause the fibre composite to wear/spall. Check for crushing of the stem near the bearing seat. Check the condition and operation of any bearings.

Shear Zones

Investigate the area near the supports for the presence of shear cracking. The presence of transverse cracks on the underside of the stems or diagonal cracks on the sides of the stem indicate the onset of shear failure. These cracks represent lost shear capacity and should be carefully measured.

Tension Zones

Check for cracks in the tension zones, which could result in the debonding of any tension reinforcement. This would include delamination and spalls. All cracks must be measured and recorded.

Cracks

Check for efflorescence from cracks and discoloration of the coating caused by overloading.

Deflection

Deflection in elements is normally small. Any clear movement under normal traffic load is to be measured and reported.

11 Appendix E – Inspection of Structural Lining for Pipes

11.1 General

- Approved pipe lining for use on the ARTC network are:
    - Berolina Liner.
    - Expanda.
    - Rotaloc.
- The above pipe products provide alternative methods of fabricating new drainage pipes or lining the interior surfaces of severely corroded corrugated steel pipes (CSP) to strengthen them to railway design loading 300LA.
- The liners are designed to sustain full design load without sharing any design loads with the existing corroded pipe.
- The annulus between the liner and the CSP pipe is pressure grouted with cementitious grout.
- These products are made from PVC or HDPE Plastic.
- ARTC has approved use of Expanda, Rotaloc and Beroliner pipes/liners for pipes up to 1000mm, 1500mm and 2000mm diameter respectively. If any additional products are approved they will be published in the Type Approval listing.

11.2 Degradation

Unlike steel and concrete, polyethylene and PVC don't corrode in acidic conditions and don't need protective coatings that need to be maintained. The liners are continuous and don't have fasteners, bolts, etc.

In general, the products deteriorate in service in the following ways:

Deformation

- As the products are flexible, deformation would indicate overstressing due to excessive loading or loss of embedment support, most likely caused by scouring around the outside of the liner and would need to be addressed.

Cracked barrel / Joint broken or separated

- When overstressed due to excessive loading the pipe will develop cracks or joint separation.

Abrasion in sectional area

- While PVC and Polyethylene are more abrasion resistant than steel or concrete, the liners/pipes should be inspected for any evidence of abrasion, particularly in floor.

Fire / Ultra Violet Radiation damage

- The products could be subject to fire/UVR damage however, they will withstand intense heat/fire.

11.3 Inspection

- The materials will not rot or decay and they are resilient to any attack by termites or fungus.

- A close visual inspection is to be made of all exposed surfaces.
- No boring for inspection purpose shall be undertaken as it will not reveal any internal defects.
- No chemical etching or hard tapping with any object shall be undertaken.

11.4 Inspection Methods

The principal inspection methods are:

Visual

Visual inspection will detect most defects in liners or pipes. The inspector is to look for signs of:

- Deformation.
- Settlement / Changed alignment.
- Cracking/Disjointing.
- Abrasion.
- Fire / UVR damages within elements or at joints.

Deformation and/or cracking in pipes are indicators of weakness. These defects must be examined for size and movement under load, and details recorded. All cracks need be noted carefully.

Length, width, and location of cracks are to be measured. A short line scribed across the midpoint of a crack will give easy indication of further movement. Reference points scribed at each end of the line can be measured to indicate changes in crack width.

Hammer Test

Hammer testing, where surfaces are tapped lightly with an examination hammer, can indicate “drumminess” and potential loss of backfill material or undermining of foundation.

11.5 Locations

Deformation

As the products are flexible, deformation would indicate overstressing due to excessive loading or loss of embedment support, most likely caused by scouring around the outside of the pipe and would need to be addressed.

Cracked barrel / Joint broken or separated

When overstressed due to excessive loading the pipe will develop cracks or joint separation.

Abrasion in sectional area

While PVC and Polyethylene are more abrasion resistant than steel or concrete, the liners/pipes should be inspected for any evidence of abrasion, particularly in floor.

Fire / Ultra Violet Radiation damage

The products could be subject to fire/UVR damage however, they will withstand intense heat/fire.

Foundation

Examine for differential settlement and undermining of the foundation and around inlet/outlet of pipe.

Deformation

Check for deformation in highly stressed zones at 10 and 2 0'clock and at any other locations along full length of the pipe.

Tension Zones

Check for cracks in the tension zones, which could result in the disjointing along seams. All cracks must be measured and recorded.

Deflection

Deflection in elements is normally small. Any clear movement in roof under normal traffic load is to be measured and reported.

12 Appendix F – Inspection of Masonry Structural Elements

12.1 Overview

This section describes typical defects that occur in masonry structures.

12.2 Defects Caused by Structural Distress

Excessive Loading

a. Excessive loading, particularly when applied as a point loading, may cause localised crushing of masonry or even displacement of individual masonry units.

b. An increase in lateral pressure of earth behind abutments, wing walls and retaining walls may cause forward movement or tilting leading to distortion of the shape of an arch structure and may cause transverse cracking of the arch barrel. Recent cracks would indicate that movement is occurring.

c. An increase in lateral forces or pressures in the fill material may destabilize spandrel walls on arch structures.

Arch Shape Deformation

Flattening of the arch may be a sign of outward movement of the abutments. Movements may be more easily identified by evidence of dips in the courses of the spandrel walls or the parapets above the arch.

Structural Cracking

Cracks in masonry construction may only affect the appearance but can also be indicative of a more serious underlying defect. The inspector should observe many aspects of the cracking, including length, width, variation of width along its length, location, distribution, and, in some cases, depth. The displacements forwards, backwards and sideways of the masonry on each side of a crack should also be recorded. The current extent of the displacement should, if possible, be marked and dated on the surface of the structure to assist future inspections.

The most serious form of cracking is that caused by structural inadequacy or overloading. The four types of cracking associated with this are described as follows:

- *Longitudinal cracks (in direction of span)* – Differential settlement or movement across the width of an abutment or pier will produce longitudinal cracks in the arch barrel, as the structure splits apart, dividing the barrel into independent sections. If accessible, the depth of the cracks should be probed to reveal whether or not the whole thickness of the arch barrel has been cracked.

- *Transverse (lateral) cracks* – These may be accompanied by permanent deformations of the arch shape and are caused by partial load failure of the arch or by movement at the supports.

- *Diagonal cracks* – These normally start near the sides of the arch at the springs and spread up towards the centre of the barrel at the crown. They are generally due to subsidence at the sides of the abutment or pier and are caused by the resultant twisting of the arch.

- *Longitudinal cracks near the spandrel walls* – Longitudinal cracks near the edge of the arch barrel may be a sign that the spandrel wall has been forced outward and, instead of the spandrel wall sliding on the extrados (i.e. the exterior curve) of the arch, the arch ring itself has cracked.

12.3 Defects arising due to the nature of the material

Arch Ring Separation

The load capacity can be significantly reduced if ring separation has occurred. Separation within the barrel of an arch may be detected by hammer tapping to detect "drumminess" as opposed to a solid "ring" if fully bonded.

Defective Mortar and Pointing

The load carrying capacity of a masonry arch is dependent upon the thickness of the arch ring. If the mortar is missing, loose, or friable, then that depth of the ring affected is unable to transmit load and contribute to the strength of the arch.

Displaced or Missing Stones or Bricks

Deterioration of mortar, localised loading or large structure movements may result in masonry units becoming loose or displaced. The displacement of individual masonry units should be noted; particular emphasis should be made to those at the crown of arches with shallow depths of cover over the crown.

12.4 Defects instigated by external agents

Deterioration under these conditions may occur due to one or a combination of two or more of the following reasons:

- Erosion by water and wind and water borne particles, by frost attack and by vegetation root growth.
- Chemical/biological attack due to acids, sulphates and chemicals either water-borne or released by water, or from air-borne pollution.
- Efflorescence staining.
- Moisture and thermal movement of bricks and blocks.

13 Appendix G – Inspection of Tunnels

Serious deterioration in the stability of a tunnel is evidenced by bulging, distortion, cracking or changing geometry in the tunnel.

Inspection requires a working platform and good lighting so that close examination of the periphery can be made.

Tunnel Inspection should highlight the following indicators:

- The general condition of the rock face in unlined tunnels, or of the lining in others.
- The condition of joints in concrete, brickwork and stonework.
- Cracks, spalling, hollows or bulges in tunnel linings.
- Ineffective drainage, especially through weep holes and track drains.
- Signs of water seepage remote from constructed drainage outlets.
- Condition of attachments to tunnel lining.
- Track heave, subsidence, or alignment change.
- Condition of tunnel refuges and lighting.
- Condition of Portals and movement of portal away from tunnel stem.

Cracks, bulges, and spalled areas are to be measured for length, position and displacement. Cracks or displacement greater than 10mm should have measurement reference pins.

All extensively cracked areas or individual critical cracks should be adequately mapped and photographed for easy reference during the next inspection.

14 Appendix H – Inspection of Substructure Elements

14.1 Introduction

The substructure is the component of a bridge that includes all elements supporting the superstructure. Its purpose is to transfer the loads from the superstructure to the foundation soil or rock. The primary structural elements of the bridge substructure are the abutments (including wingwalls) and the piers (or trestles).

14.2 Inspection procedures

Inspection procedures for substructure elements are the principally the same as superstructure elements of similar material type, particularly when it involves material deterioration. However, because stability is a paramount concern, checking for various forms of movement is required.

Vertical Movement

Vertical movement can occur in the form of uniform settlement or differential settlement. A uniform settlement of all bridge substructure units often will have little effect on the structure, although it will affect the vertical alignment of the railway track(s) and road onto and off the structure.

Differential settlement can produce serious distress in a structure. Differential settlement may occur between different substructure units, causing damage of varying magnitude depending on span length and structure type. It may also occur under a single substructure unit causing an opening of the expansion joint between the abutment and wingwall, or it may cause cracking or tipping of the abutment, pier, or wall.

The most common causes of vertical movement are soil bearing failure, consolidation of soil, scour, and deterioration of the abutment foundation material.

Inspection for vertical movement, or settlement, should include:

- Investigate existing and new cracks for signs of settlement.
- Examine the superstructure alignment for evidence of settlement (particularly the bridge deck kerbs or railing).
- Check for scour around abutment and pier footings or foundations.
- Inspect the joint that separates the wingwall and abutment for proper alignment.
- Check for any new or unusual cracking.

Lateral Movement

Earth retaining structures, such as abutments and retaining walls, are susceptible to lateral movements, or sliding. Lateral movement occurs when the horizontal earth pressure acting on the wall exceeds the friction forces that hold the structure in place.

The most common causes of lateral movement are slope failure, water seepage, changes in soil characteristics, and time consolidation of the original soil.

Inspection for lateral movement, or sliding, should include:

- Inspect the general alignment of abutments, wingwalls, piers and exposed footings.
- Check the bearings for evidence of lateral displacement.

- Examine the opening in the construction joint between the wingwall and the abutment.
- Investigate the joint opening between the primary elements.
- Settlement of fill behind the abutment and wingwalls.
- Check the expansion gap at the ends of spans.
- Examine for clogged drains and/or water seepage.
- Inspect for erosion or scour of the embankment material in front of abutments or pier footings.

Rotational Movement

Rotational movement, or tilting, of substructure units is generally the result of unsymmetrical settlements. Abutments and walls are typically subject to this type of movement.

The most common causes of rotational movement are scour, erosion, saturation of backfill, soil bearing failure, erosion of backfill along the sides of the abutment, and poor design.

Inspection for rotational movement, or tilting, should include:

- Check the vertical plumbness of the substructure.
- Examine the clearance between individual spans.
- Inspect for clogged drains or weep holes and/or water seepage.
- Investigate for cracks, and record the crack width, length, and direction.

15 Appendix I – Inspection of Underwater Structural Elements

15.1 Introduction

Where structural elements are continuously submerged, underwater inspections must be undertaken to establish their condition. Underwater structural elements must be inspected to the extent necessary to determine with certainty that their condition has not compromised the structural integrity of the bridge.

In general, the term "underwater inspection" is taken to mean a hands-on inspection that may require underwater breathing apparatus and related diving equipment.

15.2 Frequency

All structures, except for timber bridges, should receive routine underwater inspections at the time of the Engineering Inspection, but special inspections may be implemented more frequently where appropriate for the individual bridge. The underwater inspection of timber bridges should be carried out at least every 4years.

Structures representative can determine underwater examination frequency greater than 6 years for structures other than timber piles and shallow footed piers.

The decision must at least be based on the following factors:

- Last inspection date.
- Structure type.
- Water flow characteristics.
- Risk of scouring.
- Risk of deterioration of elements.
- Local environment.

The underwater examination for rail bridges, other than timber bridges, must not lapse more than 12years.

15.3 Methods of Underwater Inspection

There are three general methods used to perform underwater inspections:

- Wading inspection.
- Self-contained diving (SCUBA).
- Surface-supplied diving.
- Sonar.
- Naked eye.

Wading Inspection

Wading inspection is the basic method of underwater inspection used on structures with shallow streams. The substructure condition should be evaluated using a probing rod, sounding rod or line, waders, and possibly a boat.

Self-contained Diving (SCUBA)

In this mode, the diver operates independently from the surface, carrying his/her own supply of compressed breathing gas (typically air). This dive mode is best used at sites where environmental and waterway conditions are favorable, and where the duration of the dive is relatively short.

Extreme care should be exercised when using SCUBA equipment at bridge sites where the waterway exhibits low visibility and/or high current, and where drift and debris may be present at any height in the water column.

Surface-Supplied Diving

Surface-supplied diving uses a breathing gas supply that originates above the water surface providing the diver with a nearly unlimited supply of breathing gas and also, provides a safety tether line and hard-wire communications system connecting the diver and above water personnel. Using surface-supplied equipment, work may be safely completed under adverse conditions.

Sonar

Sonar survey of the deep-water bed around submerged structures is undertaken by trained sonar operators, typically from a suitable boat. Divers may still be required for the inspection of structures.

Naked Eye

Naked eye inspection of underwater inspection is used on structures with shallow streams, clear water and without any debris to obstruct proper inspection.

Method Selection Criteria

In determining whether a bridge can be inspected by wading or whether it requires the use of diving equipment, water depth should not be the sole criteria. Many factors combine to influence the proper underwater inspection method including:

- Water depth.
- Water visibility.
- Current velocity.
- Streambed conditions (softness, mud, "quick" conditions, and slippery rocks).
- Debris.
- Substructure configuration.

15.4 Diving Inspection Intensity Levels

Three diving inspection intensity levels have evolved as follows:

- Level I: Visual, tactile inspection.
- Level II: Detailed inspection with partial cleaning.
- Level III: Highly detailed inspection with nondestructive testing.

Level I

Level I inspection consists of a "swim-by" overview at arm’s length with minimal cleaning to remove marine growth. Although the Level I inspection is referred to as a "swim-by" inspection, it must be detailed enough to detect obvious major damage or deterioration. A Level I inspection is normally conducted over the total (100%) exterior surface of each underwater element, involving a visual and tactile inspection with limited probing of the substructure and adjacent streambed.

The results of the Level I inspection provide a general overview of the substructure condition and verification of the as-built drawings. The Level I inspection can also indicate the need for Level II or Level III inspections and aid in determining the extent and selecting the location of more detailed inspections.

Level II

Level II inspection is a detailed inspection that requires that portions of the structure be cleaned of marine growth. It is intended to detect and identify damaged and deteriorated areas that may be hidden by surface growth.

A Level II inspection is typically performed on at least 10% of all underwater elements. The thoroughness of cleaning should be governed by what is necessary to determine the condition of the underlying material. Generally, the critical areas are near the low waterline, near the mud line, and midway between the low waterline and the mud line.

On submerged piles, horizontal bands, approximately 150 to 300mm in height, should be cleaned at designated locations. On large elements, such as piers and caissons, areas approximately 300mm square should be cleaned at three or more levels on each face of the element (or at quarter points for circular elements). Deficient areas should be measured, and the extent and severity of the damage recorded.

Level III

A Level III inspection is a highly detailed inspection of a critical structure or structural element, or an element where extensive repair or possible replacement is contemplated. The purpose of this type of inspection is to detect hidden or interior damage and loss in cross-sectional area. This level of inspection includes extensive cleaning, detailed measurements, and selected nondestructive and partially destructive testing techniques.

Level III inspections are not included in the scope of Engineering Inspections and will be undertaken as part of a specific investigation.

15.5 Types of Inspection

Routine Inspections

A routine inspection is typically undertaken as part of an Engineering Inspection. It is an intermediate level inspection consisting of sufficient observations and measurements:

- To determine the physical and functional condition of the bridge.
- To identify any change from "inventory" or previously recorded conditions.
- To ensure that the structure continues to satisfy present service requirements.

The scope of work for a routine inspection should include:

- A Level I inspection of all the submerged elements.
- A Level II inspection on at least 10% of submerged elements.

The dive team should also conduct a scour evaluation at the bridge site, including inspecting the channel bottom and sides for scour and, in particular, checking for local scour in the vicinity of submerged elements.

Damage Inspections

Certain conditions and events affecting a bridge may require more frequent, or unscheduled, inspections to assess structural damage resulting from environmental or accident related causes.

A Level III inspection may be necessary to determine the need for emergency load restrictions or closure of the bridge to traffic and to assess the level of effort necessary to repair the damage. The amount of effort expended on this type of inspection will vary significantly depending upon the extent of the damage. If major damage has occurred, the inspector must evaluate section loss, make measurements for misalignment of elements, and check for any loss of foundation support.

Situations that may warrant a Level I inspections include:

- Floods - bridge elements located in streams, rivers, and other waterways with known or suspected scour potential should be inspected after every major runoff event to the extent necessary to ensure bridge foundation integrity.

Situations that may warrant Level III inspections include:

- Vessel impact - elements should be inspected underwater if there is visible damage.
- Buildup of debris at piers or abutments - the buildup effectively lessens the waterway opening and may cause scouring currents or increase the depth of scour.
- Evidence of deterioration or movement.
- Following significant earthquakes.

15.6 Qualifications of Diver-Inspectors

All divers shall have a commercial diving license and have all appropriate insurances to undertake the work.

The underwater inspector must have knowledge and experience in bridge inspection. When necessary, the structures inspector shall be present at site to direct the divers during the underwater inspection in order to determine the extent of any damage.

16 Appendix J – Inspection of Miscellaneous Structures

Generally, the elements that comprise Miscellaneous Structures should be inspected in accordance with the recommendations given in Appendices A to F of this Procedure.

Where blockage is occurring in a waterway, the inspector is required to make an assessment if the material causing the blockage will be flushed away during a storm event. Only where the inspector makes an assessment that the blockage will not be self-flushing s/he should allocate a defect category in accordance with the Standard, ETE–09-01.

It should be noted the above descriptions cannot cover every situation and the inspector is expected to exercise judgement based on local knowledge and experience to identify the criticality of identified defects and deficiencies during an inspection.

17 Appendix K – Inspection of Redundant Structures

Generally, the elements that comprise Redundant Structures should be inspected in accordance with the recommendations given in Appendices A to F of this Procedure.

Redundant structures could be located in close proximity to operational tracks or anywhere within the railway corridor.

All redundant structures must be inspected to ensure they do not incur any safety risk to the public at large and/or normal train operations.

Some typical things to look for during inspections are as follows:

- Structural integrity – ensuring that it will not fail or collapse under its own dead load, due to wind load, vibration, etc.
- Dangerous sites are properly fenced off.
- All ladders attached to structures are at least 3m above ground level to prevent children from climbing up the structures.
- All water tanks and their openings are properly secured to prevent entry of children into tanks.
- All water tanks are empty.
- Track side access roads at bridge abutments or at other dangerous locations are adequately protected by road traffic barriers, earth mounts or other suitable barricades to prevent vehicles being driven off the high embankments.
- Appropriate signage is displayed at all concerned structures, track side access roads, etc. Some typical signages are as follows:
  - "Access for Authorised Persons Only".
  - "Danger – Falling Objects".
  - "Danger – No Pedestrian Access".
  - "Danger – Do Not Climb".
  - "Road Closed".

It should be noted the above descriptions cannot cover every situation and the inspector is expected to exercise judgement based on local knowledge and experience to identify the criticality of identified defects and deficiencies during an inspection.

18 Appendix L – Load Rating of Bridges

18.1 Introduction

In addition to the requirements provided in ARTC Code of Practice Section 9 and ETE-09-01 the following is provided. Details of load rating of underbridges is defined in ETE-09-05

18.2 Load Rating Results

The definition of Rating Factor is provided in AS 5100.7 as:

$$RF = \frac{\text{Available bridge capacity for live load effects}}{\text{Live load effects from the nominated rating vehicle}}$$

Where the nominated rating vehicle is 300LA railway design load the structural capacity of a railway bridge or culvert shall be expressed in terms of the equivalent LA loading (i.e. RF x 300LA).

The live load rating of a road bridge is expressed in terms of single, tandem and tri-axle loading of nominated road traffic.

Where the structure has been rated for specific train consist the results shall be expressed in terms of:

- The Rating Factor (RF) for that vehicle under full DLA.
- The minimum equivalent LA loading.
- Where the value of RF is less than unity (1.0), for each structural element the following should be reported:
  - ➢ The reduced speed necessary to raise the value of RF to unity (1.0) i.e. reducing DLA with respect to lower speed.

Calculated load factor (λ_L) for live load with full DLA.

18.3 Train Load Effects

The load effects from the following train consists must be considered as a minimum unless otherwise specified in Scope of Work:

- For all lines – 300LA design loading with 1.6 live load factor.
- RAS 270 locomotives hauling RAS 270 wagons.
- RAS 210 locomotives hauling RAS 210 – 100T general freight or RAS 210 – 92T steel wagons with 1.6 live load factor.
- For heavy coal lines – Heavy Haulage Coal trains.
- For all main lines – Main Line Freight Trains with 25t and 23t axles.

All the above train consists with their load effects on all elements and components under consideration must be recorded on the proforma provided.

18.4 Speed Restriction

Railway bridges in Australia have historically been designed and load rated in accordance with American and British practices and to Australia New Zealand Railway Corporation (ANZRC) bridge design manual.

In 2004, Australian Standard 5100: Bridge Design was introduced, covering both road and rail bridges.

AS ISO 13822 Basis for Design of Structures – Assessment of Existing Structures (which applies to structures generally, not just bridges) aims to provide guidelines for extending the life of structures, while limiting construction intervention. The guidelines include procedures for assessment based on past performance.

The application of AS 13822 can allow the existing train operating conditions to prevail across steel bridges without reducing the operational track speed or undertaking any upgrading work to conform to AS 5100 requirements.

Application of AS 13822 -2005

Load carrying capacity of structures can be derived using AS 13822 provided the original physical and structural integrity of element under consideration have not been significantly altered and similar traffic conditions prevail.

Traffic Conditions for main lines

- Train configurations with load effects not exceeding more than the load effects of current traffic.
- Performance based on at least past 20years of operation for current traffic.

Element Conditions

- Original physical characteristics and structural integrity of element is not altered by either strengthening or replacing it
- Element has not suffered more than 10% loss in capacity when load rated using dynamic load allowance factor (impact) from ANZRC Manual 1974. The impact load for open deck steel bridges is determined by taking a percentage of live load:

$$I = \frac{31}{Y} + 40 \; \frac{-3L^3}{150}$$

Where Y = girder spacing and L = element length up to 25m

For ballasted deck steel bridges use 90% of impact for open deck.

Application of AS 5100

Where the above traffic and element conditions for the application of AS 13822 cannot be attained then the load carrying capacity of that element shall be carried out using dynamic load allowance from AS 5100.

18.5 Fatigue Rating

The theoretical remaining fatigue life of only steel elements of railway bridges are required under engineering inspection.

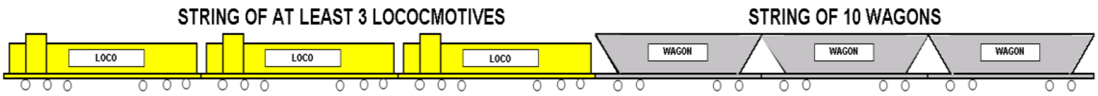
18.6 Wind & Sway Bracing

The wind bracing (secondary elements) of the old steel bridges are fabricated mostly from flat bars and as such they do not have adequate theoretical capacity for the current railway traffic in accordance with the AS 5100. The old sway bracing angles and riveted connections also do not have adequate theoretical capacity.

However, experience to date has shown that in reality there is no evidence of distress to suggest that they are being overloaded. Where the existing braces are rated between 0.8 and 0.99 for the current traffic then the structures inspector should give firm recommendations on inspection frequency, intervention levels and responses necessary to maintain safety. Where rating is below 0.8 then consideration should be given for monthly inspections and replacement within a reasonable timeframe.

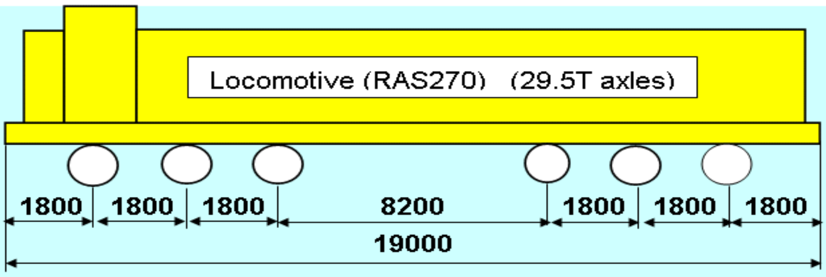
18.7 Train Consists

Some typical train consists are shown below:

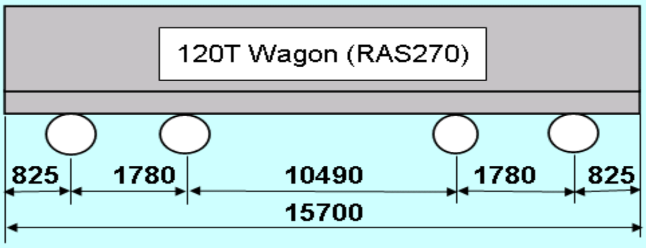


Route Access System (RAS)

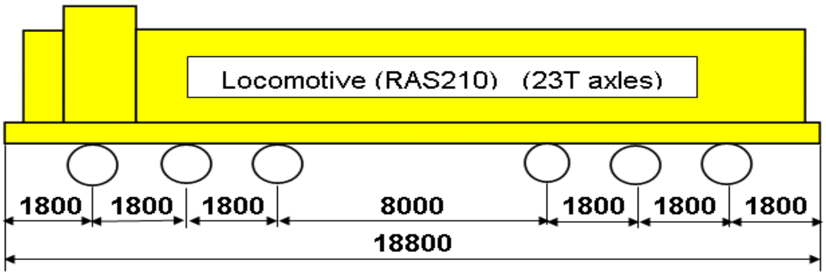
RAS270 Loco



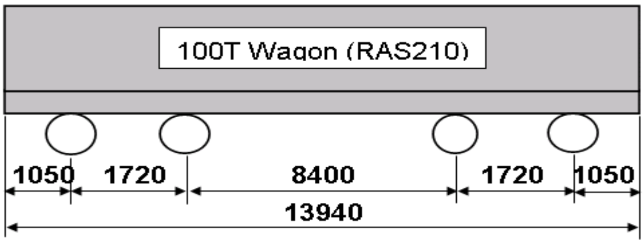
RAS270 Wagon



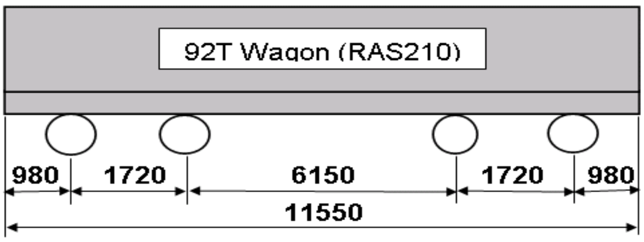
RAS210 Loco

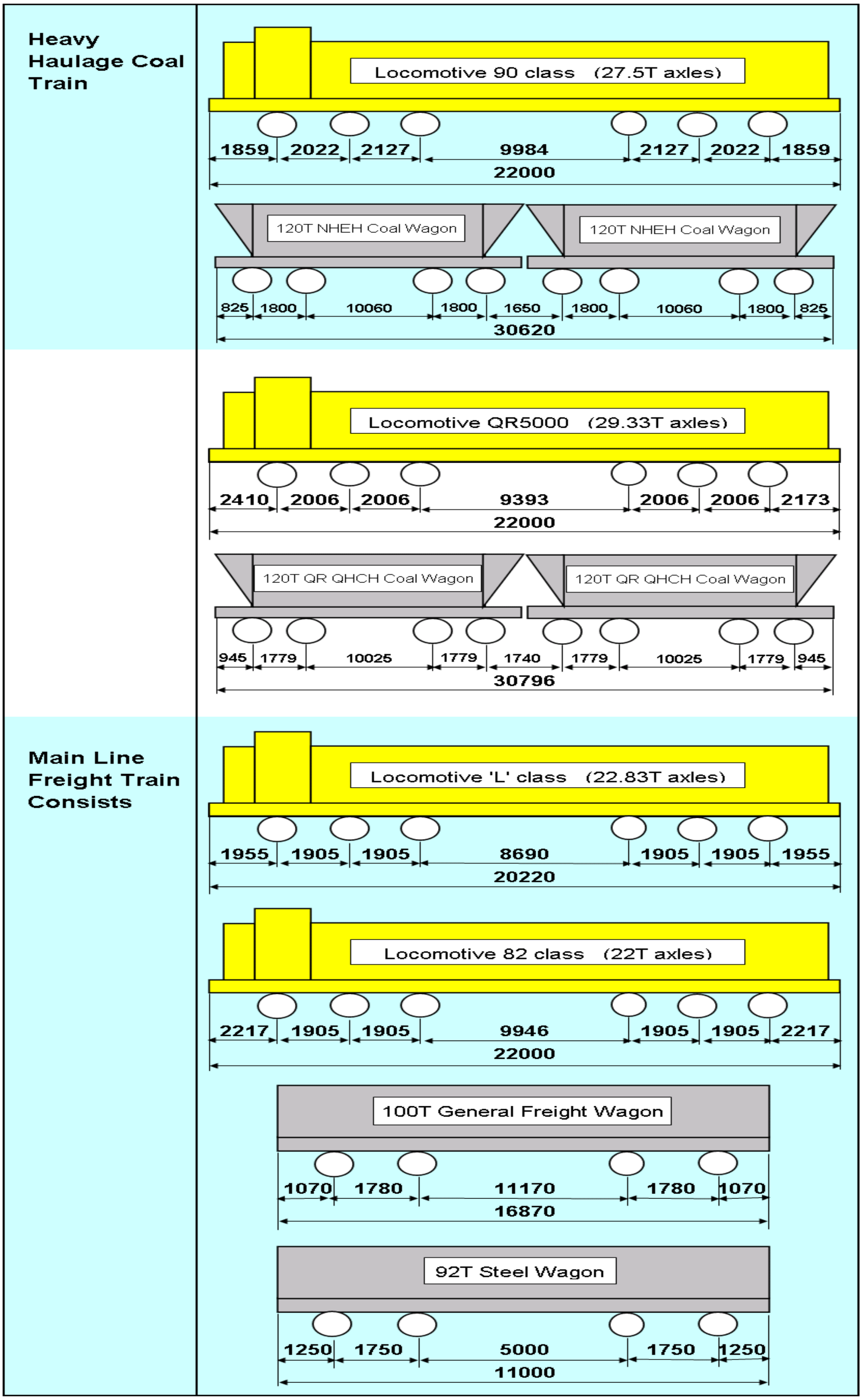


RAS210 - 100T Wagon



RAS210 - 92T Wagon




Heavy Haulage Coal Train
Locomotive 90 class (27.5T axles)
1859 2022 2127 9984 2127 2022 1859
22000
120T NHEH Coal Wagon
120T NHEH Coal Wagon
825 1800 10060 1800 1650 1800 10060 1800 825
30620
Locomotive QR5000 (29.33T axles)
2410 2006 2006 9393 2006 2006 2173
22000
120T QR QHCH Coal Wagon
120T QR QHCH Coal Wagon
945 1779 10025 1779 1740 1779 10025 1779 945
30796
Main Line Freight Train Consists
Locomotive 'L' class (22.83T axles)
1955 1905 1905 8690 1905 1905 1955
20220
Locomotive 82 class (22T axles)
2217 1905 1905 9946 1905 1905 2217
22000
100T General Freight Wagon
1070 1780 11170 1780 1070
16870
92T Steel Wagon
1250 1750 5000 1750 1250
11000

Road Bridge – Load Limit Sign