Stressing Plain Line CWR

ETM-06-10

Applicability

ARTC Network Wide SMS

Publication Requirement

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Primary Source

ETW-01-05

Document Status

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Amendment Record

Amendment Version #	Date Reviewed	Clause	Description of Amendment
1.0	05 Mar 21	All	Document renumbered from ETW-01-05, reclassified as procedure and document owner updated.
		3.2	Statement regarding pulling through reverse curves reworded.

Table of Contents

1 Introduction

1.1 Purpose

This procedure describes the process for stressing continuously welded rail (CWR).

This procedure is mandatory and shall be complied with by ARTC, alliance partners and contractors if applicable.

1.2 Scope

This Procedure specifies the procedure for stressing CWR with a tensor, when rail temperature is below design Stress Free Temperature (SFT). It applies to:

- Stressing CWR on tangent and curved track, directly on the sleepers;
- Stressing CWR on tangent and curved track, with the rail fully suspended using rollers under the head of the rail;
- Stressing when rail temperature approaches design SFT;
- Stressing adjacent to points and crossings and other fixed points;
- Stressing adjacent to transom deck bridges;
- Stressing in tunnels; and
- Removal of rail defects, and short rail closure installation.

The Procedure does not cover:

- Stressing using rail heaters;
- Stressing at design SFT or "natural destressing", which is not permitted on ARTC network; and
- Stressing with rollers under the rail foot. This practice has been discontinued due to the associated WHS risks. We now use rollers under the head rather than rollers under the foot.

1.3 Risks Controlled

This procedure is a control for the risk of potential track buckling, track misalignment and rail breakage by controlling the compressive and expansive forces in track caused by rail temperature variation.

1.4 Responsibilities

The General Manager, Technical Standards is the owner of this document. Queries should be directed to standards@artc.com.au in the first instance.

The Corridor Manager (or equivalent) is responsible for the implementation of this Procedure.

The Person in Charge of the Stressing (PICS) is responsible for managing the process and ensuring that all necessary reports are completed.

1.5 Reference Documents

The following documents support this procedure:

- ARTC Track and Civil Code of Practice: Section 1: Rail
- ARTC Track & Civil Code of Practice Section 6 – Track Lateral Stability
- ETM-06-08 Managing Track Stability
- ETE-00-01 Calibration of Track Inspection and Testing Equipment
- ETE-01-03 Non-Destructive Testing of Rail (for Internal and Surface Defects)
- ETM-01-01 Rail Weld Geometry Standard
- ETM0610F-01 Stressing Record Form
- RAP 5391 Weekly Return – Aluminothermic Welding / Adjustment Form

Note: ETM0610F-01 may be substituted by a business unit approved digital form that is linked to Ellipse.

1.6 Definitions

The following terms and acronyms are used within this document:

Term or acronym	Description
ARTC	Australian Rail Track Corporation Ltd.
Anchor length	The lengths of CWR track beyond the ends of the stressing length, which are left clipped down and are monitored during stressing, to manage any rail movements that occur at the outer ends of the stressing length. Refer to Figure 1.
Anchor point	The interface location between the stressing length and the anchor length. The anchor point sleeper is the first sleeper fully fastened in the anchor length.
Ambient	Air temperature i.e. NOT rail temperature
Compression	The compressive (squeezing) force generated in CWR when rail temperature increases above the SFT, and the rail cannot expand.
CWR (Continuously Welded Rail)	Rail lengths welded end to end into strings greater than 400m without rail joints.
Double (box) anchor	Anchors are applied to both sides of a sleeper on each rail.
Extension gap	The amount by which the rail in a stressing length and at a particular rail temperature must be extended with a tensor to be stress free at the design SFT.
Fixed point	A section of track, such as through a turnout or road crossing, which offers greater resistance to longitudinal rail movement than plain track.
Free weld	A weld formed without the use of a tensor, and without stressing the rail.

Term or acronym	Description
Person in Charge of Stressing (PICS)	All stressing work shall be under the direction of a Person in Charge of Stressing (PICS) who will plan and supervise the rail stressing work.
Personal protective equipment	Personal Protective Equipment (PPE) refers to specialized clothing or equipment worn by employees for protection against health and safety hazards.
Pulling length	The distance from the pulling point to the anchor point.
Pulling point	The location at which the rail is to be cut for stressing, a pulling force applied by a tensor, and rail extension calculated.
“Rail out = Rail in” process	A method of repairing rail defects or breaks in CWR by ensuring that there is no net change to the amount of rail in track. Also known as “Short Rail Installation” process.
Rail temperature	The average of temperatures recorded on the web of the rail, on the shaded side, as measured by several thermometers.
Reference mark (point)	A location where the stressing length is monitored to ensure correct extension and contraction during stressing. (Refer to Figure 1).
Relaxing the rail	The process of tensing and releasing the rail until it is in a stress-free state. Overlapping when required. Vibrating and rattling the rail by light tapping of the web can be used if no movement is observed at ¼ points.
Resilient fastenings	Fastenings which exert a toe load on the rail foot, inhibiting creep.
Safety Data Sheet	A Safety Data Sheet (SDS) is a document that provides health and safety information about products, substances or chemicals that are classified as hazardous substances or dangerous goods.
Short rail installation process	A method of repairing rail defects or breaks in CWR by ensuring that there is no net change to the amount of rail in track. Also known as “Rail out = Rail in” process.
Special location	For the purposes of this Procedure, a location which has an increased risk of track instability.
Stress free	Rail which has no axial thermal forces, it is neither in compression nor in tension.
Stress free temperature (SFT) Design SFT (DSFT)	The temperature at which the rail in CWR is stress free. If the rail were to be cut, the gap created would remain constant. It would neither close nor would it widen unless the rail temperature were to change. The SFT to which CWR is to be adjusted during stressing. On the ARTC network it is 38ºC in most cases.
Stressing	The process of adjusting CWR to the correct Stress Free Temperature.
Stressing length	The length of rail which is to undergo stressing.
Tell-tale Inner tell-tale (ITT)	A reference point located at the end of an anchor length. (Refer to Figure 1). The tell-tale inside the stressing length adjacent to the anchor point.

Term or acronym	Description
Outer tell-tale (OTT)	The tell-tale at the opposite end of the anchor length to the anchor point.
Tension	The tensile (pulling) force generated in CWR when rail temperature decreases below the SFT, and the rail cannot contract.
Tensor (or rail tensor)	Rail tensioning equipment including a hydraulic pulling device capable of physically extending or holding rails during stressing.
Weld gap	The distance between two adjacent rail ends required for the formation of an aluminothermic weld.
Work Method Statement	A Work Method Statement (WMS) is a document that: lists the types of high risk work being done; states the health and safety hazards and risks arising from that work; describes how the risks will be controlled, and describes how the risk control measures will be put in place. The work must be done in accordance with the WMS.

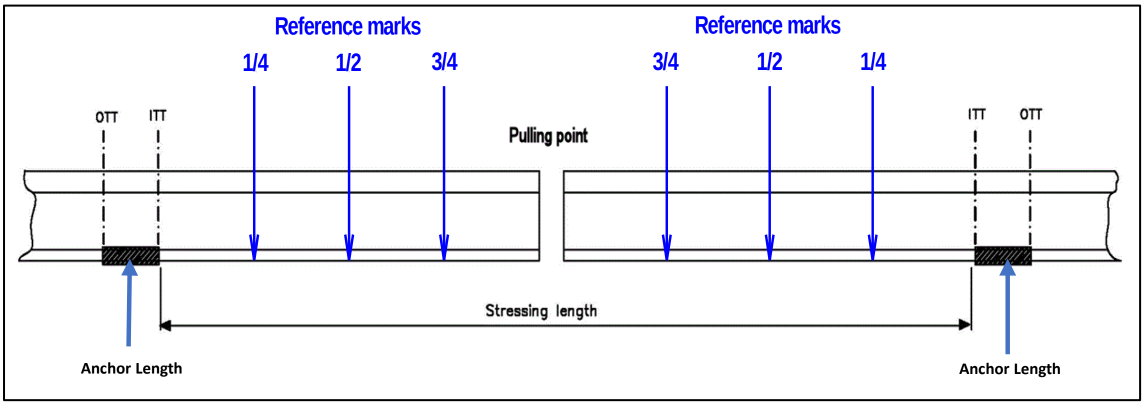


Figure 1 - Reference marks, anchor lengths, ITT and OTT

2 Pre-Work Planning (General Requirements)

2.1 Person in Charge of Stressing

All stressing work shall be under the direction of a Person in Charge of Stressing (PICS) who will plan and supervise all stressing work. The Person in Charge of Stressing shall be responsible for managing the process in accordance with this Procedure and ensuring that all necessary reports are completed.

The PICS shall have competency in this Procedure to ensure effective management of the process. The PICS shall be provided with this Procedure and hold a valid Certificate of Competence.

2.2 Safety, Quality and Environmental Planning

Prior to commencing the works, all personnel involved in the task shall be briefed on and understand the Work Method Statements (WMS). The WMS, pre-work brief and Safety Data Sheets (SDS) are to be kept on site.

All personnel shall undertake a site specific induction to be included within the daily pre-work brief for site safety, quality and site environmental issues. All personnel shall sign the pre-work brief.

All personnel shall hold appropriate certification or proof of competency. All plant and equipment shall be inspected and assessed prior to use.

A hot work permit shall be issued to the person in charge of stressing by a relevant representative of ARTC, principal contractor for ARTC or government Fire Authority. Additional permits will be required during fire season restrictions and total fire-ban days where applicable.

All personnel to abide by the ARTC Work, Health and Safety (WHS) guidelines and have access to all ARTC safety alerts and the minimum PPE requirements for the completion of hot works.

2.3 Work Site Planning

The rail stressing process is intended to be undertaken using under-head suspension rollers (refer Figure 2). The decision to undertake the stressing work using rail suspended on rollers may be dependent upon the track structure, site location geometry and the availability of rollers during track shutdown periods. Rollers are currently limited to concrete sleepers.

Where under-head suspension rollers are not an option (or not available) then rail stressing directly on the sleepers is permissible.

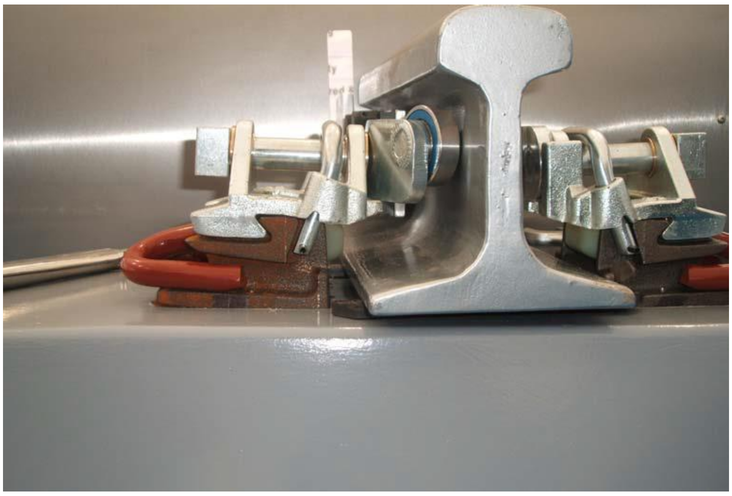


Figure 2 - Rail suspension rollers

Prior to undertaking rail stressing works, the following site planning activities must be undertaken:

- Examine the site layout for the planned stressing works. Plan location of pulling point, stress length, anchor lengths and locations for ITT, OTT, reference points and site access routes.
- Note location features including the radius of curved track, reverse curves, fixed installations, level crossings, cutting / embankment details as well as site safety requirements for steep track gradients and site access locations.
- Note the potential variation of maximum and minimum rail temperature likely to be encountered at the work location.
- During forecast hot weather periods, stressing should be planned for completion either in the early morning (before rail temperature reaches design SFT), or in the evening (when rail temperature falls below design SFT).
- Ensure track is to the appropriate operational standard and sufficiently ballasted. Excessive ballast should be cleared from the rail fastenings and rail seat area.
- Visually check the track for smooth alignment, especially on curves. Record offsets where curves have lateral alignment monuments or pegs. Track misalignments should be corrected prior to stressing.
- Identify fastening type(s) and arrange for seized (frozen) fastenings to be freed or replaced before or during the rail stressing process.
- Identify and rectify skewed sleepers, and replace worn pads, insulators and ineffective fastenings.
- Identify defective rails, defective welds or defective insulated joints and rectify where appropriate.
- Identify, plan and temporarily remove all potential obstructions to the free movement of rail (including trackside lubricators, pedestrian walkways) and rectify and straighten skewed sleepers. Reinstate removed infrastructure upon completion of the stressing process.
- Where practicable, plan the stressing works in association with other maintenance or programmed works required in the area.

2.4 Equipment Planning

The following equipment is required to undertake the rail stressing process, in addition to the normal equipment used for aluminothermic welding:

- Track tools for fastening and unfastening track;
- Under-head suspension rollers (when available). Check quantity, condition and availability.
- Welding consumables and materials.
- Fishplates and Robel clamps matched to the rail size;
- Rail Tensor with tonnage or pressure gauge;
- Lifting plate for overlapping the rail ends;
- Measuring wheel to mark out stressing lengths and anchor lengths;
- Tape measure and Gap gauge;
- Marking and scribing tools for placing reference points and Tell Tale marks;
- A minimum of three calibrated contact rail thermometers;
- A closure rail of the correct rail size to be on hand during stressing as a contingency, even if it is not expected to be required.
- Reliable communications equipment, such as hand-held radios to communicate along the length of the worksite.

2.5 Rail Tensor - Planning

Prior to using a rail tensor the following inspections shall be undertaken:

- Visually inspect the rail jaws and tie rods for faults;
- Inspect the tensor hydraulic hoses and cylinders for damage and leaks;
- Confirm availability of tonnage or pressure gauge for use as a reference only tool and check that the tensor has been tested with a current fit for use certification;
- Ensure that the tensor arms have an available secondary safety device such as safety chains or restraining straps to be securely fitted during use.
- Ensure that the maximum operating pressure of the hydraulic power pack is compatible with the tensor unit.

2.6 Stressing Temperatures - Planning

Design Stress Free Temperature

Design SFT is as per Section 6.

Measurement of Rail Temperature

Thermometers shall be calibrated in accordance with ETE-00-01 Calibration of Track Inspection and Testing Equipment. Non-contact thermometers are not permitted for use during stressing.

Rail contact thermometers are to be placed on the web of the rail on the shaded side.

A minimum of three readings must be taken for each stressing length:

- Near the pulling point; and
- Near both anchor lengths.

Additional temperature readings are to be taken where there is potential for temperatures to vary along the stressing length (within cuttings or on embankments). The average rail temperature over the stressing length shall be recorded.

The final readings used to calculate the extension shall be taken at the last possible moment before marking the reference points and undertaking the stressing calculation.

Minimum Rail Temperature

The minimum temperature at which rail can be stressed depends primarily on the proposed stressing length, and the capacity of the tensor.

As the rail temperature becomes lower:

- The force required to pull the rail becomes greater; and
- The amount of rail extension necessary to ensure correct rail movement increases.

When stressing at low temperatures, the extension and tonnage required shall be calculated to ensure the tensors have the required capacity for the maximum pulling force and maximum ram stroke required for the work. Refer to Appendix A for the calculation of the required rail extension and Appendix B for the calculation of rail tensor maximum pull tonnage.

Maximum Rail Temperature

Stressing in accordance with this procedure is not possible when rail temperature is at or above design SFT.

Varying Rail Temperatures

If design SFT is exceeded during stressing, the pulling point shall be plated and clamped or free welded, with stressing deferred until the rail temperature is lower.

If rail temperature is varying significantly during stressing, the thermometers should be monitored frequently, and the stressing calculations continually adjusted.

2.7 Stressing Through Joints - Planning

Mechanical Joints

The stressing length and anchor lengths must not contain any mechanical joints.

Glued Insulated Joints

Stressing may be carried out through glued insulated joints in good condition. It is preferable that such joints be located within, or close to, the anchor lengths, to reduce longitudinal movement and keep the joints centrally located between sleepers.

Glued insulated joints are to remain within the sleeper bay and centralised between sleepers.

3 Standard Method for Stressing

3.1 Pre-work Planning

Prior to commencing rail stressing work, confirm that the pre-work planning activities (refer to Section 2) are complete. Measure rail temperature to ensure that there are satisfactory conditions to commence the stressing process.

Refer to Appendix D for a Stressing Process Summary: Checklist for Field Use.

3.2 Establish Stressing Length and Pulling Point

The maximum permissible stressing length and the maximum pull length in one direction are provided in Table 1. The maximum stressing lengths are influenced by the use or non-use of under-head rail rollers.

The maximum length of rail stressing is also influenced by the track alignment and is proportional to the curve radius. When the curve radius changes through the stressing length, the maximum stressing length (and pull length) shall be determined by the minimum radius of the track geometry.

Alignment **(curve radius, metres)**	**Maximum Stressing Length / (pull in one direction)** **Without under-head rollers**	**Maximum Stressing Length / (pull in one direction)** **With under-head rollers**
Radius greater than 4000m and tangent track	500 (250) metres	2000 (1000) metres
Radius from 2001 to 4000m	500 (250) metres	1320 (660) metres
Radius from 1601 to 2000m	500 (250) metres	1000 (500) metres
Radius from 1201 to 1600m	330 (165) metres	800 (400) metres
Radius from 801 to 1200m	330 (165) metres	600 (300) metres
Radius from 601 to 800m	330 (165) metres	450 (225) metres
Radius from 401 to 600m	330 (165) metres	330 (165) metres
Radius less than 400m	165 (85) metres	220 (110) metres

Table 1 - Maximum stressing lengths and (pulling length in one direction)

The pulling point may be located anywhere in the stressing length, provided the maximum pulling length limits given in Table 1 are not exceeded.

Factors to be considered in establishing the stressing length and pulling point include:

- The stressing length must not exceed that permitted by Table 1;
- Rail must be free to move unimpeded along the sleepers, but with enough fastenings remaining to maintain alignment of the curve;
- The likelihood of errors in the resulting SFT is minimised when the stressing length is long;
- The pulling point must be at least 4 metres from another weld, and the closing weld located midway between two sleepers; and
- Tensor capacity (load and extension) must be adequate.

Curve stressing shall span the total length of the curve including the transition areas between the outer curve tangent points.

For reverse curves, modules may straddle the point of reversal but the pull in one direction is not to exceed the limits of one curve.

3.3 Establish Anchor Length, Tell Tales and Reference Points

Anchor Length

The minimum anchor length shall be 20m and confirmed by lack of movement at the OTT. However, the recommended minimum anchor length based on sleeper and fastenings type and condition is;

- Good condition - 40 metres and confirmed by lack of movement at the OTT
- Poor condition - 110 metres and confirmed by lack of movement at OTT

Track fastened with less than 1:2 resilient fastenings shall be Double (or box) anchored.

If there is movement at the OTT, then either increase the anchor length or replace the fastenings.

Note that the majority of ARTC main line tracks consist of concrete sleepers with resilient fastenings in good condition; such track is effectively continuously anchored.

Tell Tales Purpose & Location

Establish tell-tale marks at each end of both anchor lengths, to monitor the effectiveness of the anchor length during stressing.

A tell-tale is normally formed by using a sleeper as a monument, painting the rail foot, and accurately scribing the tell-tale on the rail foot and sleeper.

The sleeper used as a tell-tale monument must be unclipped prior to cutting the rail at the pulling point to prevent any rail movement causing the tell-tale monument sleeper to move through the ballast. There are two tell tales located at either end of each anchor length:

- Inner tell tale (ITT): the inner tell-tale sleeper is the first sleeper inside the stressing length, immediately adjacent to the anchor length. This sleeper must be unclipped, and rail foot painted and accurately scribed before cutting rail at the pulling point. The next two sleepers inside the stressing length should also be unclipped before cutting the rail.
- Outer tell tale (OTT): the outer tell-tale sleeper is the first sleeper immediately outside the anchor length. This sleeper must be unclipped, and the rail foot painted and accurately scribed before the rail is cut at the pulling point.

Alternative methods of establishing tell-tales are:

- A star dropper driven into the formation adjacent to the track with a string line used to mark the tell-tale on the rail;
- Pegs driven into the ballast adjacent to the rail and the rail marked; or
- Other approved independent method of monitoring rail movement.

Rail Movement at the ITT and OTT

Some rail movement at the inner tell-tale (ITT) is to be expected during stressing and is accounted for in the stressing process.

No rail movement at the outer tell tales (OTT's) confirm that the anchor length is effective. If there is rail movement at the outer tell-tale during the stressing process, then:

- The anchor length is not effective; and
- The anchor length must be lengthened; or
- The fastenings replaced.

Reference Marks Purpose & Location

Establish reference marks as monitoring points along the stressing length, to enable checking and confirmation of correct rail movement during stressing. The reference marks are used to ensure rail stress is evenly distributed.

Reference marks are normally established at the quarter points: ¼, ½ and ¾ locations along each pulling length (refer Figure 3). Where the pulling length is less than 55 m, only a ½ point is required.

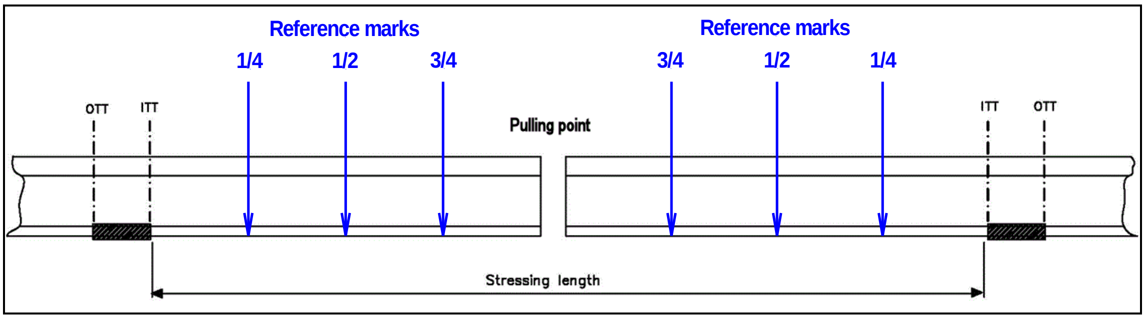


Figure 3 - Location of reference marks

Reference marks are formed in the same way as tell-tales, including unfastening the rail, but they are not scribed until later in the stressing process when the rail is fully relaxed.

Reference Punch Marks at Pulling Point

Establish reference punch marks immediately adjacent to the pulling point in order to accurately measure the amount of rail removed or added:

- Establish punch marks on the outside head of the rail to a preferable distance of 500 mm on each side of the pulling point, prior to cutting the rail;
- Note after completing stressing, accurately re-measure and record the distance between the two punch marks on the stressing site record form ETM0610F-01.

3.4 Cut Rail, Tense and Relax Rail

1 Flame cut the rail at the pulling point.

- Note: Do not use a saw for the initial cut – the rail may close up if it is in compression, causing the cutting disc to shatter. Further cuts may be saw cut or flame cut. For head hardened rail, the rail ends should be saw cut prior to welding
- Note: Do not remove fastenings before cutting the rail – the rail may pull back before the cut is complete, breaking the rail at the cut.

2 Release the fastenings over the stressing length, commencing from the pulling point and working towards the ITT on both sides. The stressing length must have all fastenings released

to allow the rail to move freely along the sleepers. This will involve the release of resilient fastenings and removing spacers whilst ensuring that rail pads are not stuck to the foot of the rail. For timber track remove rail anchors and lift the dog spikes a small amount to provide unrestrained rail movement.

Where lifting of dog spikes would be detrimental to the track for example aged timbers or timber which has previously been cross bored lifting can be avoided but ensure rail movement during the relaxing process in 7 and 8.

3 For rail stressing using under-head rollers, the rail must be lifted clear of all obstructions, placed on rollers and positioned in accordance with the manufacturer’s instructions and spaced as per Table 2.

Curve Radius R (metres)	Roller Spacing*
Radius greater than 801m and tangent track	Every 13th sleeper for 60kg/m rail. Every 10th sleeper for other rail sizes
Radius from 501 to 800m	Every 5th sleeper
Radius less than 500m	Every 3rd sleeper
* Note: decrease spacing if rail sags between rollers	

Table 2 - Spacing of rail rollers

4 For rail stressing without the use of under-head rollers, curves will require sufficient fastenings to keep the rails aligned. If on a curve with resilient fasteners, replace one clip (without spacer/insulator) on the outside of the curve every 25 sleepers, to prevent the rail from rolling in. For fast clips, use zero toe load fast clips (heated and bent up to give a few mm clearance) with the insulators removed. Similarly, for other types of fasteners, ensure zero toe load. Note that the fastening pattern may vary due to the type of sleeper, fastenings and curve radius.

5 Recheck that throughout the stressing length, the rail is free of obstructions such as protruding welds and is able to move freely.

6 Measure rail temperatures and average the thermometer readings. Calculate the amount of rail extension required being the sum of the extension gap and add movement out of the inner tell tales. Note that the extension gap can be calculated using the tables or formula in Appendix A.

7 Fit the rail tensor. tense and release the rail by the required extension, overlapping the rail at the cut point where necessary. Overlapping is necessary when rail is in compression, or when in tension but the rail temperature is close to SFT such that the gap after cutting the rail is less than the required extension. When overlapping rail use a lifting plate. The overlapped rail should only make contact at the web. The relaxation process shall be repeated a minimum of 3 times. Refer to Figures 4 – 7.

Notes:

- The extension required for the relaxation process is minimum 12mm per 100m of stressing length.
- Position the tensor rail clamps and collar centred between the sleepers to avoid sleepers being moved if the clamps do not initially grip. It is good practice to mark the

head of the rail at the clamp location to monitor if the clamps are sliding during the process.

8 Visually check the reference marks to confirm that the rail is moving freely and evenly distributed along the stressing length. Movement at the ½ reference point should be approximately half the total rail movement.

- Note: If the monitoring points do not show correct rail movement, examine the possible reasons and correct identified problems (e.g. sleepers twisted, foul weld), then continue the rail relaxation process until an even result is obtained.

9 Check there has been no rail movement past the OTT – if there has been, extend the anchor length, or strengthen with replacement fastenings, and reset the OTT.

Figure 4 - Tensor setup. Ensure that safety chains are firmly connected to tensor arms under rail foot. Remove slack from restraining chain.

Figure 5 - Insert rail lifting plate (required for overlapping rail ends)

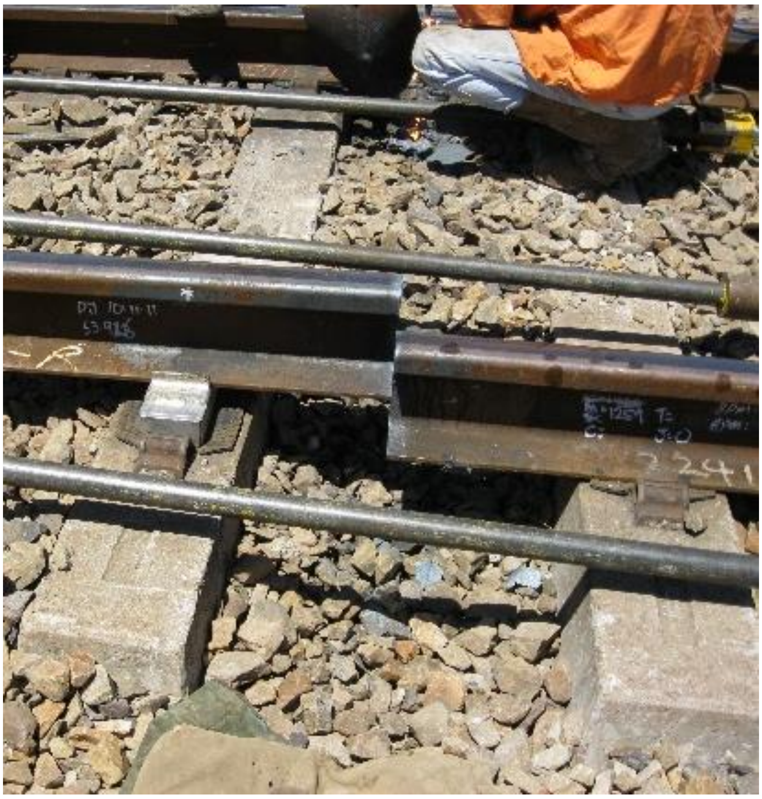


Figure 6 - Rail extension and relaxation process

Figure 7 - Overlapped rail with contact only maintained at the web

3.5 Carry out Final Tensing

1. When the rail is in the relaxed position finally mark and scribe the reference marks at the ¼, ½ and ¾ length positions. Measure and record the distance between punch marks.
2. Measure rail movement (if any) out of the stressing length at each ITT.
3. Re-measure the rail temperature.
4. Determine the extension gap using the tables or formula in Appendix A.
5. Add to the extension gap the total amount of rail movement out of the stressing length at the ITTs, plus the weld gap.
6. Trim the gap between the rails at the pulling point to this amount.
7. Tense the rail to give the required weld gap.
8. Measure any net rail movement into the stressing length at each ITT.
9. Further trim from the pulling point the additional rail movement into the stressing length, as measured at the ITTs, and further tense the rail to achieve the required weld gap.
    - Note: Amounts of less than 3mm for stressing lengths less than 300m, or 5mm for stressing lengths over 300m need not be trimmed.
    - If for any reason the weld gap is too wide after the rail is correctly tensed, a wide gap weld or a closure rail will be required.
    - Confirm there has been no movement at the OTT's.
10. Measure and record the rail movement at the ¼, ½ and 3/4 quarter reference points on the Site Stressing Record form ETM0610F-01.
    - Note: The intermediate extension at the reference marks should be within 5mm of the correct figure. Where this is not achieved, the cause should be investigated, and any identified problems corrected.

11 Measure and record the maximum pressure gauge reading on the tensor and compare to the calculated pressure reading from Appendix B. Record details on the site stressing record form ETM0610F-01 – excessive pressure may mean that rail has jammed on an obstruction.

3.6 Complete the Stress Weld Process

1 Whilst the rail is under tension, release the under-head rollers (if applicable) and lower the rail onto the sleepers.

2 Fasten down a minimum of 40 metres of rail on each side of the tensor. For track fastened with less than 1:2 resilient fastenings install double (or box) anchors for these 40 metres.

3 Commence the lining up and welding process.

4 Replace remaining fastenings. For timber track, install the remaining anchors to achieve the standard track anchor pattern and drive home all dog spikes. Cross bore sleepers if necessary.

5 Complete welding process.

6 Leave the tensor in position for at least 20 minutes after the excess weld head metal has been removed, to allow the weld to solidify and gain strength.

7 Complete the site works including all track fully fastened, the removal of the rail welding equipment, inspection of fastenings, compaction of disturbed crib/shoulder ballast, removal of all welding debris and inspection of the track for the safe passage of trains.

- Note where the track is not fully fastened or fastened using a pattern prior to the passage of trains, then the track shall be assessed by a competent person and the appropriate TSR applied. Rail movement at the reference marks shall be monitored and details recorded in the comments section on the stress form. Where the track was not fully fastened prior to the passage of trains, then the SFT of the site shall be checked in accordance with Section 7.2.

3.7 Site Records and Follow-Up Actions

1 Complete site stressing record form ETM0610F-01 containing the following information:

- Name of Person in Charge of Stressing;
- Location of stressing length;
- Rail temperature during stressing;
- Pulling lengths;
- Calculated extension;
- Movement of rail at ITT away from the pulling point when rail is relaxed;
- Required and achieved extension at each reference point;
- Pulling tonnage (gauge pressure) measured on the tensor immediately prior to welding whilst ensuring the rail is not binding along the stressing length;
- Movement at each ITT when rail is extended immediately prior to welding;
- Measurements before and after stressing at the reference punch marks;
- Additionally, also complete the weld records information.

2 Complete all additional quality management site records including:

- Weld geometry testing – refer ARTC Engineering Standard ETM-01-01 Rail Weld Geometry Standard;
- Weld ultrasonic testing – refer ARTC Engineering Standard ETE-01-03 Non-Destructive Testing of Rail (for Internal and Surface Defects);
- SFT quality check measurement - refer Section 7, SFT Quality Management and Compliance.

4 Setting Up the Next Stressing Length

4.1 General

When stressing on a face, the anchor lengths are to be reversed so that the previous anchor length is now included within the next stressing length. Overlapping stressing lengths are permitted provided the new anchor is installed before the old anchor is released.

The following procedure explains the process for stressing each side about a common anchor point.

4.2 Anchor Lengths

As shown in Figure 8, the anchor length for the next stressing length shall be located within the completed stressing length. One sleeper at the common point may be used in both anchor lengths.

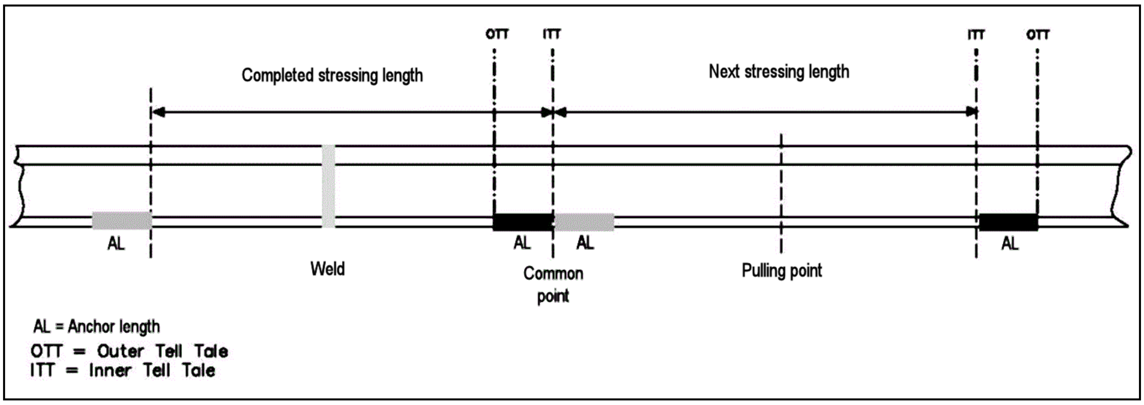


Figure 8 - Changing anchor lengths to the next stressing module

4.3 Inner Tell-tales

The ITT is within the stressing length as close as practical to the anchor point. When the rail is scribed using a sleeper as the monument it is the first sleeper inside the stressing length next to the anchor point sleeper.

When using a common anchor point sleeper, the ITT sleeper for the next stressing length becomes the sleeper the other side of the anchor point than the previous ITT.

4.4 Stressing the Next Length

The next length is stressed in accordance with the standard method.

Note that when working on a face, the stressing of both rails should proceed as concurrently as practicable. Stressing should be carried out progressively in one direction whenever possible, with a new stressing length directly abutting the completed stressing length.

5 Special Situations

5.1 When Rail Temperature Approaches Design SFT

At rail temperatures within a few degrees of design SFT, the extension gap may be too small to achieve movement at the reference marks when the rail is pulled up. In such situations, one or more of the following techniques may be implemented:

- Increase the design SFT up to 40^{0}C in the extension calculation. This will increase the required gap;
- Overlap the rail ends to achieve the required extension, with the assistance of a rail lifting plate (refer to Figures 4 – 7);
- Use a shorter stressing length (for shorter lengths the gap may be sufficient to allow the rail to be relaxed);
- Cut the weld gap prior to trial tensing instead of afterwards (refer clause 3.4), optionally in combination with a wide gap weld;
- Cut a very wide extension gap and, after trial tensing and while the rail is relaxed, cut and weld in a closure rail (not desirable due to the additional weld placed in track).

The key requirement is that the rail moves up and back at the reference marks closest to the ITTs. If this movement cannot be achieved, stressing must be delayed until the rail is cooler and a larger gap can be used to relax the rail.

5.2 Turnouts

When stressing rail adjacent to a turnout it is important to adopt the following general requirements:

1 Free weld all joints through the turnout, using closure rails where necessary to remove mechanical joints and bolt holes. Fully fasten and anchor each turnout bearer.

2 Turnout must be fully ballasted and lifted to line and level.

3 Ensure that both rails adjacent to the turnout are planned to be stressed.

4 For new turnout installation or replacement then both rails on all three sides of the turnout shall be stressed. The through road (facing and trailing roads) shall be stressed firstly as separate elements. The turnout road is to be completed last.

5 Note that the rails through the turnout are not stressed.

6 Arrange for the points interlocking to be checked and adjusted after stressing and prior to the passage of trains.

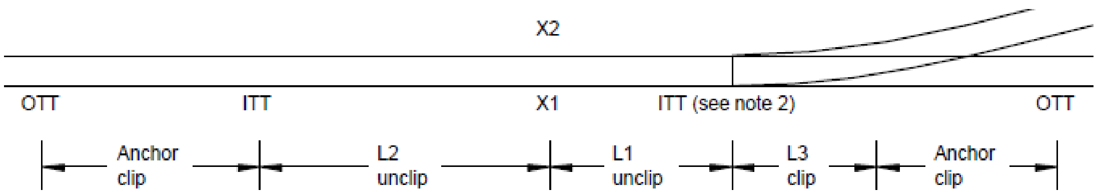
Stressing Adjacent to the Turnout Switch Toe

1 Establish the anchor length from the first plain (flat) sleeper at the front of the turnout points and extending through the turnout for the full anchor length. The sleeper in front of the blade shall remain fastened/anchored as the anchor point sleeper and is the interface location between the stressing length and the anchor length. Refer to Figure 9.

2 The ITT next to the switch toe shall be on the second plain (flat) sleeper, which shall be unclipped and is the first sleeper into the stressing length.

3 Switch toes must be maintained square and therefore both rails shall be stressed, preferably at the same time or stressed consecutively during the same work shift during a period of stable rail temperature.

4 Carry out the stressing process in accordance with the standard method including monitoring rail creep adjacent to the turnout (refer Section 3).



X1 and X2 are the rail cut and pulling points

L1 and L2 are the stressing pull lengths (total stress length)

L3 length is fully fastened through the full turnout length and forms part of the total required anchor length

OTT = Outer Tell Tale

ITT = inner Tell tale

Note 1: Anchor Point sleeper is the first plain (flat) sleeper at the front of the turnout points and remains fully fastened.

Note 2: ITT positioned at the front of the turnout points shall be on the second plain (flat) sleeper, which shall be unclipped and is the first sleeper into the stressing length.

Note 3: Switch toes must be maintained square and shall have interlocking inspected and adjusted after stressing. Ensure that anti-creep devices are maintained centred in accordance with manufacturers specifications.

Note 4: L3 length is fully fastened through the full turnout length to prevent movement of rail through the turnout. The turnout forms part of the total required anchor length.

Figure 9 - Stressing adjacent to the turnout switch toe

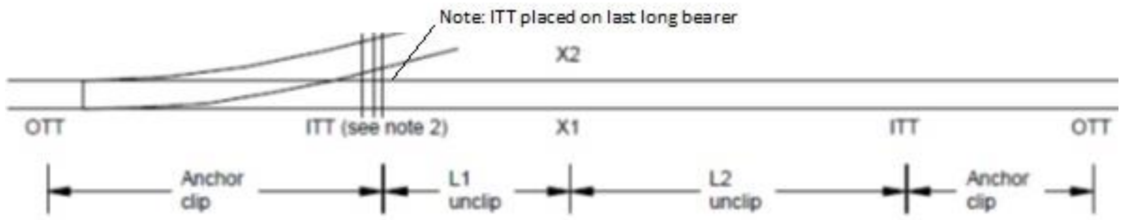
Stressing Adjacent to the Turnout Heel

1 Establish the anchor length from the second last long turnout bearer and extending through the turnout for the full anchor length. The second last long bearer shall remain fastened/anchored as the Anchor Point bearer and is the interface location between the stressing length and the anchor length. Refer to Figure 10.

2 The ITT shall be placed on the last long bearer, which shall be unclipped and is the first sleeper into the stressing length.

3 The switch heel and toes must be maintained square and therefore both rails adjacent to the turnout shall be stressed, preferably at the same time or stressed consecutively during the same work shift during a period of stable rail temperature.

4 Carry out the stressing process in accordance with the standard method including monitoring rail creep adjacent to the turnout (refer Section 3).



X1 and X2 are the rail cut and pulling points

L1 and L2 are the stressing pull lengths (total stress length)

OTT = Outer Tell Tale

ITT = inner Tell tale

Note 1: Anchor Point bearer is the second last long bearer and shall remain fully fastened.

Note 2: ITT shall be placed on the last long bearer, which shall be unclipped

Note 3: Switch heel and toes must be maintained square and shall have interlocking inspected and adjusted after stressing. Ensure that anti-creep devices are maintained centred in accordance with manufacturers specifications.

Note 4: Through road shown, same method applies to turnout road.

Figure 10 - Stressing adjacent to the turnout heel

5.3 Road Crossings

To stress up to a road crossing which is not opened out for stressing:

1. Create an anchor length through the road crossing and out beyond the other side of crossing to achieve the required anchor length.
2. Carry out stressing in accordance with the standard method (refer Section 3).
3. To then stress the other side of the crossing install the anchors on the side away from the stressing length before releasing the anchors from the previous stress.
4. To stress through a road crossing that has been opened out and the crossing surface removed, the standard method shall apply (refer Section 3).

5.4 Transom Deck Bridges

To stress up to a transom deck bridge, where the rails are anchored or fastened with full toe load clips, an anchor length is created immediately adjacent to the bridge. This anchor length is not subsequently stressed.

However, if zero toe load clips or unanchored timber transoms are used on the bridge, overlapping stressing lengths are used, with the bridge within the stressing length for both stresses. The anchor length for the first stress is one side of the bridge and for the second stress is the other side, the first anchor not being released until the second is installed.

5.5 Tunnels

Rail deep in tunnels is not exposed to the same range of temperatures as rail in open track. Expansion and contraction, and therefore compressive and tensile forces, are very small and should not lead to misalignment or broken rail conditions.

For the first 50 metres from the portals, rail inside a tunnel must be stressed in accordance with the standard method (refer Section 3).

Elsewhere within a tunnel, rail may be free welded at ambient temperature. Rail must have been inside the tunnel, and unrestrained, for at least two hours prior to welding, to enable rail temperature to adjust to ambient.

Record and note the site details of all special locations that do not meet the design SFT on the Stress Recording form ETM0610F-01. The measurement of SFT outside of the standard SFT limits shall be referred to the person responsible for asset management of the area.

5.6 Maintaining correct Rail Stress in Track Adjoining a Major Renewal or Reconditioning Works

At the interface between major renewal or reconditioning works and existing CWR track, it is important to also maintain the correct rail stress within the adjacent sections of track:

1. Stress an additional length of minimum 50 metres both sides of the major renewal or reconditioning works. Before commencement of the works install a tell tale on both sides at the end of the nominated additional length. The tell tales will become the ITTs for stressing.
2. Stress in accordance with the standard method (refer Section 3).

A major renewal or reconditioning involves any track disturbance works greater than 15m in length including long length rerailing, level crossing, track reconditioning and turnout renewal works that have potential to alter the SFT in the adjacent existing track.

6 Removal of Rail Defects and Short Rail Installation

6.1 General

At all sites that require the removal of rail / weld defects or require short rail installation, it is recommended to establish the SFT status of the track either from historical records, from any indication that the SFT of the rail may be incorrect or established using the Rail Frame or Verse as being within the range (38^0C +/- 5^0C) prior to the commencement of work.

Generally, short rail installation will comprise activities associated with the removal of rail or weld defects, repair of broken rails, insulated joint replacement or short rail replacement not exceeding 15 metres. The installation of short rail is an acceptable alternative for the preservation of the existing rail SFT, where the SFT status is known to be within the range (38^0C +/- 5^0C).

Note: The minimum length of closure rail inserted shall be 4 metres.

The short rail installation process is also known as the “rail out = rail in” process.

6.2 SFT Status - Unknown Stress Free Temperature of existing track

Where the stress history of the rail is unknown and where there is any indication that the SFT of the rail may be incorrect, then the standard stressing method shall be undertaken (refer to Section 3).

6.3 SFT Status – Known Stress Free Temperature of existing track

Where the stress history of the rail is known or where there is no indication that the SFT of the rail may be incorrect, then the following short rail installation method can be applied.

The requirements following works is that the existing SFT of the track is preserved. To achieve this, adopt the following steps:

1 Mark the location of the intended cutting points for the closure rail.

2 Establish punch marks outside of the cutting points on the field side of the rail head clear of where tensors or weld will be located.

3 Measure the distance between punch marks:

- For rail or weld defect removal accurately measure the distance between punch marks and record.
- For broken rail, accurately measure the distance between each punch mark and nearest end of the broken rail. Add these two measurements together to give the total amount of rail in track between the punch marks; this excludes the gap at the break. Record the sum of these measurements.
- The recorded amount of rail between the punch marks should also be marked on the rail.

4 Establish secondary tell-tale reference marks at least 6 metres from each end of the proposed closure rail (or weld location) to monitor for rail movement.

5 Cut and remove the defective rail.

6 Weld in the closure rail at one end.

7 After the weld has cooled for the required period, using the rail tensors re-establish the original distance between punch marks.

8 Record the pull force tonnage/pressure gauge reading (for reference only).

9 Complete final weld.

10 Measure and record the final distance between the punch marks, which should equal the original distance. A tolerance of +/- 3 mm is acceptable. The secondary tell-tale marks can also be used to gauge rail movement. The final distance should also be marked in the rail.

Note: At step 5, after cutting the rail and if the rail gap closes up (and the distance between the punch marks reduces), then the existing SFT is too low (and there is too much rail), this method must be discontinued with the repair completed using the standard method for stressing (refer Section 3).

It is recommended that the SFT of the adjacent sections of track be established using the Rail Frame or Verse and corrective stressing works undertaken until achieving an SFT within the range (38°C ± 5°C).

Each rail repair or rail replacement shall be documented by the person in charge of the welding.

The defective rail shall be marked as scrap and not fit for further use.

7 SFT Quality Management and Compliance

7.1 Introduction

This section describes the monitoring requirements, controls and corrective actions necessary to ensure that all rail stressing activities comply with ARTC Standards.

7.2 Standard Stressing Programs and Short Rail installation

Rail stressing sites and short rail installation sites over each 12-month period shall be inspected by measuring the SFT using an approved method of measurement, as follows:

- All work sites stressed when the rail temperature is recorded as being between 33°C and 38°C; and
- A further 10% of work sites selected at random, incorporating where work was performed by each PICS; and
- Quality control documentation for handover to include stress testing results; and
- Where the track was not fully fastened or fastened using a pattern prior to the passage of trains, then the SFT of the site shall be checked as detailed in Section 3.6.

Verse and Rail frame measuring techniques are the ARTC approved methods of measuring the SFT of rail. In future, other methods may become accepted and listed in the type approval register.

The acceptable limits for correct stressing are the design SFT ± 5°C (or 33°C to 43°C). Measured SFT outside these limits shall be referred to the person responsible for asset management of the area.

Appendix A: Rail Extension Gap Determination

From Table: (based on design SFT of 38ºC, rate of thermal expansion 0.0115 mm/m/ºC)

CWR EXTENSION GAP CALCULATION (mm) FOR SFT OF 38°C

Note: Destressing gap should be calculated as per equation: ***Extension [in mm] = [38 - Rail Temperature in °C] x 0.0115 x Rail Length in metres .***

This table should only be used as an approximate double check.

Destressing Length [metres] of free rail.

Rail Temperature [oC]	50	100	110	150	165	200	220	250	300	350	400	450	500	600	700	800	900
0	22	44	48	66	72	87	96	109	131	153	175	197	219	262	306	350	393
1	21	43	47	64	70	85	94	106	128	149	170	191	213	255	298	340	383
2	21	41	46	62	68	83	91	104	124	145	166	186	207	248	290	331	373
3	20	40	44	60	66	81	89	101	121	141	161	181	201	242	282	322	362
4	20	39	43	59	65	78	86	98	117	137	156	176	196	235	274	313	352
5	19	38	42	57	63	76	83	95	114	133	152	171	190	228	266	304	342
6	18	37	40	55	61	74	81	92	110	129	147	166	184	221	258	294	331
7	18	36	39	53	59	71	78	89	107	125	143	160	178	214	250	285	321
8	17	35	38	52	57	69	76	86	104	121	138	155	173	207	242	276	311
9	17	33	37	50	55	67	73	83	100	117	133	150	167	200	233	267	300
10	16	32	35	48	53	64	71	81	97	113	129	145	161	193	225	258	290
11	16	31	34	47	51	62	68	78	93	109	124	140	155	186	217	248	279
12	15	30	33	45	49	60	66	75	90	105	120	135	150	179	209	239	269
13	14	29	32	43	47	58	63	72	86	101	115	129	144	173	201	230	259
14	14	28	30	41	46	55	61	69	83	97	110	124	138	166	193	221	248
15	13	26	29	40	44	53	58	66	79	93	106	119	132	159	185	212	238
16	13	25	28	38	42	51	56	63	76	89	101	114	127	152	177	202	228
17	12	24	27	36	40	48	53	60	72	85	97	109	121	145	169	193	217
18	12	23	25	35	38	46	51	58	69	81	92	104	115	138	161	184	207
19	11	22	24	33	36	44	48	55	66	76	87	98	109	131	153	175	197
20	10	21	23	31	34	41	46	52	62	72	83	93	104	124	145	166	186
22	9	18	20	28	30	37	40	46	55	64	74	83	92	110	129	147	166
23	9	17	19	26	28	35	38	43	52	60	69	78	86	104	121	138	155
24	8	16	18	24	27	32	35	40	48	56	64	72	81	97	113	129	145
25	7	15	16	22	25	30	33	37	45	52	60	67	75	90	105	120	135
26	7	14	15	21	23	28	30	35	41	48	55	62	69	83	97	110	124
27	6	13	14	19	21	25	28	32	38	44	51	57	63	76	89	101	114
28	6	12	13	17	19	23	25	29	35	40	46	52	58	69	81	92	104
29	5	10	11	16	17	21	23	26	31	36	41	47	52	62	72	83	93
30	5	9	10	14	15	18	20	23	28	32	37	41	46	55	64	74	83
31	4	8	9	12	13	16	18	20	24	28	32	36	40	48	56	64	72
32	3	7	8	10	11	14	15	17	21	24	28	31	35	41	48	55	62
33	3	6	6	9	9	12	13	14	17	20	23	26	29	35	40	46	52
34	2	5	5	7	8	9	10	12	14	16	18	21	23	28	32	37	41
35	2	3	4	5	6	7	8	9	10	12	14	16	17	21	24	28	31
36	1	2	3	3	4	5	5	6	7	8	9	10	12	14	16	18	21
37	1	1	1	2	2	2	3	3	3	4	5	5	6	7	8	9	10
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix B: Rail Tensor Pull Force Chart (70 Tonne Permaquip Tensor)

Rail Tensor Pull Force Chart

Relationship between rail temperature difference, rail weight, pull force and tensor gauge pressure reading

The Appendix shows the relationship between temperature difference, pull force and tensor gauge pressure reading for each rail section. The maximum pull to be applied shall not exceed 60 tonnes which is 10 tonnes less than the maximum capacity of the tensor unit (70T Permaquip).

Tensor pull force (tonnes) = rail weight per yard (lbs) x (38 -T) x 0.01543
Tensor pull force (tonnes) = rail weight per metre (kg) x (38 -T) x 0.03111

Pressure reading (lb/sq.in) = 110 x Tensor pull force (tonnes) for 70Tonne Permaquip Tensor

Rail Size kg/m (nominal)	41		47		50		53		60	
	40.8	kg/m AS rail	47.0	kg/mAS rail	50.6	kg/m AS rail	53.0	kg/m AS rail	60.6	kg/m AS rail
Rail Temperature C	Pull force (tonnes)	Pressure (lb/sq in)	Pull force (tonnes)	Pressure (lb/sq in)	Pull force (tonnes)	Pressure (lb/sq in)	Pull force (tonnes)	Pressure (lb/sq in)	Pull force (tonnes)	Pressure (lb/sq in)
0	48	5305	56	6111	60	6579	63	6891	72	7879
1	47	5165	54	5950	58	6406	61	6710	70	7672
2	46	5026	53	5789	57	6233	59	6528	68	7465
3	44	4886	51	5629	55	6060	58	6347	66	7257
4	43	4746	50	5468	54	5887	56	6166	64	7050
5	42	4607	48	5307	52	5713	54	5984	62	6843
6	41	4467	47	5146	50	5540	53	5803	60	6635
7	39	4328	45	4985	49	5367	51	5622	58	6428
8	38	4188	44	4824	47	5194	49	5440	57	6220
9	37	4048	42	4664	46	5021	48	5259	55	6013
10	36	3909	41	4503	44	4848	46	5078	53	5806
11	34	3769	39	4342	42	4675	45	4896	51	5598
12	33	3630	38	4181	41	4501	43	4715	49	5391
13	32	3490	37	4020	39	4328	41	4534	47	5184
14	30	3350	35	3860	38	4155	40	4352	45	4976
15	29	3211	34	3699	36	3982	38	4171	43	4769
16	28	3071	32	3538	35	3809	36	3990	41	4562
17	27	2932	31	3377	33	3636	35	3808	40	4354
18	25	2792	29	3216	31	3463	33	3627	38	4147
19	24	2652	28	3055	30	3290	31	3446	36	3940
20	23	2513	26	2895	28	3116	30	3264	34	3732
21	22	2373	25	2734	27	2943	28	3083	32	3525
22	20	2234	23	2573	25	2770	26	2902	30	3318
23	19	2094	22	2412	24	2597	25	2720	28	3110
24	18	1954	20	2251	22	2424	23	2539	26	2903
25	16	1815	19	2091	20	2251	21	2357	25	2696
26	15	1675	18	1930	19	2078	20	2176	23	2488
27	14	1536	16	1769	17	1904	18	1995	21	2281
28	13	1396	15	1608	16	1731	16	1813	19	2073
29	11	1256	13	1447	14	1558	15	1632	17	1866
30	10	1117	12	1287	13	1385	13	1451	15	1659
31	9	977	10	1126	11	1212	12	1269	13	1451
32	8	838	9	965	9	1039	10	1088	11	1244
33	6	698	7	804	8	866	8	907	9	1037
34	5	558	6	643	6	693	7	725	8	829
35	4	419	4	482	5	519	5	544	6	622
36	3	279	3	322	3	346	3	363	4	415
37	1	140	1	161	2	173	2	181	2	207
38	0	0	0	0	0	0	0	0	0	0

Legend	
White:	Normal operating range of 70 Tonne Permaquip Tensor
Yellow:	Extreme caution as within 10 Tonne capacity of Permaquip Tensor
Red:	Exceeds the capacity of a 70 Tonne Permaquip Tensor
Notes:	Note the table values are based on the 70 tonne Permaquip Tensor. Other brands and types of rail tensor may require separate callibration details

Notes on Maximum Pull Tonnage

Appendix B shows the relationship between the rail temperature, pull force and tensor gauge pressure reading for common ARTC rail sizes, using a design SFT of 38^{0}C. The maximum pull to be applied shall not exceed the lesser of:

- 60 tonnes; or
- 10 tonnes less than the maximum capacity of the tensors.

Note that the table values are based on 70 Tonne Permaquip Tensor.

Other brands and types of rail tensor may require separate calibration details.

During tensioning, the rails shall be extended to the reference marks at the pulling point and the movement checked at any intermediate reference points. The force applied by the tensor shall be monitored during tensioning to confirm whether it is reasonably related to the required temperature difference. If this is not so, it is likely that uniform extension has not been achieved and the rail shall be checked for possible obstructions to free movement. The tensors shall be checked for slippage of the clamps or for defects in the tensor dial pressure gauge.

When this maximum pull is insufficient to achieve the full rail extension, the required SFT will not be obtained and it will be necessary for the CWR length to be re-stressed.

Appendix C: Stressing Process Summary – Checklist for Field Use

Refer to attached spreadsheet - Appendix C: Stressing Process Summary – Checklist for Field Use

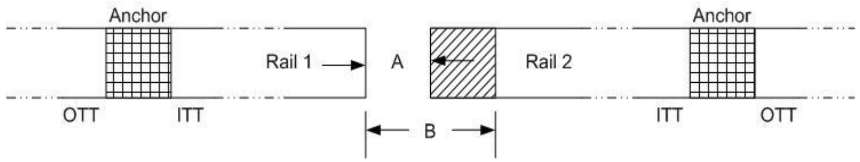
Stressing Process Summary - Checklist for Field Use

Pre-Work Planning - General Requirements	
Description	**Activity Details**
Person in Charge of Stressing	Nominated Person in Charge of Stressing (PICS) to supervise, monitor and record the stressing process
Safety, Quality and Environmental	Safety, Quality, Environmental Planning & WMS, Risk Assess, SDS, site induction, pre-work brief. Hot Work Permit, Fire Authority Permit, Team PPE
Work Site	Availability of under-head suspension rollers, size matched to sleeper and rail size, number required Plan site layout, location of pulling point, stress length, anchor length, ITT, OTT, reference points, site access routes Note curve radius, fixed points, level crossings, track standard, excessive ballast, obstructions Weather forecast, potential variation of max / min rail temp Track occupation plans & Train control notifications
Equipment	Welding equipment, consumables, rail rollers, rail lifting plate for overlapping rail Track tools for track type, fishplates, Robel clamps Rail Tensor, hydraulic power pack, tonnage/pressure gauge Measuring wheel, tape measure, gap gauge, marking and scribing tools for ITT, OTT Minimum three calibrated contact rail thermometers Closure rail contingency Reliable communications equipment, hand-held radios Other equipment required
Rail Tensor	Inspect Rail jaws, Tie rods, hydraulic hoses, cylinders for faults Tensor secondary safety device such as safety chains securely fitted Check planned extension & tonnage, ensure tensors have capacity for the maxm pulling force & maxm ram stroke
Stressing Temperatures	Design SFT is 38°C, SFT tolerance +/-5°C, 33°C to 43°C. No stressing above design SFT Minimum 3 temp readings near pulling point & both ITT's, monitor regularly

	Standard Method for Stressing
Start Up	Prior to commencing stressing, complete all pre-work planning activities. Measure rail temperature, ensure satisfactory rail temperature conditions before starting stress process
Establish Stressing Length and Pulling Point	Check the maximum stress/pull lengths are acceptable (Table 1, with/without rollers) Pulling point is minimum 4 metres from another weld, midway between two sleepers Tensor capacity (load and extension) is adequate
Establish Anchor Length Minimum	Minimum 20 metres; Recommendation based on condition of fastenings (40m for good condition and 110m for poor condition) Track fastened with less than 1:2 resilient fastenings install double (or box) anchors All anchors must confirm no movement at OTT, otherwise increase anchor length or strengthen fastenings
Establish Tell Tales **Establish Reference Marks, ¼, ½ and ¾** **Establish Rail Reference Punch Marks**	Establish ITT & OTT Tell Tales, sleeper unclipped & rail foot painted & accurately scribed before the rail is cut. The next two sleepers inside the stressing length should also be unclipped before cutting the rail Establish reference marks at ¼, ½ and ¾ locations, but DO NOT scribe until rail is relaxed Establish rail punch marks, nominal distance of 500 mm each side of the pull point, prior to cutting the rail. Measure distance
Cut Rail, Tense & Relax Rail (x3)	1. Check average temp, if OK proceed. Flame cut rail at the pulling point 2. Release fastenings; install under-head rollers at correct spacing. Without rollers on curve apply zero load clips 3. Measure average rail temperatures, then calculate rail extension = sum of the extension gap plus movement out of ITT's 4. Fit tensor & tense rail minimum 3 times by the calculated extension, overlap the rail (where necessary) then relax 5. Visually check reference marks ¼, ½, ¾ . Confirm rail moving freely & evenly distributed 6. Check for no rail movement past the OTT. Otherwise, reset OTT
Carry out Final Tensing	7. Mark & scribe reference marks ¼, ½ & ¾ positions 8. Remeasure rail temperature, recalculate Rail extension required = Extension + Weld Gap + ITT1 +ITT2 9. Trim the gap between rails & tense to Weld Gap 10. Further trim any additional rail movement into the stressing length, measured at the ITTs. Tense to weld gap 11. Measure and record the rail movement at the ¼, ½ and 3/4 quarter reference points and at ITT's 12. Measure and record the maximum pressure gauge reading on the tensor and compare to the calculated pressure reading. If excessive pressure, then check rail jam or obstruction
	13. Whilst rail under tension, release under-head rollers (if applicable), lower rail onto sleepers

Complete the Stress Weld Process	14. Fasten <u>minimum 40 metres</u> rail each side of the tensor. For track fastened with less than 1:2 resilient fastenings install double (or box) anchors for 40 metres 15. Commence the lining up and welding process and replace all remaining fastenings 16. Complete welding process but leave the tensor in position for <u>minimum 20 minutes</u>, allow weld to gain strength 17. ITT's, OTT's, reference marks and rail pop marks are to be left in track at the completion of work. The marks are to be available for confirmation of stressing and quality compliance
Complete Site Records	**Complete site stressing record form ETM0610F-01 and weld records**

Summary of Stressing Calculation



To determine required gap:

Step 1:	A = gap as first cut or placed
Step 2:	B = required total gap = weld gap + extension length (from calculations) + Inner Tell Tale ITT (Rail 1) + ITT (Rail 2)
Step 3:	Cut rail B mm from the end of Rail 1
Step 4:	Pull up rail and recheck both ITT's. Any rail pulled into the stressing length past the ITT to be measured at each anchor. The total amount ITT is to be further trimmed from the rail at the weld location.
Step 5:	Further tense to close up weld gap - weld up.

Notes:

1.	The design SFT is 38°C.
2.	For rail stressing lengths use equation: **Extension [in mm] = [38 - Rail Temperature in °C] x 0.0115 x Rail Length in metres**.

Example Calculation

Stressing Module Length: 534 metres

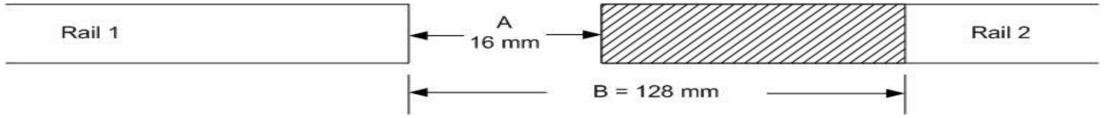
Average Rail Temperature: 22°C, ARTC SFT = 38°C

Actual Gap when rail was first cut (A) = 16 mm

Assume ITT (Rail 1) moves 2 mm and ITT (Rail 2) moves 3 mm

Extension required (E) [mm] = (38 - Rail Temperature [°C]) x 0.0115 x stressing Length [m] + movement at ITTs
= 98 mm + 3 mm + 2 mm = 103 mm

Required Gap (B) = E + Weld Gap = 103 + 25 = 128 mm



Cut Rail 2 at 128 mm from the end of Rail 1 Pull up, check ITT (Rail 1) and ITT (Rail 2). If either ITT pulls in again, trim gap accordingly Then remove rollers, and clip up starting from the pulling point