FRONZ / ONTRACK

APPROVED CODE OF PRACTISE
FOR
HERITAGE NETWORK OPERATORS

Mechanical Task Instruction B3.1.4.01

Corrosion, Crack and Structural Inspection of Vehicle Components

Issue	Prepared (P), Reviewed (R), Amended (A)	Approved by	Effective Date
1	P McCallum (P)	Heritage Technical Committee	7 May 2007
2	P McCallum (A)	Heritage Technical Committee	21 July 2008

Reference Material

Source	Description	Date
NZ Law	Health and Safety in Employment (Pressure Equipment, Cranes and Passenger Ropeways) Regulations 1999 (PECPR)	1999
DOL	Pressure Equipment, Cranes, and Passenger Ropeways Regulations 1999 - A general guide to the Health and Safety in Employment	1999
Standards NZ	AS/NZS 3788 “Pressure Equipment – In-service Inspection”	2001
Castings Information Technology & Metallurgical Services	Suggested Repair Procedure for Coupling Buffers	2005
Toll Rail	Task Instruction TKU 09 - Structural Inspection of 56 Foot, A Series Carriages	2002
Toll Rail	Recommendation for Repair of corroded anti-collision end of OETT 50’ passenger car	2005
Taieri Gorge Railway	Standard practices for inspection and repair of carriage frames	

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Amendment History

Version	Section	Amendment
Draft	All	
1.0	2, 3, 5, 6	Added instruction to mark ID and / or inspection date on components
	1	Added notes re inspection periods and competent persons
	Various	Amended inspection periods
	8	Amended criteria for crack testing of locomotive frames. Added information on welding of “Supertough” steel. Added note re tender frames.
	11	Added section on locomotive wheel spokes
	12	Added section 12 and Appendix D on inspection of wagon frames
	App A	Added criteria re crack limits.
	App A	Added section re open platform carriages - end bracing
2	1	Added section extending inspection periods for vehicles under overhaul

Paragraphs marked thus are recent revisions or additions.

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1 Introduction

Various rail vehicle components are subject to corrosion, fatigue cracking or rot and need to be inspected at regular intervals to ensure that the vehicle is safe to operate.

The intervals are based on time or distance run and are set so as to identify problems before failure occurs.

These periods recommended in this task instruction are based on typical or expected age and use of heritage vehicles Operators should consider their own equipment, its likely use and repair history when setting or adjusting the intervals between inspections.

Competent Persons

Throughout this task instruction reference is made to using competent persons for inspections or repairs. Competency can be established by

- Qualification and/or
- Experience

A qualified person can produce documentary evidence of competence and this should be noted on the repair records for a vehicle.

Acceptable qualifications include

Item	Qualifications
Crack testing	• CPIP – Surface Method Operators Certificate – Level 2 (Level 1 can do them but must follow a specification written by a level 2 person). This is being replaced by the Australian equivalent. • Unit Standard 15126 - Inspect parts using magnetic particle inspection • Unit Standard 15127 - Inspect parts using liquid penetrant inspection
Ultrasonic axle testing	No qualification known. Need to use operators with proven experience in this field.
Welding	• NZS 4711 for the positions used • NZS 1554 part 1 • AWS or ASME.
Pressure vessel inspection	Person holding a relevant certificate of competency and appointed by an inspection body recognised under the Health and Safety in Employment (Pressure Equipment, Cranes, and Passenger Ropeways) Regulations 1999.)

If an unqualified person with suitable experience is used for any work then their experience needs to be well documented. Rail operators are responsible for ensuring such a person is competent for the task appointed and, if in doubt, should seek external advice (e.g. from a professional engineer) as to a person's suitability.

Extension of Time for Vehicles Under Repair / Restoration

Where crack testing of components is carried out during the overhaul or restoration of a vehicle then the time interval to next inspection can start at the date the vehicle is returned to service (either on the NRS or the operators own railway).

The internal inspection period for air reservoirs may likewise be extended with the approval of a pressure vessel inspector, who should take into consideration the conditions under which the vessel has been stored after inspection.

2 Air Reservoirs

Air reservoirs used in braking systems are exempt from the "Health and Safety in Employment (Pressure Equipment, Cranes and Passenger Ropeways) Regulations 1999 (PECPR)". Other reservoirs (eg workshop air supply) are not exempt.

However this does not remove rail operators' obligations under the Health and Safety in Employment Act to ensure that pressure vessels are safe to operate.

Guidelines to inspection procedures are laid out in AS/NZS 3788; Pressure Equipment – In-service Inspection. With reference to this standard, and after consultation with industry experts[1], the following inspection procedure is recommended.

Classification
Pressure vehicles are classified by pressure times volume. Ie PV = maximum pressure in MPa x Volume in litres (Mpa.L)

Maximum pressure is usually defined by the safety valve setting. Many steam locomotives are not fitted with safety valves and in these cases the maximum pressure is that which the steam driven compressor can deliver at maximum boiler pressure.

In general locomotive main reservoirs will exceed 150 Mpa.L. Other reservoirs (e.g. brake auxiliary reservoirs) will be less than 150 Mpa.L.

External Inspections
These are carried out as specified in Table 2.1. Inspection includes visual confirmation of condition of fittings, protective devices, protective coatings, insulation, bolting, pressure equipment identification and security of attachments, and the absence of defects, such as corrosion, leaks, bulging, signs of heat or cold, signs of cracking, e.g. at exposed welds particularly those adjacent to supports, excessive dents and integrity of supports and clamps.

Internal Inspections
These are carried out as specified in Table 2.1. Internal inspections may be executed by other than actual internal examination using non-destructive examination methods such as radiography, ultrasonic survey and acoustic emission.

Where an internal inspection is not possible, and none of the above alternatives give satisfactory results, a hydraulic pressure test may be the only alternative. (This test method is no longer favoured but may be the only option.)

Commissioning or Recommissioning Inspections
All new pressure vessels and existing vessels after repairs (excluding minor repairs) or alterations, or change of duty outside the design parameters that could affect safety, should be inspected in accordance with AS/NZS 3788, clause 4.2.

Inspections shall be carried out by a certified Pressure Vessel Inspector.

In addition a first year internal inspection (after 12 months in service), in accordance with AS/NZS 3788, clause 4.4.2, may be carried out if recommended by the Inspector for vessels larger than 150 Mpa.L

[1] SGS National Advisor

In-service Inspections

Table 2.1 Inspection Periods

Vessel Size	Inspection type	Period	Inspected by
All vessels	External	12 monthly	Rail operator appointed competent person
PV > 150 Mpa.L	External	2 yearly	Certified Pressure Vessel Inspector
	Internal	5 yearly *	Certified Pressure Vessel Inspector

* Internal inspection periods may be extended up to 12 years, with the agreement of the Inspector, where there is satisfactory evidence from several inspections that doing so does not compromise safety.

Safety Valves
Pressure relief devices should be inspected annually by a competent person to check for external damage, blockage in the outlet or discharge piping, and leak tightness of the device and fittings.

If possible the operating pressure of the device should be verified annually in-situ against a certified pressure gauge. If this is not possible the device should be removed and bench tested against a certified pressure gauge every 5 years. Where more than one device is fitted they should be tested independently.

Records
The reservoir ID, last inspection date and / or next inspection due date should be marked on the reservoir.

The vehicle maintenance records should be endorsed with the results of all inspections and test certificates.

3 Axles

Axles should be crack tested as follows.

Interval	50,000 km or 10 years	
Method	Roller bearing axles	Ultrasonic far end test
	Plain bearing axles	Ultrasonic near end and far end tests.
Performed by	Competent and experienced test operator	
Action	If the axle is cracked the wheelset must be withdrawn from service immediately.	
Records	Vehicle records to be endorsed with operator supplied certificate. If practical the last test date should be painted on the wheelset.	

4 Boilers

Boilers should be inspected in accordance with “Health and Safety in Employment (Pressure Equipment, Cranes and Passenger Ropeways) Regulations 1999 (PECPR)”, AS/NZS 3788 “Pressure Equipment – In-service Inspection” and the FRONZ Boiler Code.

All inspections must be carried out by a certified Pressure Vessel Inspector.

Records
The vehicle maintenance records should be endorsed with the results of all inspections and certificates.

5 Bogies

Bogie frames should be crack tested and inspected for corrosion as follows.

Area	All stress areas and old repairs. (Examples of areas to be tested are shown in Appendix C.)
Interval	At overhaul or first use by rail operator.
Method	Magnetic Particle Inspection (MPI) or Liquid Penetrant Test (LQI) (While a liquid penetrant test does not show sub-surface cracks it is adequate for this inspection provided the surfaces tested are free from all oil, grease and other contaminants.)
Performed by	Competent Person
Action	All cracks to be repaired before bogie is placed into service. Welding repairs must be carried out by a welder certified to one of • NZS 4711 for the positions used • NZS 1554 part 1 • AWS or ASME.
Records	Each bogie should be marked with a unique ID. Vehicle and / or bogie records to be endorsed with results of inspections and details (including photographs) of any repairs undertaken.

6 Buffers

Older buffers have been constructed by flash butt welding a cast head to a forged tail with an (optional) forged shank section in between. This type of buffer is prone to fatigue failure, especially in the area of the weld(s). (An inspection of 40 carriage buffers found 60% with cracks[2].) An example of a buffer failure is shown in Appendix B.

Flash butt welded buffers should be crack tested as follows:-

Interval	50,000 kms or 10 years. (Start at 50,000 kms and extend if no cracks found at 2 consecutive inspections.)
Method	Magnetic Particle Inspection (MPI) or Liquid Penetrant Inspection (LQI). (While a liquid penetrant test does not show sub-surface cracks it is adequate for this inspection provided the surfaces tested are free from all oil, grease and other contaminants.)
Performed by	Competent Person

[2] Taieri Gorge Railway, 2005

Recommended Test Method	• Remove buffer yoke key and withdraw buffer as far as possible outside headstock. • Remove all surface corrosion, etc. • Inspect buffer for cracks by MPI or LQI on all faces of shank. • An ultrasonic test of the flash butt weld area(s) may also be done for peace of mind.
Short Term Action	If buffer is cracked it must not be used until replaced or repaired. A suitable temporary repair method is described in Appendix B. Welding repairs must be carried out by a welder certified to one of • NZS 4711 for the positions used • NZS 1554 part 1 • AWS or ASME.
Long term Action	Replaced cracked buffers with cast versions or normalise for a minimum of 4 hours.
Records	Each buffer should be given a unique ID. Vehicle or buffer records to be endorsed with operator supplied inspection certificate plus description and welding certificate for repairs undertaken. See Appendix B for a suitable test record form.

7 Carriage Underframes

Carriage underframes should be crack tested and inspected for corrosion as follows.

Areas	As specified in Appendix A.
Interval	5 years or more frequently depending on results of previous inspections. (See Appendix A.)
Method	Visual
Performed by	Rail operator appointed competent person
Action	Repairs to be carried out as detailed in Appendix A. Welding repairs must be carried out by a welder certified to one of • NZS 4711 for the positions used • NZS 1554 part 1 • AWS or ASME.
Records	Use a suitable form to record the condition of the critical components and any repairs necessary for the carriage to remain in service This, plus details (including photographs) of any repairs undertaken, should be added to the vehicle maintenance records.

8 Locomotive Frames

Locomotive frames should be crack tested as follows.

Area	Areas with a history of problems eg horn guide openings, rivets just behind cylinder mounts (cylinders cause the frame to flex at these points), pedestal guide rivet holes on K locomotives. (In general J series underframes have a trouble free history.)
Interval	50,000 km or 10 years
Method	Magnetic Particle Inspection (MPI) or Liquid Penetrant Inspection (LQI). (While a liquid penetrant test does not show sub-surface cracks it is adequate for this inspection provided the surfaces tested are free from all oil, grease and other contaminants.)
Performed by	Competent Person
Action	Repair any cracks by an approved method. Welding repairs must be carried out by a welder certified to one of • NZS 4711 for the positions used • NZS 1554 part 1 • AWS or ASME.
Records	Vehicle records to be endorsed with test operator supplied certificate and details (including photographs) of any repairs undertaken.

Note:- Tender underframes should be inspected as for wagons or carriages.

9 Locomotive Side and Connecting Rods

Locomotive side rods should be crack tested as follows.

Interval	50,000 km or 10 years
Method	Magnetic Particle Inspection (MPI) or Liquid Penetrant Inspection (LQI). (While a liquid penetrant test does not show sub-surface cracks it is adequate for this inspection provided the surfaces tested are free from all oil, grease and other contaminants.)
Performed by	Competent Person
Action	Advice should be taken as to the practicality and method of repairing the side or connecting rod. See also B3.4.2.06 - Side And Connecting Rods for what welding repairs were permitted in NZR days on older locomotives. Side and connecting rods on J and K locomotives made from “Supertough” steel should not be welded. If repairs cannot be satisfactorily undertaken the side rod must be replaced. Welding repairs must be carried out by a welder certified to one of • NZS 4711 for the positions used • NZS 1554 part 1 • AWS or ASME.

Records	Vehicle records to be endorsed with test operator supplied certificate and details (including photographs) of any repairs undertaken.

10 Locomotive Crank Pins

Locomotive crank pins should be crack tested as follows.

Interval	50,000 km or 10 years
Method	Ultrasonic through test
Performed by	Competent and experienced test operator
Action	If the crank pin is cracked the wheelset must not be used until the crankpin is replaced.
Records	Vehicle records to be endorsed with test operator supplied certificate

11 Locomotive Wheel Spokes

Locomotive wheel spokes should be crack tested as follows.

Interval	50,000 km or 10 years
Method	Visual, Magnetic Particle Inspection (MPI) or Liquid Penetrant Inspection (LQI).
Performed by	Competent and experienced person
Action	Repair any cracks by an approved method. Welding repairs must be carried out by a welder certified to one of • NZS 4711 for the positions used • NZS 1554 part 1 AWS or ASME.
Records	Vehicle records to be endorsed with test operator supplied certificate

12 Wagon Underframes

Wagon underframes should be crack tested and inspected for corrosion as follows.

Areas	As specified in Appendix D.
Interval	5 years or more frequently depending on results of previous inspections. (See Appendix A.)
Method	Visual
Performed by	Rail operator appointed competent person

Action	Repairs to be carried out as detailed in Appendix D. Welding repairs must be carried out by a welder certified to one of • NZS 4711 for the positions used • NZS 1554 part 1 • AWS or ASME.
Records	Use a suitable form to record the condition of the critical components and any repairs necessary for the carriage to remain in service This, plus details (including photographs) of any repairs undertaken, should be added to the vehicle maintenance records.

Appendix A
Structural Inspection and Repair of Carriage Frames

Purpose
To ensure the structural integrity of carriages by inspecting for corrosion and cracking in critical areas.

Frequency
Inspections must be done at no greater than 5 year intervals. If an inspection reveals that a item, while fit for service, will deteriorate to a not-fit-for-service condition within 5 years then the inspection interval should be shortened. The revised period should be based on the best estimate of the life of the item.

Inspectors
Inspections must be done by experienced and competent persons appointed by the rail operator.

Corrosion Classification
The categories to be applied to corrosion on any of the steel components being inspected is as follows:-
Light: Indicates that corrosion up to a maximum of 25% of the original metal thickness has occurred.
Medium: Indicates that corrosion between 26% and up to a maximum of up to 50% of the original metal thickness has occurred.
Heavy: Indicates that corrosion between 51% and up to a maximum of 75% of the original metal thickness has occurred.
Severe: Indicates that corrosion of between 76% and up to 100% of the original metal thickness has occurred.

Repairs
For areas of light corrosion the carriage may be left in service and a new structural inspection date set according to the corrosion location and the duty cycle of the carriage.

Areas of medium corrosion must be dealt with within 3 months of being identified during inspection for the carriage to remain in service.

Areas of heavy or severe corrosion must be dealt with before a carriage can continue in service.

Any crack longer than 25 mm in main solebar members must be immediately repaired. Cracks in other members extending across 25% or more of any face must be immediately repaired. Other cracks should be recorded and monitored.

Any defect identified as affecting the safety of the vehicle during the structural inspection must be repaired before the carriage can return to service.

Welding repairs must be carried out by a welder certified to NZS 4711 for the positions used.

Inspections

Underframes
All areas to be inspected should first be cleaned of dirt and scale using a chipping hammer, wire brush, etc. Inspection of some areas will require removal of the bogies.

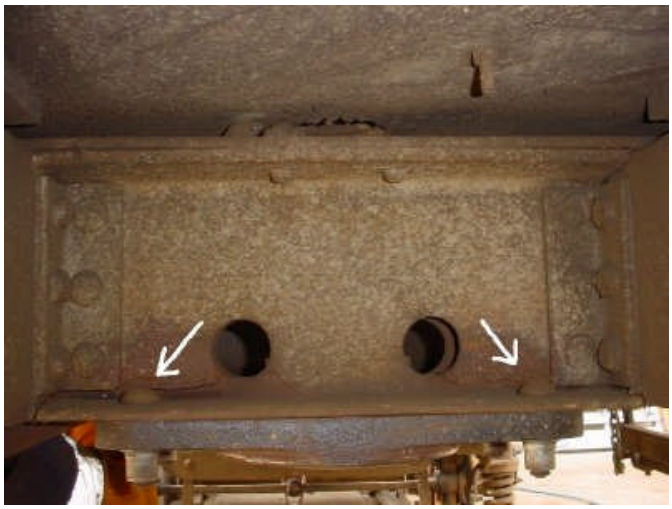
Inspect the areas listed for corrosion, cracks (usually start at a hole or rivet), cracked welds or loose rivets.

Areas that need to be inspected are (note - not all areas apply to all underframe types):-

- The inner and outer gussets welded between the solebars and the headstocks on each end of the underframe (if fitted).
- The inner and outer solebar and headstock flanges on either end of the underframe.
- The truss plate / rod to underframe interface areas
- The queen post to truss plate / rod and queen post to underframe interface areas.
- The inner transom channels and attachments to the sole bars.
- The outer transom channels / plates and attachments to the solebars.
- Float brackets and attachments to the outer transoms.
- Other transoms and the attachments to the solebars.
- Shear plate to solebar welds / rivets.
- Any place where battery boxes are or have been attached.
- Any other area of the underframe showing signs of corrosion.

See B3.1.1.01 – Mechanical Code – Clause 3.23 for the allowable limits for cracking etc of underframe members.

Truss rod corrosion should not cause more than 15% loss of strength of the member.



Cracked transom in wood carriage

Crack propagating from rivet

Corrosion of truss rod at battery box attachment

Welded replacement for a riveted transom

When repairing riveted frames the welds should be designed to take the full stress of the connection. Do not rely on the remaining rivets for strength as riveted and welded joints move differently under stress and the load will not be shared evenly.

Wrought iron components (e.g. truss rods) should not be welded.

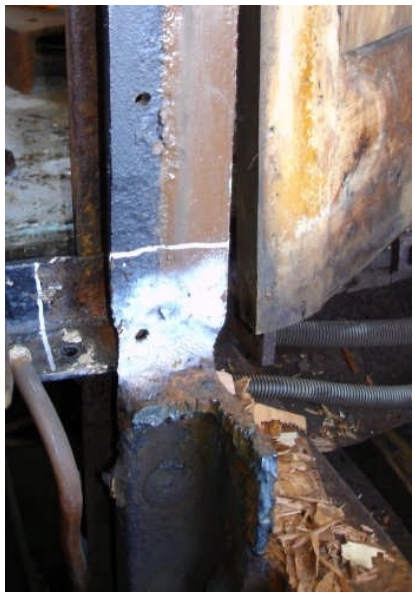
Collision ends

56 foot and 50 foot Steel Panelled Carriages

Gas cut out the threshold plates in the entrance to each vestibule end door, to expose the base of the anti collision posts (plates) and the section of shearplate between the anti collision posts. Use a chipping hammer and cleaning tools to remove dirt and corrosion from this area. Once cleaned assess the level of corrosion of the shearplate and each anti collision post and record.

If the thickness of the shearplate is in doubt either use an ultrasound thickness gauge or drill a small hole to confirm actual thickness. The ultrasound thickness gauge is to be used as the preferred method where possible. Most corrosion on the anti collision posts takes place in the first 20mm above the inner solebars.

Severely corroded shearplate and collision posts (riveted construction)



Severe corrosion at bottom of side doorpost

In a correctly built, welded, collision end the anti collision posts are welded directly to the top of the inner solebars. The shearplates are slotted to accommodate the anti collision posts and this slotted section of the shearplate is then also directly welded to the top of the inner solebars. During the inspection ensure that all these welds have been correctly carried out. A correctly sized shearplate should extend from the headstock back 600mm over the underframe ends.

For 56 ft cars the new shearplate and anti collision post thickness is 8mm.

If repairing a riveted 50 ft car collision end the above procedure can be adopted. See Appendix A1 for recommended procedure for a 50 ft carriage. New thickness is ¼ " (6 mm) and loss of more than 25% of original thickness requires replacement.

Note: when the section of threshold plate is welded back into place it pays to brace the bottom of the end door pillars to prevent distortion of the brass frame that separates them.

Door Openings
The upright channels each side of the side doors needs to be inspected at floor level where corrosion is common due to timber against the steel.

Some floor timbers may need to be removed for a good view of the steel.

Since this steel channel section is no longer available commercially, renewal of sections requires reusing good second hand channel or fabricating new sections from 12 mm flat steel.

In addition the curved angle irons that transfer the load from the side walls to the door uprights need to be inspected, especially the bottom one.

Open Platform Carriages – Shear Plates
The thickness of the shearplate should be compared with the original thickness. If the thickness of the shearplate is in doubt either use an ultrasound thickness gauge or drill a small hole to confirm actual thickness

Access to the shearplate may require removal of some platform timbers.

Open Platform Carriages - End Bracing
Some open platform 50 ft carriages have had end bracing added ("half height protection") (see plan Y7383).

These should be inspected for cracking and corrosion, particularly the attachments to the underframe and where the steel is in contact with floor timbers.

Knee Brackets
Use a chipping hammer to remove any dirt and corrosion from each knee bracket and the exposed portion of the knee bolt and nut. Also tap the hardwood packer to ensure that it is tight and not rotted.

Once the knee brackets have been cleaned assess the condition of each one, and its attachment to the solebar, and record the results. Also assess the condition of each knee bolt, nut and packer and add any comments as needed.

Note - on 56 ft cars originally the knee brackets were made of one horizontal piece of 12 x 50 flat bar. All of these should now have been upgraded to also include a support gusset on the under side.

Whilst checking the condition of the knee brackets also ensure that the spark guards are in good condition.

Carriage Sides
Remove at least 2 panels below window level off each side of the carriage to expose the studs, body brackets, body bolts, window ladder/stud brackets and window ladder bottom rails for inspection. Preference should be given to removing rusted panels or panels that do not appear to be fully sealed at either the top or sides, as this is where degradation of these components is most likely to occur. For a new vehicle or major overhaul / restoration all body panels should be removed.

Body Brackets/Bolts: These brackets are used to tie together the studs with the floor side and lateral rails. Some body brackets are also through bolted to the knee brackets, although on some locations this also may be done directly between the floor outer rail and knee bracket, by passing the body bracket. 13mm coach bolts are used to through bolt the studs and floor rails to the body brackets. Non structural wooden dust rails may also be bolted horizontally between the body brackets.

Assess the level of corrosion on the bottom portion of every body bracket when checking the condition of the knee brackets. Assess the level of corrosion of the upper portions of the exposed body brackets and body bracket bolts. Any bracket showing any more than light corrosion should have the corroded sections replaced.

Where the exposed portions of the body bracket bolts appear to be corroded or wasted either x-ray the bolts to show their true condition or remove them for a better condition assessment. Any body bracket bolt showing more than 2mm wastage on the diameter is to be replaced.

Where the exposed body brackets and bolts show levels of corrosion that require repair, further panels should be removed to ensure that other body brackets are still in serviceable condition.

Studs: Most original studs were made of Rimu. During the past some rotted studs may have been replaced with treated pine.

Stab all exposed studs in a number of places with a sharp implement to check for signs of rot or wetness. Wet studs tend to be soft, but will firm up if they can dry out and if the source of the moisture can be closed off.

Pine stud replacements have an inferior shear stress compared to the original Rimu and should therefore be replaced where more than 1 pine stud has been installed consecutively.

A carriage may remain in service with up to 10% of its studs defective, although the defective studs are not to be consecutive locations.

If more than 2 defective studs are found under the 2 panels removed for inspection, more panels should be removed to ensure that the damage is isolated.

Defective studs may be replaced with either 50 x 50 x 5 RHS or Rimu or timber of equivalent strength and resilience.

Records

Use a suitable form to record the condition of the critical components and any repairs necessary for the carriage to remain in service. A copy of the form should be kept with the carriage records.

Appendix A1
Recommended Procedure for Welded Repair to the Shearplate / Collision Posts on a 50 Ft Riveted Frame

1. Remove flooring and linings as required to access the corroded area.

2. Cut off the bottom part of the corroded collision post. It is recommended that the post is cut approximately 100mm above the floor level to ensure all corroded material is removed and to permit access for welding in new material.

3. Remove the corroded centre part of the shear plate. If the outer parts of the shear plate are also heavily corroded then they will also have to be replaced. The shear plate was manufactured from ¼" plate. Loss of thickness of up to 25% is acceptable. Any more than this requires replacement.

4. Manufacture a new partial or full shear plate from 6mm plate. Material to AS1594 grade HA250 or equivalent is required. The full shear plate on the 50' car is a plain rectangle 1829mm (6') x 610mm (2').
    - Item K on drawing X25472 is the shear plate for the 56' car. This drawing can be used to mark the position of the slots for the collision posts.
    - 32mm diameter holes aligned with the door sill drain tubes should also be cut. These should be finished clean and free from notches and should preferably be drilled.
    - A 76mm diameter hole should be cut above the yoke pin. This hole is on the car centreline and 279mm (11") back from the headstock front face. This hole should be finished clean and free from notches.

5. Weld the shear plate patch to the solebars and headstock with continuous 6mm leg length fillet welds.

6. Manufacture new bottom sections for the collision posts from 6mm plate. Material to AS1594 grade HA250 or equivalent is required. The profile is shown on drawing X25474 (items C and C1). Length should be determined to allow the piece to be fitted in to place and to provide satisfactory root gaps for welding.

7. Weld the new bottom sections to the car. Full penetration butt welds are required between the old and new sections of the collision post. 6mm leg length fillet welds all round are required between the new collision post sections and the headstock and inner solebars of the car. Also weld the slotted section of the shear plate to the solebars and headstock.

8. Weld on new lobby floor plate support bars as shown on drawing x25474 item C1 and C2.

9. Protection of the repaired steelwork with an anti corrosive paint system before closing the area in is recommended.

10. Extending the door sill drain tubes so that they terminate 10mm below the shear plate (rather than above it) is recommended as a design improvement. The tubes could be extended using a short length of rubber or plastic hose, or replaced completely with new longer pieces of 1" bore copper tube swaged into the door sills.

11. Replace the lobby floor plate, item E on X25889. Note on 56’ cars this item is chequer plate, whereas the original 50’ car specified plain plate. You may want to make this minor upgrade in the interests of safety.

12. Replace vestibule flap plate brackets (A and C on Z/X26037/2) See drawing X25889 for positioning and welding of these brackets.

Appendix B
Repair of Cracked Buffers

Example of buffer failure showing areas of no or poor weld fusion and crack propagation.

Repair Criteria

Buffers are not suitable for repairing if:-

- If any single crack runs the entire width of the section and continues down one or more sides.
- If any side has 4 or more cracks longer than 30 mm or the total number of cracks longer than 20 mm on all 4 sides exceeds 6.
- If any crack longer than 30 mm has opened more than 2mm between crack faces.
- Any crack is more than 25 mm deep after step 5 below is carried out.

Suggested Repair Procedure for Cracked Buffers

1. Give each Buffer a unique identification – record this on the buffer and report form.
2. Identify all crack defects by Magnetic Particle Inspection (MPI) or Liquid Penetrant Inspection – mark their position and extent on the buffer for crack removal
3. Record the positions and extents on the report form.
4. Determine if the Buffer is within the acceptable criteria for repair. If not, reject the buffer and record this on the report form.
5. Remove the cracks by grinding or arc-air gouging followed by grinding – a min. root radius of 5mm should be acceptable.
6. Check by inspection that the cracks are completely removed.
7. Pre-heat the entire buffer or area within 75mm surrounding the area to be repaired to 30-80^{o}C.
8. Weld the required areas using the selected welding method and filler material indicated below.
9. When welding is complete cover the buffer with an insulating blanket to allow slow cooling.
10. Inspect the weld repair area for any signs of defects after the buffer has cooled to below 40^{o}C
11. If any cracks or other defects show then repair again as from step 5.
12. When no cracks show on inspection then mark on the report form as accepted.

For Manual Metal Arc Welding: use filler to AS/NZS 1553.1: E41XX-2 or E48XX-2 (eg. CIGWELD Weldcraft or Ferrocraft 21 or 22 – or other equivalents) – follow manufacturer's requirements for power settings.

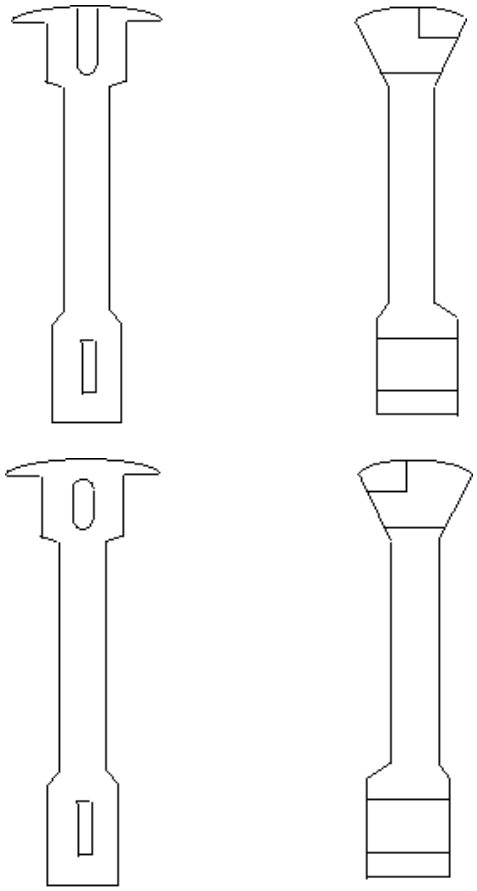
For Gas Metal Arc Welding (MIG): use filler to AS/NZS 2717.1: ES2-GC/M-W503AH (eg. CIGWELD Autocraft Super Steel – or other equivalents) – follow manufacturer's requirements for power settings and gas usage.

Normalising
It is recommended that any repaired buffers be replaced within 5 years. However if it is intended to retain a repaired buffer in service for any length of time then it should be normalised for a minimum of 4 hours to remove any work hardening that may have occurred during the life of the buffer.

Records
Each buffer should be given a unique identification number and the inspection / repair details recorded on an individual form.

Sample Buffer Inspection Record

Initial MPI Crack Positions **Buffer ID #:** _____



	YES	NO	Accepted / Rejected By	Date
Accepted for Repair:	☐	☐	_____	_____
Repair Passed MPI:	☐	☐	_____	_____
Placed into Service:	☐	☐	_____	_____

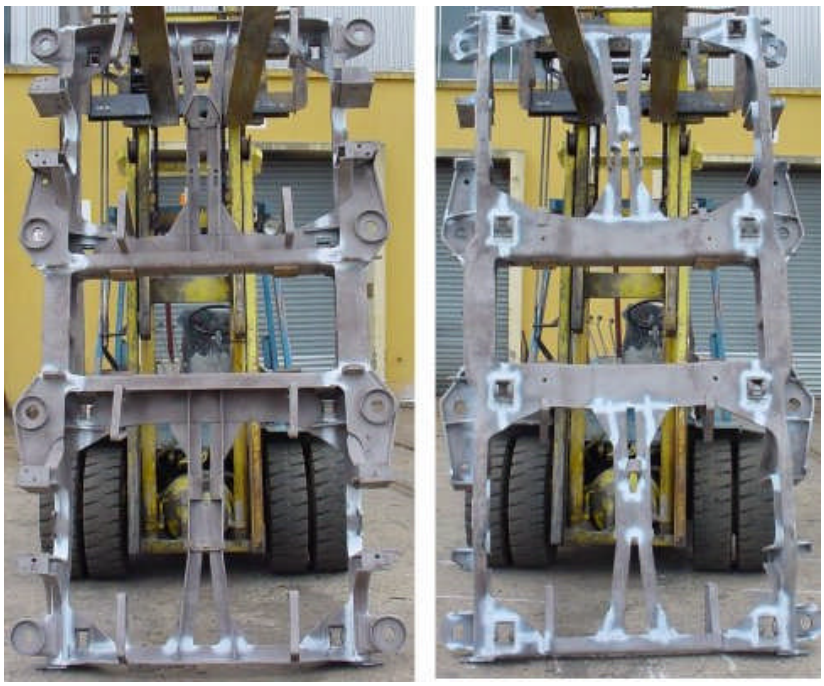
Notes on Repair:

Appendix C
Bogie Crack Testing

The photographs below show the areas (in white) on welded bogies that need to be crack tested.

These include

- All welds
- Horn openings
- Brake rigging suspension fittings
- Old repairs



25330 Bogie – Typical frame test areas

25330 Bogie - Bolster & spring cradle test areas

Typical repair to crack in horn opening

Other areas to test

- Bolster cradle swing links.
- All riveted joints (visual inspection)

Appendix D
Structural Inspection and Repair of Wagon Frames

Purpose
To ensure the structural integrity of wagons by inspecting for corrosion and cracking in critical areas.

Frequency
Inspections must be done at no greater than 5 year intervals. If an inspection reveals that a item, while fit for service, will deteriorate to a not-fit-for-service condition within 5 years then the inspection interval should be shortened. The revised period should be based on the best estimate of the life of the item.

Inspectors
Inspections must be done by experienced and competent persons appointed by the rail operator.

Corrosion Classification
The categories to be applied to corrosion on any of the steel components being inspected is as follows:-
Light: Indicates that corrosion up to a maximum of 25% of the original metal thickness has occurred.
Medium: Indicates that corrosion between 26% and up to a maximum of up to 50% of the original metal thickness has occurred.
Heavy: Indicates that corrosion between 51% and up to a maximum of 75% of the original metal thickness has occurred.
Severe: Indicates that corrosion of between 76% and up to 100% of the original metal thickness has occurred.

Repairs
For areas of light corrosion the wagon may be left in service and a new structural inspection date set according to the corrosion location and the duty cycle of the wagon.

Areas of medium corrosion must be dealt with within 3 months of being identified during inspection for the wagon to remain in service.

Areas of heavy or severe corrosion must be dealt with before a wagon can continue in service.

Any crack longer than 25 mm in main solebar members must be immediately repaired. Cracks in other members extending across 25% or more of any face must be immediately repaired. Other cracks should be recorded and monitored.

Any defect identified as affecting the safety of the vehicle during the structural inspection must be repaired before the wagon can return to service.

Welding repairs must be carried out by a welder certified to NZS 4711 for the positions used.

Inspections

Underframes
All areas to be inspected should first be cleaned of dirt and scale using a chipping hammer, wire brush, etc. Inspection of some areas may require removal of the bogies.

Inspect the areas listed for corrosion, cracks (usually start at a hole or rivet), cracked welds or loose rivets.

Areas that need to be inspected are (note - not all areas apply to all underframe types):-

- The inner and outer solebar and headstock flanges on either end of the underframe, including any gusset plates
- The truss plate to underframe interface areas
- The queen post to truss plate and queen post to underframe interface areas.
- The inner transom channels and attachments to the sole bars.
- The outer transom channels / plates and attachments to the solebars.
- Float brackets and attachments to the outer transoms.
- Other transoms and the attachments to the solebars.
- Deck to truss plate angle braces (both ends).
- Container twistlocks, stanchion pockets, end board attachments.
- Tank attachments.
- Any other area of the underframe showing signs of corrosion.