Transport Industry Guideline

Maxibinder Chain Tensioner Wear and Tear and Inspection

Issue 1 – **2 June 2022**

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1. Introduction

Where loads are restrained on vehicles using chains, the tensioners, including Maxibinders, are an essential part of achieving and maintaining the required tension in the chain. Accordingly, tensioners are safety-critical equipment in the transport industry.

Proper inspection and maintenance practices are important to ensure the tensioners are reliably capable of generating and maintaining the tensions required throughout their lifecycle.

There have been many injuries while using tensioners. The likelihood of injuries to drivers/users can be significantly reduced by inspection and maintenance of the tensioner.

This transport industry guideline (Guideline) aims to provide the industry and users with relevant, fact-based guidance regarding the inspection and maintenance of Maxibinder tensioners through their lifecycle. It can also assist businesses within the industry to comply with their legal responsibilities. See Section 2 for a discussion of legal obligations.

This Guideline focuses on the 8 mm Maxibinder chain tensioner because of the high number of this type of tensioner used in the transport industry. However, many of the systemic controls discussed would be pertinent to other transport tensioners used.

The process of developing this Guideline commenced with lifecycle testing of the 8 mm Maxibinder. The testing provided numerical life-cycle data that showed that the Maxibinder tensioner could perform reliably for the equivalent of several years, depending on the intended usage regime. However, being laboratory-based, this may not be easily transferable to on-truck life limits. The testing did provide potential failure modes and confirm several of the inspection requirements articulated in this Guideline. See the Appendix in this Guideline for some background information on the lifecycle testing performed and a summary of the results.

This Guideline should be seen as an independent guide to checking and maintaining Maxibinder tensioners through their lifecycle. It is not intended and should not be used to reduce or negate any current or future requirements advised by the manufacturer.

This Guideline should not be used as a substitute for advice from a competent certified engineer with load restraint experience.

1. Introduction

Introducing Risk Hierarchy Advice

Throughout this Guideline, industry identified risk controls are provided for consideration, including, from sections 5 to 11, Risk Hierarchy Advice tables. The structure of these tables, and how they should be read is described below.

It may be necessary to use a combination of higher and lower order risk controls to reduce the risk so far as reasonably practicable.

Uncontrolled	Lower Order Controls	Stronger Controls
Hazards remain unidentified and/or risks are essentially uncontrolled.	Lower Order Controls are used to reduce risks typically via administrative controls and personal protective equipment where higher order controls are not available or reasonably practicable. Basic administrative controls and use of personal protective equipment are susceptible to human behavior and errors and thus may be less effective than stronger controls.	Higher levels of risk that cannot be eliminated must consider the use of higher order controls. Higher order controls include substitution, isolation and engineering controls. Given inspection systems are highly administrative, the controls within an inspection system will not usually fall into the upper levels of the Hierarchy of Controls. However, where risks associated with the hazards are assessed as low, the likelihood of occurrence can be reduced by robust and managed systems including procedures, training and monitoring activities.

2. Legal Obligations

There are various legal obligations that are related to ensuring that tensioners, including Maxibinders, remain safe and capable of fulfilling their intended purpose. The advice in this Guideline is based on the obligations found in:

A. Work Health and Safety Legislation

B. Heavy Vehicle Legislation.

This Guideline does not purport to cover legislative obligations relating to other modes of transport or which exist outside Australia. This Guideline is not a substitute for legal advice and cannot be relied upon as legal advice.

A. Work Health and Safety Legislation

Under Work Health and Safety laws, all Australian jurisdictions place a general duty on employers to provide workplaces that are safe and free of risk to health, so far as is reasonably practicable. This general duty includes requirements for employers to:

a) Provide and maintain safe plant (machinery and equipment).

b) Provide and maintain safe systems of work.

c) Ensure the safe use, handling, storage and transport of plant.

d) Provide employees with the necessary information, instructions, training or supervision to work safely.

e) Implement a process of hazard identification, risk assessment, risk control and review in all systems of work.

Maintaining a safe workplace is a shared responsibility of employers and workers.

Proper inspection and maintenance of transport chain tensioners is an important safety measure.

B. Heavy Vehicle Laws

Laws relating to heavy vehicles set out the loading requirements and performance standards for load restraint, including the minimum forces that a load restraint system must be able to withstand.

Tensioners form part of the load restraint system and must therefore be capable of attaining and maintaining the forces required by the load restraint. The required forces are discussed in Section 3 of this Guideline.

3. Required Performance of the Tensioner

Required tension generating ability

The National Transport Commission (NTC) Load Restraint Guide (NTC Guide) provides guidance on how to satisfy Australian load restraint laws. The NTC Guide provides a set of tables for tie-down lashing capability. For chain lashings, there are two generic types of tensioner, each with an assumed average tension they will achieve in the lashing. The 8mm chain Maxibinder fits within the “over-centre” type. To achieve compliance with the chain tie-down restraint requirements for this tensioner type, the tensioner must be capable of generating an average tension in the lashing of 750 kg.f. To achieve this average, the tensioner will typically be required to pull more than 750 kg.f.

The tension will always be difficult for drivers/users to measure in the workplace. It is good practice to train users with a load cell that measures tension. This will provide users with a better understanding of the “feel” of a tensioner that has achieved the appropriate tension and the tensioned chain itself. See discussion in Section 10 of this Guideline.

The tensioner must be checked and maintained in a condition that allows this tension to be reliably and safely achieved by the user.

⚠ The use of handle extensions to aid in achieving tension is not advised. Handle extensions would be considered as a modification. Refer to section 7.

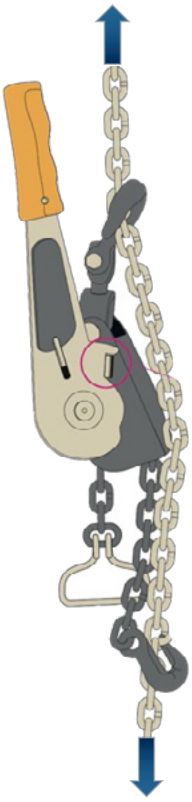
Required tensioner capacity

A tensioner must be capable of holding the full lashing capacity of the chain type it is tensioning.

Transport chain capacities can be found in the NTC Guide and the Australian Standard AS/NZS4344:2001 Motor vehicles - Cargo restraint systems - Transport chain and components.

For an 8 mm transport chain, full lashing capacity is 3.8 tonnes.

The tensioner capacity is difficult and impractical to check in service, and therefore is not included in the checks listed in section 5. The tensioner must be checked and maintained during its lifecycle to a standard where the user is confident that the unit is capable of withstanding this full chain tension capacity. Sections 5 and 6 of this Guideline respectively explain the checking and maintenance requirements. If there is any concern remaining after the checks described in section 5, the tensioner is to be removed from service.



4. Tensioner Condition Hazard Management

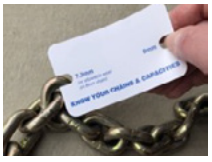
It is important to manage the hazards presented by tensioners. The table below includes important checks and maintenance activities that will help to control the hazards involved with tensioner usage.

Steps	Hazard	Controls	Reference
Apply tension	Excessive force required to generate acceptable tension. Risk of user strains and sprains.	Manage lubrication, checks and life span.	Section 5 & 6
	Insufficient tension achieved in lashings for safe and compliant restraint.	Checks of tension generated. Checks of tensioner, lubrication and life span.	Section 5 & 6
	Unexpected tension release while tensioning causing injury to the user.	Checks of tensioner.	Section 5 & 6
	Unexpected tension release in transit. Load shift/loss.	Checks of tensioner.	Section 5 & 6
	Twist in the tensioner chain prevents free chain flow and proper tensioning.	Checks of tensioner, including chain. Check swivels are rotating freely if twisting during tensioning.	Section 5 & 6
	Failure due to accidental re-use of a tensioner that was previously found faulty or non-compliant.	Segregation, disposal or destruction of tensioners that have been identified as being faulty or having potential to fail.	Section 5
General	Non-compliant tensioner. Risk of tension failure.	Check tensioner, chain and connections in particular.	Section 5, 6 & 7
	Mechanical failures or other incident types repeat due to lack of appropriate incident management.	Businesses should have an effective system to manage incidents and implement solutions. This system should be utilised to manage any incidents involving tensioners. It is recommended that the system involves operators, management, and relevant other parties such as industry safety networks, manufacturer, WorkSafe, NTC.	Section 8
	Modifications to the tensioner, adversely affects safety and/or performance of the unit.	Avoid or tightly manage modifications to the tensioner.	Section 7
	Modifications not involving the original manufacturer and designer can lead to the modifier taking on the responsibilities of the designer.	Before modifying the tensioner, check with the manufacturer.	Section 7

5. In-service Checks

Tensioner Parts and Performance to Check

In-service checks are those performed by the driver/user or other appropriately trained and competent personnel. They should include the checks listed below. See the next page for the tensioner parts terminology.

Check Type	Frequency Guidance		
	Out of Box	Each Use	Weekly*
While undertaking the below checks, ensure the tensioner is sufficiently clean for reliable service.		✓	✓
Check the handle is not significantly distorted and there are no cracks in it or its cross-members.	✓	✓	✓
Check control plate (handle pawl) slides freely within the handle.	✓	✓	✓
Check the springs easily push the control plate and body pawl deeply into the base of the ratchet teeth.	✓	✓	✓
Check swivels rotate freely.	✓	✓	✓
Check for free flow of the chain when the tensioner is put into the unlocked position.	✓	✓	✓
Check lubrication and add more if required. See Lubrication Schedule in Section 56.	✓	✓	✓
Check the tensioner chain for wear and tear, or damage/distortion of links. (Descriptions later in this section) Consider a gauge check where there is some level of visible wear. (Maximum of 10% loss in diameter, in the worst plane)		✓	✓
Check all pins, including split and s-pins are in place and appear to be in reasonable condition.		✓	✓
Check nuts, screws and bolts are present and at least tight when checked by fingers (if any are loose, finger-tight will NOT be sufficient).		✓	✓
Check that the gear pin does not exhibit excessive clearance (that allows significant lateral movement).			✓
Check that the ratchet teeth are not damaged or significantly worn.			✓

*** Weekly** - a more thorough check is recommended together with cleaning and lubrication on a weekly basis. However, the business can vary the frequency, based on a risk-based assessment of the type of service experienced by the unit. This should consider issues such as cycles of use, levels of contaminants/grime, weather conditions, etc.

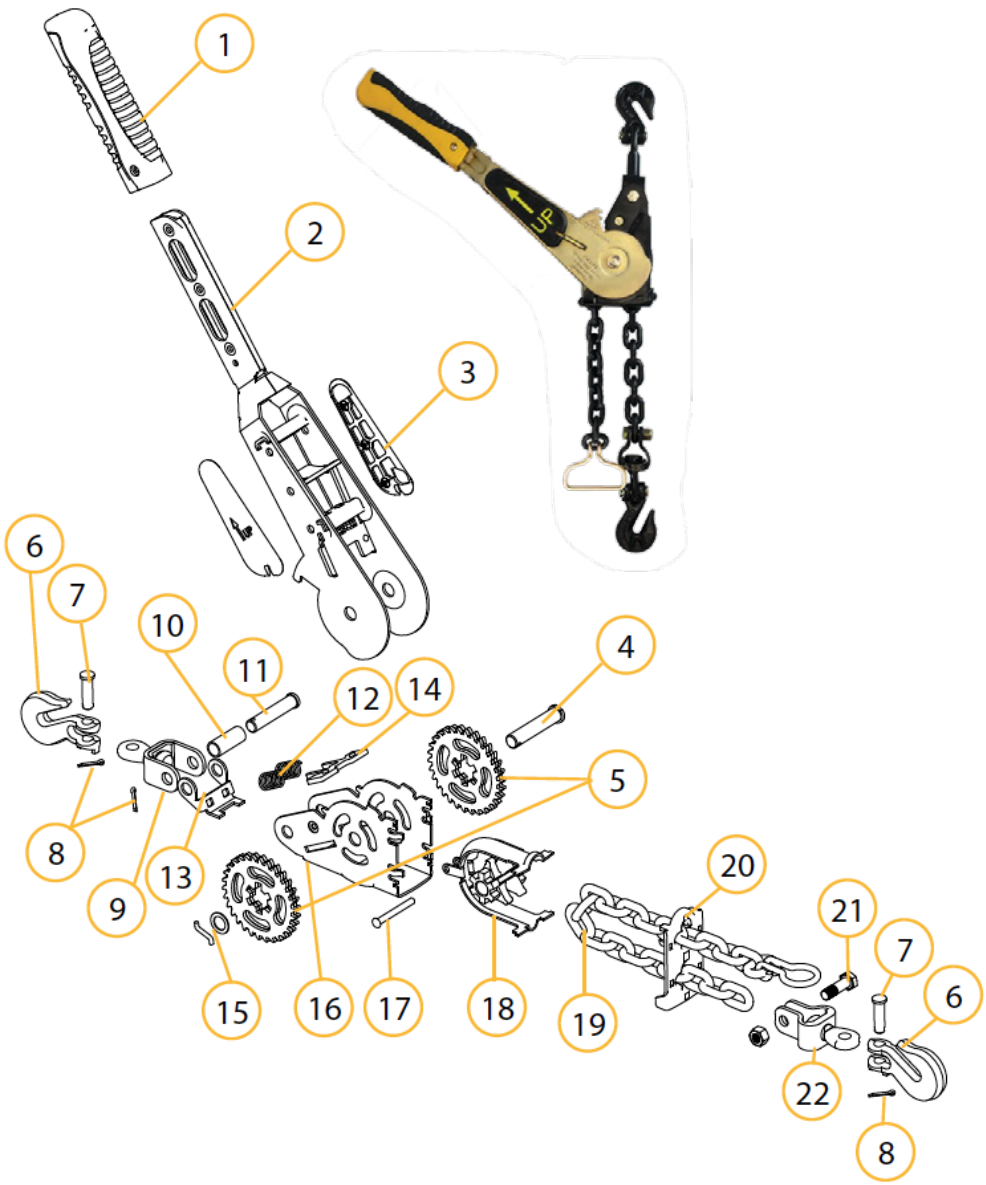
5. In-service Checks

Tensioner Parts Terminology and Layout

The figure below will aid readers to identify the parts being discussed above and in subsequent sections.

Figure 1. Annotated diagram of the Maxibinder 3.
Courtesy of Austlift

1) Moulded handle grip
2) Handle assembly
   A. Control plate (handle pawl) and springs within handle
3) Handle cover
4) Gear pin
5) Ratchet Gear x 2
6) Grab hook x 2
7) Load pin x 2
8) Split pin x 3
9) Hook swivel
10) Bush
11) Swivel pin
12) Pawl springs
13) Spring bracket
14) Pawl
(sometimes called the body pawl)
15) Gear washer and “S” pin
16) Main body
17) Body pin
18) Chain guard and chain wheel
19) Chain
20) Chain guide
21) Swivel bolt
22) Tail swivel (on chain)



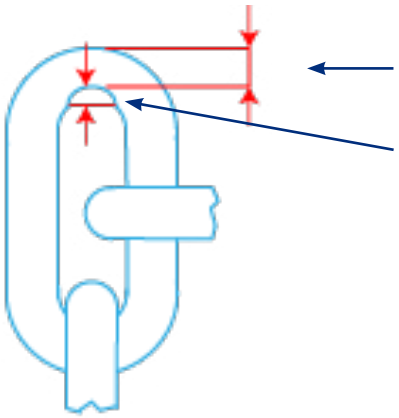
5. In-service Checks

Chain Wear and Tear Descriptions

To inspect the chain for wear and tear, there are a few defects to look for. The figures below show the main concern types. It is important to rotate the chain to check all angles and to displace the links to expose bearing surfaces.

Figure 2. Chain defect types

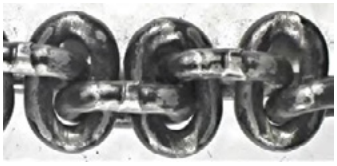
a) Chain wear at the bearing surface



Measure/check remaining cross-section

The wear is found by deducting the above from the original nominal chain diameter.

Chain wear should not exceed 10% of the nominal chain diameter, according the NTC Load Restraint Guide.

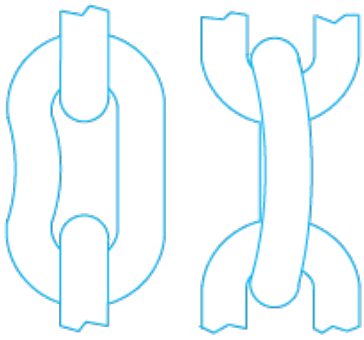


b) Twisted chain links

Check the chain for a permanent twist in any links

Replace the chain or dispose of the tensioner if the chain contains any twisted links.

c) Bent chain links



Check the chain in each plain to look for bent links.

Replace the chain or dispose of the tensioner if any link in the chain is bent.

5. In-service Checks

Steps When a Defect is Identified

When checks identify defective tensioner parts or operations, then:

- Remove the tensioner from service; OR,
- Perform minor maintenance when the situation is appropriate. See Section 6.

Removal of the Tensioner from Service

Removal of the tensioner from service should be managed in a way that prevents re-use until any defects have been remedied.

This removal of service can be achieved by:

- Permanent disposal or destruction of the tensioner; OR
- Quarantining the tensioner in a manner that prevents accidental re-use.

Ensure Ease of Replacement

Ensure there is a readily available supply of replacement tensioners in new or good condition.

Quarantining

Quarantining of defective tensioners is important to prevent re-use before further checks, maintenance, disposal or destruction have been undertaken

Quarantining can take several forms, including:

- Storage in a designated "quarantine" area; on-vehicle and/or at base; OR
- Applying a warning tag to the unit using zip-tie or other secure method.

Table 1. Risk Hierarchy Advice for In-service Checks

Uncontrolled	Lower Order Controls	Stronger Controls
Rely on drivers to: – know of and perform sufficient tensioner checks. – properly dispose of defective tensioners.	Provide instructions to drivers on the appropriate checks. Expect drivers and others to carry out such checks and to remove defective tensioners from service.	Systems are in place that ensure users/ drivers or other appropriate personnel: – check tensioner parts and performance. – do such checks at a prescribed frequency. – properly remove defective tensioners from service. – Checks should be done on every use but have a more thorough check on a weekly basis (consult table for weekly checks)
		System checks are in place to ensure the above measures are being taken.

6. Minor Maintenance

Given the cost-benefit relationship for a consumable part such as the Maxibinder tensioner, minor maintenance is usually all that can be justified. If any user or business considers more major maintenance necessary, they should consult a specialised technician or the manufacturer.

Minor maintenance should be limited to the capability of the person performing it. Recommended combinations between the person/role and the minor maintenance task are as follows:

- Driver/users who have received some basic instructions are likely to be capable of the following tasks:
- Cleaning of the tensioner.
- Lubrication is considered minor maintenance, and should be performed on a regular basis, whether there are problems with the tensioner or not. See Lubrication Schedule in this Section 6.
- Replacement of split pins.
- Technicians or business-approved persons with appropriate training and skills are recommended for the following tasks:
- Replacement of any other pins (other than the split pin) or screwed items on the Maxibinder tensioner.
- Replacing the chain.

See Figure 1 in Section 5 for identifying the parts mentioned.

Tools – maintenance should only be performed using the intended tools.

Spare parts – Only manufacturer-approved parts or those verified to be equivalent in size, strength, grade and designation should be used. Where the equivalence cannot be verified by an appropriate technician or business-approved person, the part should not be used.

Where the manufacturer advises the part must be sourced through them, this advice should be followed.

One such advice from the manufacturer is that internal tensioner chain be sourced through them. This is because the variations in chain dimensions, allowed in the standard AS4344, may not be suitable for the Maxibinder tensioner.

Refer to the manufacturer and their literature or website for further information.

6. Minor Maintenance

Cleaning & Lubrication Schedule

The unit should be cleaned using the manufacturer's recommended method (details available in the manufacturer's manual) prior to the application of lubrication.

Lubricant selection recommendations include:

- The manufacturer's recommendation current at the time of publication is for silicon-based grease spray. Check manufacturer's publications for up-to-date specification.
- Use lubricant of a type that minimises pick-up of contaminants such as road-grime.
- Use lubricant of a type compatible with rubber components.
- It is recommended that the lubrication spray system comes with an application nozzle/straw, and that this straw is used to assist with direction and penetration. Permanent nozzle/straw attachment is recommended.

Lubrication points include:

- All contact points / interfaces that have relative movement to each other.
- See Figure 3 for some recommended lubrication application points. This list does not limit the user from applying to other areas.

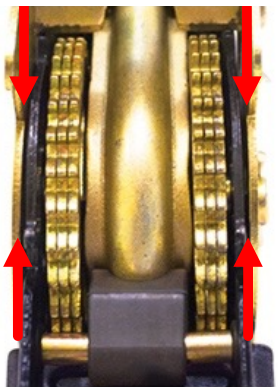
Silicone based spray is recommended by the manufacturer. Best when applied with a nozzle/straw.

Figure 3. Key lubrication points

a) Between pin and handle

b) Between pin and handle (opposite side)

c) Through chain guard towards the chain wheel



d) Between handle and body plates

6. Minor Maintenance

Amount of Lubrication to Apply:

- 3 separate spray applications are recommended for each lubrication point.
- Each spray application to last for 1 full second.
- Frequency of cleaning and lubrication:
- Lubrication is highly recommended prior to first use (out of the box).
- Whenever checks or usage indicate that lubrication is required.
- It is recommended that lubrication is applied weekly in accordance with the lubrication schedule. However, the business can vary frequency through a risk-based assessment of the type of service experienced by the unit. This will consider issues such as cycles of use, levels of contaminants/grime, weather conditions, etc.

Table 2. Risk Hierarchy Advice for Maintenance

Uncontrolled	Lower Order Controls	Stronger Controls
Rely on drivers to know what they can do to keep their tensioners operating.	Provide instructions for drivers for inspection and maintenance of tensioners.	Ensure robust systems are in place that ensure drivers and technicians: – Know when maintenance is required and do it. – Know what maintenance they are capable of and allowed to do. – Know they can simply segregate and swap, rather than perform maintenance they are not capable to perform.
If the driver feels they are competent, then they can have a go.	Instruct people on what to do and what not to do.	Ensure robust systems are in place that limit maintenance to those people capable of the task.
The drivers are left to their own devices.	Have proper tools and spares available.	Ensure robust systems are in place to make available and use only the correct tools and replacement parts.
Lubrication left to driver discretion.	Lubrication is part of tensioner checks.	Lubrication is performed to a set schedule and at extra times if required.
Leave lubricant choice to the driver.	Use the lubricant spray recommended or a business-approved alternative.	Use the lubricant spray recommended or a business-approved alternative.

7. Modification Controls

There may be occasions where there is a perceived operational need to modify a Maxibinder tensioner. This can be for many reasons, including the type of load, height of vehicle, or driver needs.

⚠ Caution - Only modifications designed or design-checked and approved by the manufacturer should be considered.

Several Australian jurisdictions impose obligations on businesses if they modify plant (including tensioners). If a business chooses to modify tensioners without approaching the manufacturer, they are advised to check these requirements.

An example of such a requirement is found in WorkSafe Victoria's Compliance Code – Plant, which states as follows:

> *"All modifications or alterations to the design of the plant or a component of plant should be undertaken by the original designer. If the manufacturer or any other person modifies the design of the plant or component of plant without that alteration or modification being designed by the original designer, that manufacturer or person will take on the duties of the designer."*

The key step when considering modifications is to check with the manufacturer directly, to seek advice.

Significant modifications can generate a requirement for full proof-testing. This can also be checked by reference to the manufacturer and to appropriate standards and compliance codes.

See examples below of modifications that have previously been approved by the manufacturer. These are historical examples and must be checked with the manufacturer for currency.

Examples of Previously Approved Modifications

The following modifications have been previously approved by the manufacturer:

- Replace chain with a different length of the same specification of transport chain, usually of a length that allows a chain to go around the vehicle lashing point.

Note - The manufacturer requires the replacement chain to be supplied through them. They require tighter as-delivered dimensional tolerances than allowed under AS4344.

- Removing the tail swivel, usually as a part of the above modification.

Further examples may be found by consulting the manufacturer or through their website.

Note that further requirements may be required of the business for any modifications, even where manufacturer approved. See below.

7. Modification Controls

Further Requirements if Modifying (even where manufacturer-approved)

If considering or committed to modification, tensioner modifications should require approval by an appropriate management level within the business, and only after ensuring the following points have been considered:

- Risk-assess the modified unit for mechanical performance and operational issues. Include controlled trials with prototypes.
- It is good practice to identify modified devices using attached plates or durable tags, and/or segregation from the standard tensioners in the fleet. This is important because their performance can differ from the original.
- (Re)training in the use of modified units may be required. For example, without training for users, the removal of the swivel can generate twists in the chain and tensioner, which can result in significantly reduced applied lashing tension and loss of compliance.
- The actual modifications should be performed by the manufacturer, approved person or a person who has been assessed and approved by the user-business as appropriately skilled.
- Fulfil any design management requirements in relevant laws and codes for the safe management of plant.

Table 3. Risk Hierarchy Advice for Managing Proposed Modifications

Uncontrolled	Lower Order Controls	Stronger Controls
Assume drivers or business sites will know not to allow uncontrolled changes.	Tell people not to modify the tensioner without checking with management first.	Ensure robust systems are in place that ensure people seek guidance from management for any tensioner modification suggestion.
	Check with and gain approval from the tensioner manufacturer prior to any modifications.	Check with and gain approval from the tensioner manufacturer prior to carrying out any modifications.
		Check relevant Codes such as WorkSafe Victoria's Compliance Code – Plant, to ensure the process is correct.
	Work with drivers to ensure the expected tensioner performance is retained.	Risk assess the potential impacts of modification on tensioner operation. Put in place controls including training in the modified unit.

8. Incident Management

Incidents or near misses involving tensioners should be managed appropriately. The proper investigation and reporting of investigations for cause, and the development and deployment of solutions are important elements in reducing future risk.

Examples of tensioner incidents include, but are not limited to:

- Sudden tension release while a user is tensioning
- Tension release that occurs through a journey
- Lashings with low tension, where this might be linked to the tensioner performance
- Injury to the user while operating the tensioner

The business should:

a) Have systems to appropriately manage incidents and near misses.

b) Ensure these systems are utilised to manage tensioner incidents and near misses.

c) Include systems for appropriate communications and cooperation with other stakeholders.

d) Assess third party incidents for relevance.

Table 4. Risk Hierarchy Advice for Managing Incidents

Uncontrolled	Lower Order Controls	Stronger Controls
Assume drivers or business sites will fix a problem with a tensioner without systemic intervention.	Ensure root causes of a tensioner incident are ascertained and remedied.	Ensure systems resolve root causes, drive solutions, and generate appropriate communications.
	Follow through with required actions.	Ensure robust systems are in place that capture incidents involving tensioners and monitor the processes.
		Best practice is to share issues through the industry.

9. Audits and Inspections

Incidents or near misses involving tensioners should be Audits and inspections are key to assisting businesses in ensuring that they keep their workers and the public safe, minimise legal risks, increase efficiency, and determine compliance with relevant laws, standards and codes.

There are two aspects of auditing relevant to tensioners. These are:

a) Auditing and inspection/checks of the tensioner condition.

b) Auditing of tensioner management systems in accordance with this Guideline (see Section 11 of this Guideline).

In this Guideline, audits will be defined as equipment or system reviews that are often prompted at regular intervals and are formally recorded. They will normally be performed by people who are not the driver/user currently in control of the tensioner.

Auditors other than drivers/users can include:

- People from the same business as the driver/user, but who are not the user or person in control of the vehicle on which the tensioners are stored.
- Drivers/users who are not currently the owner or in control of the tensioner being audited.
- People from businesses other than the business that owns/uses the tensioner. This could include others in the same supply chain, such as representatives of the prime contractor, consignor, loader and other businesses. For management system audits, this might also include businesses that specialise in auditing.

a) Audits and Inspections of Tensioner Condition

Section 5 provides the detail for driver or user checks.

Audits of tensioner condition are defined as checks that are often prompted at regular intervals and are formally recorded.

Key elements of such tensioner condition audits are:

- Audits are focussed on tensioner condition.
- At a frequency based on assessment by the business.
- When prompted by any industry or business incident involving Maxibinder or other tensioners.

Preferably performed by persons with training and competencies in the operation and inspection of Maxibinders. Skilled operators of tensioners are likely to add further rigour to such audits. (See Section 10 of this Guideline)

9. Audits and Inspections

Tensioner Parts and Performance to Check

Check		Methodology
Check for overall cleanliness while performing the checks below.	✓	Visual
Check the handle is not significantly distorted and there are no cracks in it or its cross-members.	✓	Visual
Check control plate (handle pawl) slides freely within the handle.	✓	Visual plus feel
Check the springs easily push the control plate and body pawl deeply into the base of the ratchet teeth.	✓	Visual plus feel
Check swivels rotate freely.	✓	Visual plus feel
Check for free flow of the chain when the tensioner is put into the unlocked position.	✓	Feel
Check for signs that lubrication has been applied.	✓	Visual plus feel
Check the tensioner chain for wear and tear, or damage/distortion of links. (Maximum of 10% loss in cross-section)	✓	Visual plus tool - consider a gauge to check for loss of cross-section where visible wear is noticed. 
Check all pins, including split and s-pins are in place and appear to be in reasonable condition.	✓	Visual
Check nuts, screws and bolts are present and at least tight when checked by fingers.	✓	Visual plus feel
Check that the gear pin does not exhibit excessive clearance (that allows significant lateral movement).	✓	Visual plus feel
Check that the ratchet teeth are not damaged or significantly worn.	✓	Visual

Caution: Do not release or re-tension lashings already restraining a load unless with the knowledge and permission of the user. Only experienced and competent users should release or apply tension during the audit.

9. Audits and Inspections

b) Auditing Tensioner Management Systems

Businesses should consider including auditing of tensioner management systems (see Section 11 of this Guideline) within their overall management system's auditing regime.

This audit would test the level of conformance to the elements within this Guideline.

It is likely this auditing would be performed by persons considered by the business to be skilled in management systems' audits.

It can be a focussed audit on tensioner systems or potentially a part of a larger systems audit regime.

Table 5. Risk Hierarchy Advice for Managing Audits and Inspections

Uncontrolled	Lower Order Controls	Stronger Controls
No auditing systems. Only driver equipment checks, not overseen by a business management system.	Ensure someone other than the driver/ user in control of the tensioners audit the tensioners periodically.	Ensure robust systems (such as safety/ quality management) are in place to ensure regular audits by those other than the immediate driver/user for: a) Tensioner condition and operation b) Tensioner management systems
	Some level of information collated by the business on driver checks.	
	Corrective action not necessarily escalated and documented.	The system shows that corrective action is escalated and closed out.

10. Training and Education

Training is vital for ensuring critical equipment is properly checked, used and maintained through its lifecycle.

Elements of training that need to be considered are:

a) Training for users/drivers

b) Consideration of training methods and tools

c) Training and competency for auditors

d) Training and competency for trainers.

It is recommended that businesses include these training elements and their frequency within a training register/matrix.

a) User/Driver Training

Training for user/drivers should include:

- Training is essential in the recommended checks and minor maintenance, as per Sections 5 and 6 of this Guideline.
- Training is recommended in the systems for and limits to allowable modification as per Section 7 of this Guideline.
- Users/drivers can be useful in checking the tensioners under the control of other users. Businesses should assess whether training in audit competencies would be relevant for their users/drivers.

The training should be conducted:

- **When a new employee is initially inducted into or trained in** a role where Maxibinder tensioners may be used.
- **When an existing employee changes to a role** where Maxibinder tensioners are used.
- **Refresher training** is recommended at an interval of **once every two years**, or at a frequency assessed as appropriate for the business.

b) User/Driver Training Methods

Consider methods of maximising the understanding of user/drivers of the required processes. Consider how the selected methods will assist in reducing the risks to as low as reasonably practicable. Choices available for consideration are:

- Web-based e-learning or video training
- Face-to-face training conducted by experienced/trained person
- Face-to-face training conducted by trained and competent trainer
- Face-to-face training conducted by trained and competent trainer, utilising hands-on practice.
- Face-to-face training conducted by trained and competent trainer, utilising hands-on practice and inclusion of tension/force measurement.
- Good practice is for the business to record a verification of completion. Best practice is to include verification of competency as part of the training.

10. Training and Education

c) Auditor Training

Auditor Training – Tensioner Condition

It is recommended that the business:

- Include the same user/driver training in the elements of checks and maintenance (Sections 5 and 6 of this Guideline).
- Include training in allowable modifications (Section 7 of this Guideline) where assessed as relevant.
- Consider training in any audit competencies assessed as relevant by the business.
- Consider some basic, hands-on training in the operation of the tensioner, to allow suitable and safe access to all checks.

Auditor Training – Tensioner Management Systems

It is recommended that:

- Training in audit competencies is recommended for internal auditors.
- External auditors should be selected on the basis of their competencies.

d) Training of Trainers

Training for Trainers in Checks and Maintenance

It is recommended that:

- Trainers are people who have practical experience in the use, checking and minor maintenance of Maxibinder tensioners.
- Trainers are trained in the checks, minor maintenance, and allowable modifications to the user/driver level.
- Businesses should assess the level of formal qualifications or competencies that trainers require to train others in relation to tensioner condition monitoring and maintenance: E.g.: Trainers to have training and competencies in load restraint theory and practice.

10. Training and Education

Table 6. Risk Hierarchy Advice for Managing Training and Education

Uncontrolled	Lower Order Controls	Stronger Controls
Assume drivers know how to manage tensioners and provide instructions if they don't.	Provide driver/user training without competencies or assessment.	Train driver/users, assess competencies and retrain every 2 years.
	Provide procedures to be read by the driver and others.	Utilise training methods that consider and manage the people and the risks they must manage.
	Train auditors.	Train people other than the normal users to audit the tensioners.
	Training staff are not assessed for competency or knowledge around tensioners and load restraint.	Consider the selection of trainers. Aim for a balance in training skills and important practical understanding of tensioners and load restraint theory.

11. Incorporation of Tensioners into Management Systems

Tensioners are critical equipment. Therefore, the management of tensioner condition should be incorporated into management systems for a business critical equipment.

The key steps in this task are:

- Businesses should assess this Guideline for incorporation or reference within their systems.
- While there are recommendations and options on how to satisfy this Guideline, the business should formally assess the options, and include those that reduce the risk to as low as reasonably practicable.
- Businesses are free to enhance or go further than the recommendations provided by this Guideline.

Table 7. Risk Hierarchy Advice for Use of Management Systems

Uncontrolled	Lower Order Controls	Stronger Controls
The business relies on the drivers to ensure the tensioners remain in a good condition.	Business has no suitable management system, but managers ensure critical safety issues are well controlled.	Business has management systems that incorporate tensioners.
	The business managers ensure that the hazards and controls outlined by this Guideline are understood and performed.	Incorporate the critical elements within this Guideline and the manufacturer's manuals.

12. Acknowledgements

This Guideline has been developed utilising the time, skills and experience of several people and organisations. BlueScope engaged Swinburne University to perform accelerated life-cycle testing, and it engaged Engistics to provide independent technical support and review. WorkSafe Victoria has also been consulted in the development of this Guideline.

Several other organisations and their people have shared their valuable time and experience in the development of this Guideline.

These organisations include:

- The Australian Steel Institute
- Austlift
- K&S Freighters
- Kings Group
- Rock Logistics
- Spiral Logistics
- Toll Group
- Visy Industries
- Vulcan Steel

Our thanks and recognition go to all involved.

Appendix A.
Summary of Lifecycle Testing Outcomes

In the Swinburne Research report: Lifecycle Assessment of Maxibinder Chain Tensioners, the handle force, and wear and tear were monitored through life-cycle testing. Relevant issues to arise are included in Table A1.

Table A1. An amalgamation of tables from the above referenced testing report.

Test No.	Min. Handle Force (kg.f)	Max. Handle Force (kg.f)	Tension Failure Reached	Target Cycles	Cycles Completed	Full Lashing Capacity Test	Lubrication Protocol	Cross-section at Wear (mm)	% Loss of Cross-section
1	53.32	79.75	Yes	N/A	2901	Passed every 1000 cycles	No straw	7.34	8.25
2	51.85	76.11	No	N/A	5193		Straw but short burst	7.48	6.50
3	53.96	73.85	No	N/A	5731			7.06	11.75
4	54.53	71.92	No	5000	5000		Full lubrication schedule	6.88	14.00
5	53.38	71.65	No	5000	5000			7.12	11.00
6	52.03	69.17	No	5000	5000			7.28	9.00
7	52.07	71.20	No	5000	5000			7.21	9.88
8	54.14	71.74	No	5000	5000			7.32	8.50
9	52.11	68.58	No	5000	5000			7.20	10.00
10	51.79	71.67	No	7000	7000	Passed every 2000 cycles		5.92	10.00
11	46.52	95.47	No	10000	10000			6.78	26.00
12	54.97	87.63	Yes	10000	7975			6.90	15.25
13	49.18	74.17	No	10000	10000			7.06	13.75
14	59.99	75.38	No	10000	10000			6.65	11.75
15	55.87	73.89	No	10000	10000			7.03	16.88

To put the outcomes into perspective, the target number of cycles at the end of testing was 10,000 cycles. That is equivalent to a long and industrious service life. Table A2 shows examples of frequency of application. Other numbers could be substituted for the number of applications per day, but these will suffice for a perspective on equivalent service life.

Table A2. Relating tensioning cycles to potential service life.

Application Cycles	5,000	5,000	10,000	10,000
No. of applications per day	5	10	5	10
No. of days worked in week	5	5	5	5
Time in service - WEEKS	200	100	400	200
Time in service - YEARS	4	2	8	4

Appendix A.
Summary of Lifecycle Testing Outcomes

Items relevant to the Guideline are:

1. Chain wear
2. Lubrication
3. Handle force required
4. Excessive wear of gear pin and bore hole through body

1. Chain wear

Chain wear was shown to be a significant factor for failure when the unit had undergone repeated cycles. Importantly, this is an easily checked and well understood visual measure that has been included in the checks recommended in this Guideline.

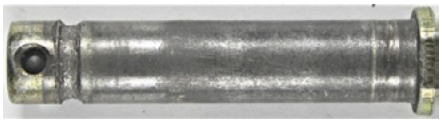
2. Lubrication schedule

The lubrication schedule was not a part of the planned variables within the testing regime. However, when initial lubrication was performed with less information on the positioning and amount of lubrication per application, the wear outcomes were more severe than for those where the lubrication schedule was improved. Therefore, the lubrication schedule has been incorporated into the Guideline.

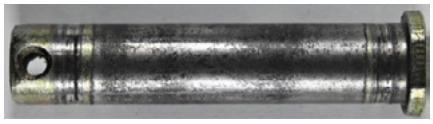
The lubricant used in testing was the lithium grease recommended by the manufacturer at the time. The manufacturer at the time of publication, recommends a silicon grease as being more compatible with rubber components.

Figure 4. Extreme wear examples during lower lubrication

Reference image - New swivel pin



Test 3 - Swivel pin with no lubrication



Test 11 – Swivel pin with lubrication

3. Handle force

The required force to operate the ratchet handle varied through the testing of each unit. No limit has been set on the required force within the Guideline, as it is extremely difficult to measure in service. However, the ease of achieving suitable chain tension is an important check for drivers/users, and the business is advised to seek and react to feedback on this aspect.

4. Wear at gear pin and body hole

The tension fails came from excessive wear at the gear pin and bore hole through the body. The actual clearances are hidden by the handle plate in operation. There has been a check included *"that the gear pin does not exhibit excessive clearance (that allows significant lateral movement)".*